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2014•2015
SCHOOL FOR TRANSPORTATION SCIENCES
Master of Transportation Sciences

Master's thesis

The role of parking in the accessibility of destinations

Supervisor :
Prof. dr. Davy JANSSENS

Syed Ali Raza
Thesis presented in fulfillment of the requirements for the degree of Master of Transportation Sciences

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KNOWLEDGE IN ACTION

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Summary

Transportation sector is a key element in the growth of a society. During the last century, rapid urbanization took place. As a result of which vehicle ownership increased. The increase in vehicle ownership led to an increase in traffic related problems like traffic congestion, traffic accidents and environmental pollution. With the increase in vehicle ownership, the demand of parking spaces also increased. Due to this various traffic problems related to parking arose. This includes the cruise traffic which is the unnecessary traffic in search for a parking space. Parking is one of the essential components of a transportation system. Problems in parking would lead to a restrain in accessibility. The aim of the transport planners is to develop a sustainable transport system. Accessibility is one of the key characteristics of the sustainable transport system. Parking is amongst one of the factors that affect accessibility. Parking plays a vital role in the accessibility of destination since it is an integral part of the transportation system.

The objective of this research is to evaluate the role of parking in the accessibility towards destination. A car journey can be divided into various stages. These stages include walk time to vehicle, in-vehicle time, parking search time and final walk time to the destination. The effect of the last part of the journey has been evaluated in this paper. By analyzing the effect of parking search time and final walk time to the destination, the role of parking in the accessibility of destination was evaluated.

In order to evaluate the role of parking in accessibility, a stated preference survey was carried out. An online questionnaire for the survey was developed. The survey consisted of three portions. In the first portion, the respondents were asked about their current behavior/opinion regarding non-daily shopping. The second portion of the survey was the choice task. In the choice task portion of the survey, respondents were given three choice situations. Each choice situation consisted of three shopping areas. The three shopping areas had certain attributes like location of the area, spatial distribution, walk time to vehicle, in-vehicle time, parking search time, final walk time to destination, parking charges and parking limits. Based on their preference, they were asked to select one shopping area for non-daily shopping. After that the respondents were asked to evaluate the accessibility of all the shopping areas presented to them. Non-daily shopping was the trip purpose used in the choice task situation since an individual can alter the decision to go to a place for shopping based on the attributes but this cannot be done for work/educational activities. The third portion of the survey inquired about the socio-economic characteristics of the respondents.

The collected data was then analyzed. The main findings of the survey pointed to the fact the main attributes influencing the evaluation of accessibility include in-vehicle time, parking search time and final walk time to the destination. This points to the fact that parking components such as parking search time and final walk time to destination are essential while evaluating the accessibility of an area. Therefore, these attributes should be taken account in future researches regarding accessibility.

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CHAPTER 1

INTRODUCTION

1.1 Background

Transportation is defined as the movement of goods and people from one place to another. The importance of the transportation sector for any country is considered to be immense since it acts as a backbone for the country. Transportation plays a great role in the development of a country. In a recent survey, it was estimated that transportation contributes almost 20% to the total gross national product (GNP) of the nation. In most of the developing countries, the contribution of transportation in the GDP is 6% to 12% [30].

Since the turn of the 20th century, rapid urbanization in most of the cities around the world took place. These cities grew at an enormous rate which led to an increase in vehicle ownership. It is expected that by the year 2020, the number of automobiles in the world would be doubled [21]. The rapid increase in vehicle ownership led to many transport related problems which included traffic congestion, traffic accident and environmental pollution [1]. The increase in vehicle ownership has also led to an increase in the demand for parking spaces particularly in the city centres. This has given rise to many traffic problems associated with parking which includes the unnecessary traffic searching for a parking space termed as "cruise traffic" [11]. This cruise traffic also hinders the movement of traffic which leads to congestion.

In order to overcome these problems, transport planners are looking forward to develop a sustainable transportation system. The characteristics of the sustainable transport system include accessibility, safety, affordability and being environmental friendly [13][31].

Traditional approaches by transport planners took into account mobility patterns of individuals for the improvement of transportation system. Mobility is referred to as the ability of an individual to move from one place to another place which is measured in terms of number of trips made the individual and person-kilometre [21]. With the passage of time, the planners have decided to shift from the more conventional approach transportation planning based on mobility to the planning based on accessibility [38].

Accessibility is defined as the ease with which a person reaches the desired destination. As compared to the mobility approach, accessibility also takes into account the ease of reaching a particular destination along with the ability to cover the distance. Accessibility is affected by many factors which include quality of dedicated lanes and pathways for non-motorized traffic, density of traffic, quality of public transport, network connectivity, quality of highways and roadways, choice of transportation mode, availability of parking facilities and land use mix [23].

Parking plays a major role in affecting the accessibility towards a destination since it is an integral part of the transportation system. Parking search time is considered to be a nuisance for the drivers. If there is an option for the drivers to choose between two alternatives to reach a particular destination, drivers would prefer the alternative having an easier access in terms of getting a parking spot.

The objective of this research is to evaluate the role of parking in the accessibility towards destination. Travel time and travel distance are of utmost importance while evaluating the accessibility towards a destination. However, this does not reflect the ease with which a destination can be reached. In this paper, it has been shown that a journey by car can be divided into several stages. The last part of the journey includes the parking search time, time required to park the vehicle and walk towards the destination. The main purpose of the paper is to evaluate the effect of the last part of the journey on the overall trip. This paper would serve as frame of reference for the transport planners, policy makers and municipalities to take into account an important factor in the assessment of accessibility towards a particular place which is parking.

1.2 Problem Statement

Transport planners utilize different approaches to improve the transportation systems. Traditional approach assumes motorized traffic to be the most essential component of the transportation system. It can be measured by car ownership, vehicle-kilometres travelled and average speeds. According to this approach, an increase in vehicle speeds and volume is desirable and a reduction in these characteristics is not desirable.

A slightly more complete methodology is to take mobility patterns into account for the improvement of the transport system. These are measured in terms of number of trips made by individuals and person-kilometres travelled. According to this approach, an increase in number of trips and person-kilometres travelled is desirable [21].

The most complete approach while evaluating a transportation system is to take into account the accessibility towards a particular destination [21]. It is termed as the ease with which an individual reaches a place of desired activity. It is considered to be the primary objective of transportation system. Transport planners could use this concept to improve the transportation system. This could be done by devising strategies that could improve the accessibility towards a destination.

Accessibility for cars could be improved by some strategies including the increase in capacity of roads and average traffic speeds. However, these strategies might affect the accessibility towards the destination while using other modes of transportation namely walking, cycling and transit. As mentioned earlier, accessibility is affected by many factors namely network connectivity, choice of transport modes, land use distribution, quality of dedicated paths for different modes of transport, cost of travel and convenience in parking [23]. This shows that accessibility analysis takes into account variety of factors while evaluating a transportation system. Therefore, it is considered to be the most comprehensive approach in the planning process to improve the transportation system.

Accessibility is different for different modes of transport. If the accessibility is measured in terms of travel time, the accessibility of a destination would be high if the travel time is lower. However, this is not the case since the ease of reaching the destination could be less despite of the lower travel time.

The different stages of a journey should be taken into account while evaluating the accessibility. If bus is used as a trip mode, accessibility is affected by walk towards the bus stop, waiting time, in-vehicle travel time, parking search time and final walk towards the destination [12][39]. If car is used as a trip mode, accessibility is affected by walk towards the car, in-vehicle travel time, parking search time and final walk towards the destination. In order to evaluate accessibility towards a destination, these factors should be taken into account as well.

Among the various factors influencing accessibility, one main factor concerns the parking facilities. Rapid urbanization and motorization around the world has led to an increase in parking demand. Parking demand is dependent upon the type of land use and the trip attraction of that particular land use.

A person using the car as a transport mode tends to park the car at the destination or a parking facility not very far from the destination. The decision of an individual to choose car as a transport mode is also dependent on the price and quality of the parking facilities at or near the destination. Route choice also depends on the parking conditions en-route to the destination. The parking facilities have a limited number of parking stalls. When a user does not get a parking spot immediately, he has to wait for a certain amount of time to get a parking spot at the destination or he will move towards a different parking facility to park the vehicle. Waiting time for a parking spot or the time required to move to a different parking facility, find a parking stall and move back towards the destination will increase the overall travel time and travel distance to reach the destination. The cars cruising in search of a parking spot not only increases the travel time and travel distance of the journey but it also leads to various problems associated with traffic which includes congestion, restraining of accessibility and environmental pollution.

Parking conditions play a major role in the accessibility towards a destination. If two possible locations to perform a similar activity have an equal total travel time, driver would always prefer to go the location where parking search time is less. Previous research takes into account the total travel time while evaluating accessibility. However, not much evidence was found when it came to evaluating accessibility on the basis of different stages of a car journey. The breakdown of different stages in a car journey would be helpful in evaluating the impacts of different stages on the total travel time.

1.3 Research Objectives and Scope

The main purpose of this paper is to provide a frame of reference with regards to the planning for accessibility to the transport planners, policy makers and municipalities.

The title of the thesis is **"The role of parking in the accessibility of destinations".** As accessibility has a number of domains, the focus for the thesis would be to evaluate the role of parking in the accessibility towards destination.

As discussed in the previous section, a car journey has a number of stages. The last part of the journey includes parking search time, park the vehicle and walk towards the destination. The main aim of this paper would be to evaluate the effect of the last part of the journey on the basis of total travel time. This would help in quantifying the role of parking in the accessibility towards destination.

1.4 Research questions

In order to begin a research project, an extensive literature review about the topic and related practices is required. Certain questions need to be answered while conducting the literature for the project. The answers of these questions would help in conducting the research. Some questions that needs answering could be as follows

1. What is the advantage of shifting from planning for mobility to planning for accessibility?
2. What are the roles of parking and accessibility on the transportation system?
3. Does parking have an effect on accessibility?
4. How to incorporate parking in the accessibility analysis?

1.5 Research methodology

A stated preference survey was carried out and the analysis of the survey would be carried out using a discrete choice approach.

The main question of the survey would be to choose an alternative for shopping amongst the given options having certain attributes and levels.

The last step in the methodology would be to analyze the collected data. Figure 1.1 shows the flow chart of the methodology.

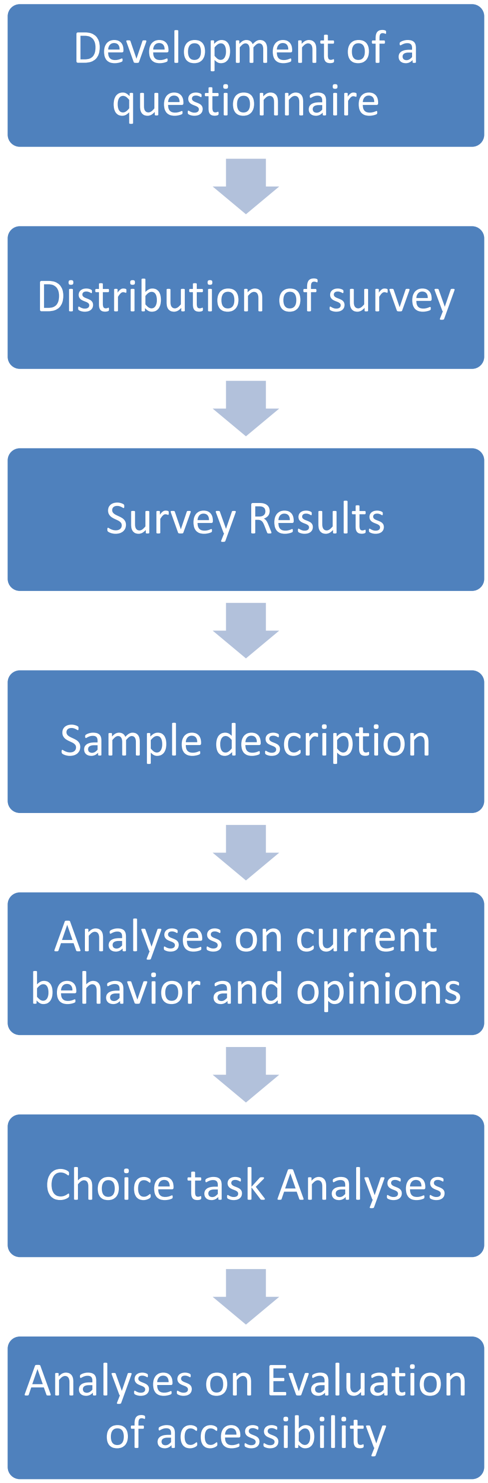

Figure 1.1 Flow chart of methodology

1.6 Outline of the report

The report for the master thesis consists of seven chapters including Introduction, Literature review, Research Methodology, Experimental Design, Survey Questionnaire, Data Analyses, Conclusion and Recommendations.

Chapter 1 of the report comprises of the background, problem statement, research objectives and scope, research questions and an overview of the methodology.

Chapter 2 of the report is the literature review. This chapter discusses about the characteristics of accessibility and parking with reference to the studies conducted. It also describes about the importance of these components of transportation. The link between accessibility and parking is also provided in this chapter.

Chapter 3 is the research methodology. It discusses about the research methodology adopted for the project. Details for the survey are also presented in the chapter. After the collection of data, analysis technique is also discussed in this chapter.

Chapter 4 is the experimental design. It discusses in detail about the process of generating an experimental design for the stated preference survey.

Chapter 5 is the survey questionnaire. It discusses about the various portions of the survey questionnaire namely current behavior/opinion, stated choice task and socio-economic characteristics.

Chapter 6 is the Data Analyses. It discusses about the analyses of the data collected during the survey period.

Chapter 7 is the Conclusion and Recommendations. It discusses about the critical findings of the research.

CHAPTER 2

LITERATURE REVIEW

2.1 General

Transportation plays a vital role in the development of a country [30]. There is a strong link between the economy and the transport system of a country. Growth of the economy of a country is dependent upon the growth of transportation system in the country.

Due to ever increasing number of private vehicles, an extra burden is being added to the road infrastructure which has resulted in many traffic related problems such as congestion, environmental pollution, accidents and parking problems. Increase in vehicle ownership causes traffic jams specially during the morning and evening rush-hours in the central business districts (CBD) [30]. The negative effects of traffic congestion include increase in travel time, decrease in speed and environmental pollution such as air and noise pollution. The attractiveness of city centres is also greatly influenced by the the level of congestion. The dramatic increase in the traffic volume and congestion levels of the city centres has affected the attractiveness of these areas negatively.

Transportation systems are generally evaluated using mobility factors such as average speeds and delays in congestion [23]. Traffic congestion has a negative impact on the accessibility towards the destination. Increasing the mobility such as the traffic speeds and volumes may have a negative effect on the accessibility of other forms of transportation. Therefore, recent trend is a shift towards accessibility analysis.

This chapter focuses on establishment of link between the accessibility and parking based on the literature found. The first section of the chapter focuses on accessibility (definition, influential factors, components and measures). Second section deals with the importance of accessibility. Third section of the chapter deals with the importance of parking in transportation systems. In the next section, the effect of and importance of including parking in the overall analysis for accessibility has been discussed. The last part of the section lists out some crucial findings of this chapter.

2.2 Accessibility

The main objective of the transportation systems is the provision of access to different activities (work, educational, social, recreational, shopping, etc.)[9]. Therefore, accessibility is a key component of the transportation system.

The measure of the degree of ease with which an individual can reach the destination of a desired activity at a particular time through a preferred transport mode is referred to as accessibilty [4][6][23]. Accessibility can also be defined as the amount and variety of different destinations that can be reached within a specific amount of time and cost [3].

2.2.1 Factors affecting accessibility

Accessibility is dependent on several factors. Litman and Muska [23][27] have discussed these factors in detail in their studies. These factors are as follows

a) Road network:

Accessibility of a particular area is dependent on the connectivity of road and/or path networks. Accessibility is directly proportional to the connectivity between road networks.

There are different types of road networks which include grid network, hierarchical road networks and modified grid road network. Accessibility of these road networks is different from each other because of the different characteristics of these networks.

Grid road network are consists of a number of routes and are in the form of short blocks. These road networks have high accessibility since the connectivity between roads is high. This high connectivity between roads in turn reduces the travel distances and increases the choice in travel mode. This results in lower levels of congestion.

Hierarchical road networks consist of street roads being connected to arterial roads. These road networks have lower accessibility since it consists of dead ends which mean connectivity between roads is low. Due to lower accessibility and low number of choices in travel modes, levels of congestion are higher for these road networks.

Modified grid road networks consist of T-intersections and shorter blocks. These road networks also have higher accessibility since the connectivity and choice in travel mode especially non-motorized transport modes is higher. This results in lower distances in travel and lower congestion levels too.

b) **Mobility factors:**

Physical movement by means of different modes of travel is referred to as mobility.

Mobility is measured in terms of trips, travel speed and travel distance. An increase in mobility means an increase in accessibility. However, it is different for each mode of travel. In a given time period, accessibility to a particular area is different for a person travelling on a bicycle and a person travelling on a car. The area accessible to a person travelling on a car is more since the speed of the car is more as compared to the bicycle. In the same amount of time car is able to cover more distance and reach more destinations.

c) **Land use distribution:**

Land use refers to the function for which a particular area is used. A commercial land use refers to the area which is generally used for commercial activities like buying and selling of goods. Different characteristics of land uses such as spatial distribution, density, number of opportunities and connectivity of networks affects the accessibility.

The number of destinations and people in a particular area refers to the density of that location. An increase in number of opportunities at a particular place will result in higher number of people and destination for activities at that place. This will increase the density as well as the accessibility since in a shorter amount of time people would be able to perform more activities. The reason for this is the high accessibility levels to different opportunities.

d) **Available transport modes:**

The accessibility is high if the quality and number of options in travel modes to reach the desired destination is high. However, accessibility is also dependent on the characteristics of the trip being made. For shorter trips, accessibility of non-motorized transport modes is higher. For longer trips availability of more options in travel modes increases the accessibility towards destination.

e) **Cost of travel:**

Cost of travel also affects the accessibility towards a destination. If the cost of travel while travelling to a location is high, the traveller might opt for an alternative location to perform the same activity. This means that cost of travel and accessibility are inversely proportional to each other.

f) Parking convenience:

Convenience in parking plays a major role in the accessibility. Accessibility is hugely affected by problems in parking at a particular place. Locations where searching for parking consumes too much time is not favored by the drivers and they opt for a different place and in some instances abandon their trip completely. Therefore, parking search time is an important factor in the accessibility towards destination. Lower parking search times at a particular destination increases the accessibility of that location.

2.2.2 Accessibility components

Accessibility comprises of different components which include land-use, transportation, temporal and individual component [41]. Accessibility is dependent on these components.

Land-use component reflects the amount of opportunities available at the origin and destination. Opportunity refers to the prospect of performing a particular activity at a certain place. The supply and demand of these opportunities lead to trips for different purposes from one place to another.

Transportation component helps in measuring accessibility by estimating the travel time, travel distances, travel costs, comfort and risk levels to reach the desired destination. Lack of accessibility would result in higher travel times, travel distances and/or travel costs. This would have a negative effect on the transportation system since it would lead to congestion problems.

Temporal component is associated with different time windows of the day during which the opportunities are available.

The individual component refers to the socio-economic parameters of a person. These parameters play an important role in decision for mode choice and selection of a place to perform a particular activity. These factors also affect the accessibility towards a destination [21].

The relationship between the different components of accessibility is shown in figure 2.1. Accessibility has a direct relationship with each of its component. Each component is linked to the other component indirectly. Land use component is helpful in determining the travel demand and it also has an effect on the temporal and individual components. The individual component also links with the different components of accessibility. From a person’s perspective, the accessibility is affected by his abilities and needs. This will have an impact on type of activities he performs, cost he is willing to pay and the time he is willing to spend on a particular activity.

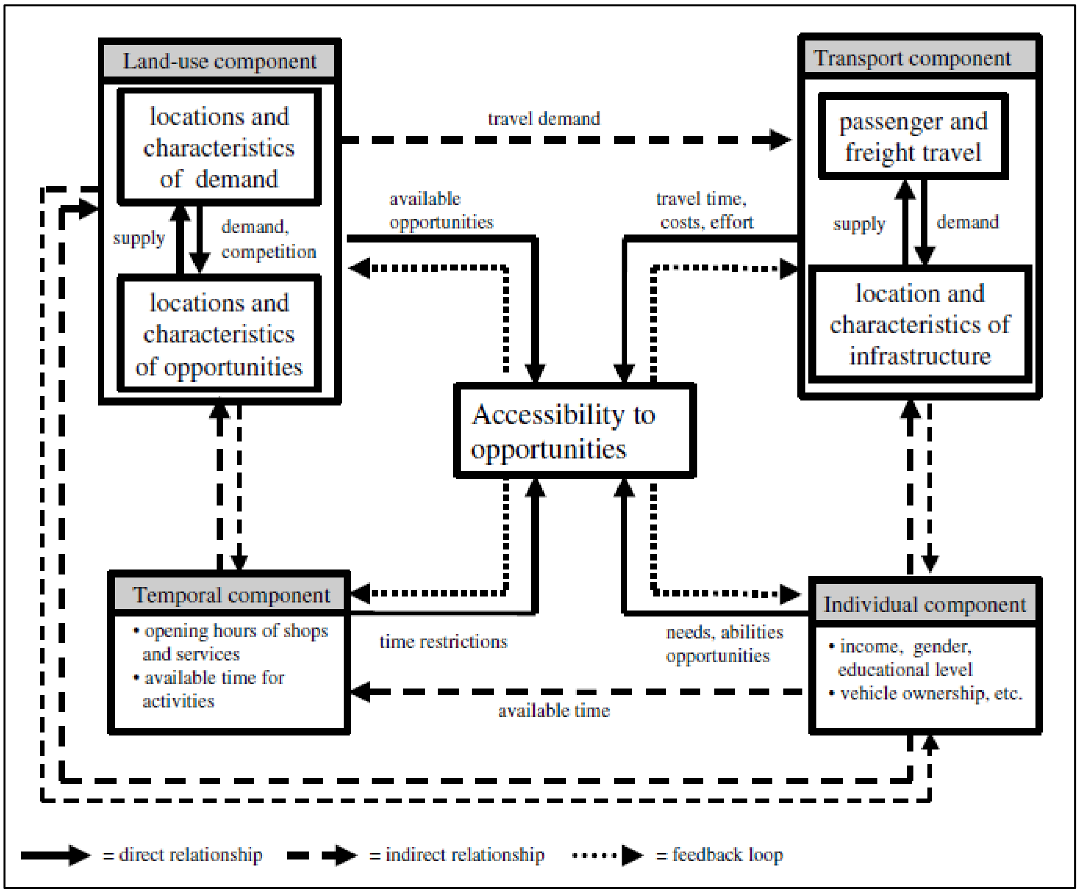

Figure 2.1 Relationship between accessibility components [41]

2.2.3 Accessibility measures

The accessibility measures impact the land-use and transport development policies. Some of the accessibility measures are as follows

a) Spatial separation measures

These type of measures are referred to as the infrastructure based measure as they only take into account the distance between different elements of the infrastructure [6]. These type of measures are helpful in analyzing various nodes and networks in the infrastructure. These type of measures do not take into account the land-use patterns, spatial distribution of activities or certain limitations of the network including travel speed. These measures also do not take into account the attraction

b) Contour measures

These measures use travel time as the primary indicator [4]. The catchment areas are plotted out in the form of contours for different time intervals as shown in figure 2.2. Catchment areas include various locations to perform certain activities. It is referred to as the cumulative opportunity model as well. Land-use patterns and infrastructure limitations are taken into account in this type of measures. This measure has a limitation that it treats every activity as same within one catchment area. The travel time for each activity within a given contour is different but this measure does not differentiate between them [6].

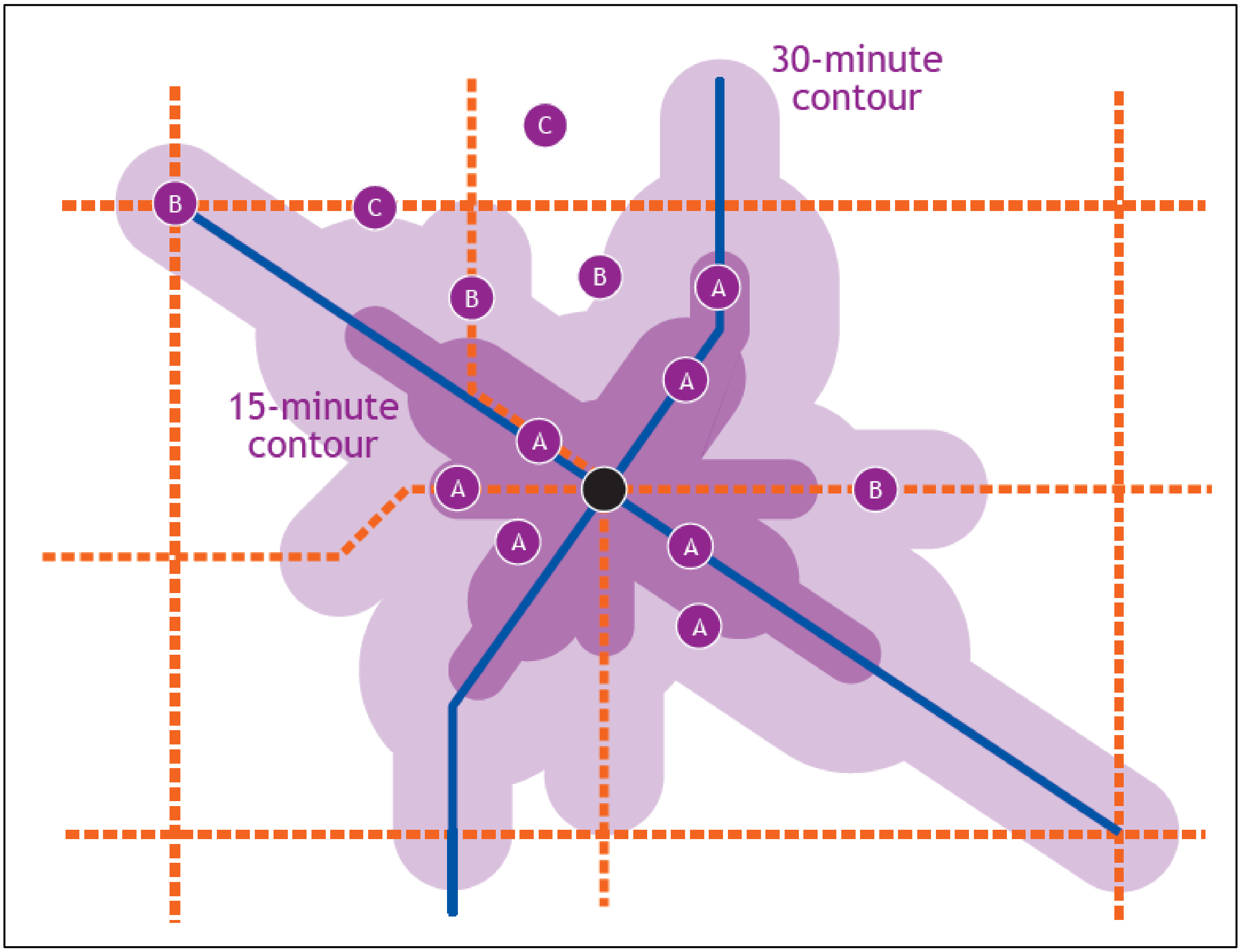

Figure 2.2 Contour measures [6]

c) Gravity measures

These type of measures are similar to the potential accessibility measures [6]. This type of measure tries to overcome the shortfall in the contour measures. As compared to the contour measures, these types of measures differentiates between different activities in one specific contour catchment on the basis of their individual travel time as illustrated by the figure 2.3. A distance function is utilized in this model to measure the disutility experienced by the user in terms of cost, effort and increasing travel time. However, every transport user in the area is treated equally in this measure [6].

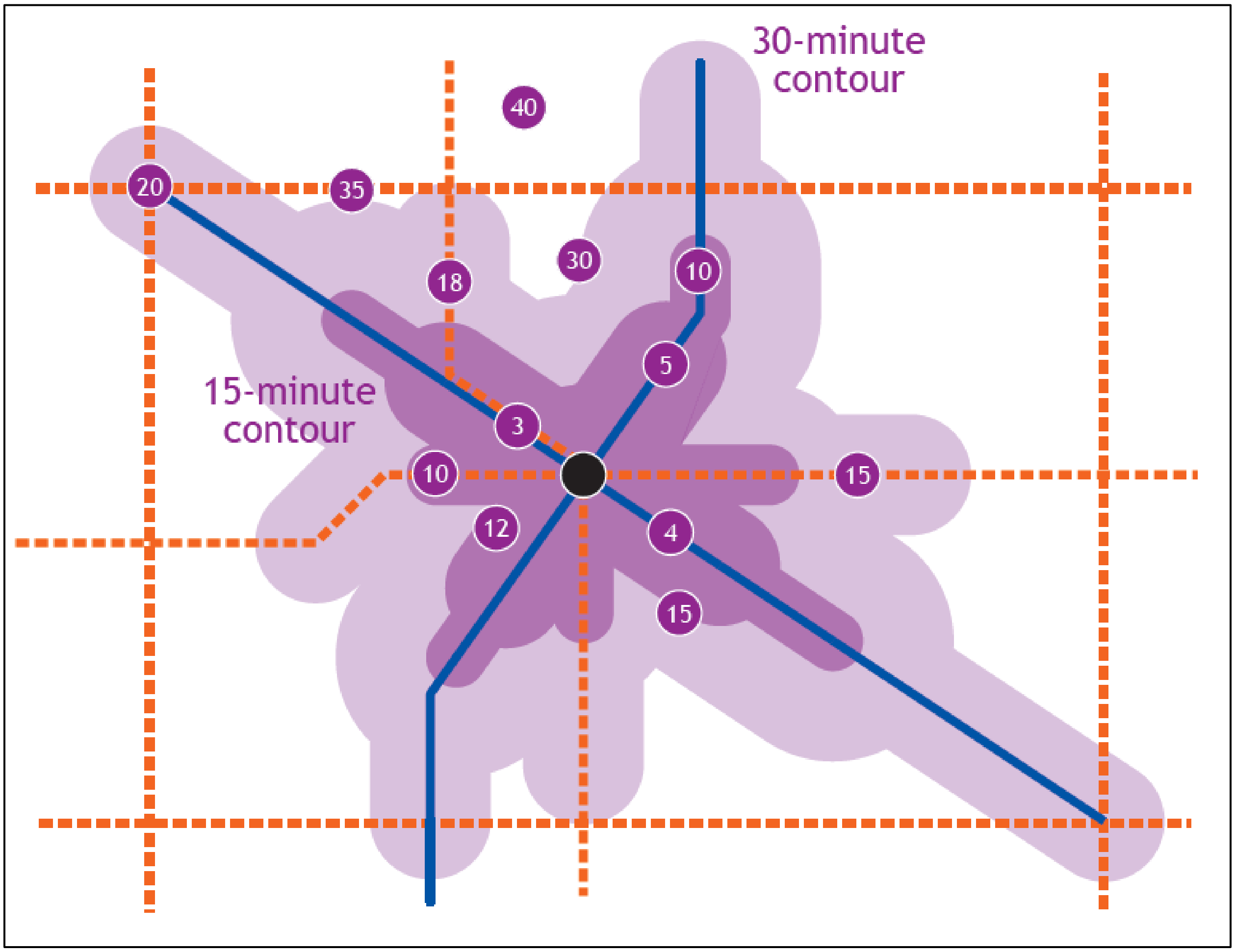

Figure 2.3 Gravity measures [6]

d) <u>Competition measures</u>

These measures take into account the effect of competition. According to the contour and potential accessibility measures, locations having a higher accessibility would be central in the transport network. But this is not true since the activities are centralized in a particular place, a time will come when the number of jobs exceed a point beyond which the accessibility for different employees is restrained [41]. This type of measures takes into account the effect of competition between different employees and employers. A location is then not only evaluated for the number of activities based on travel time but capacity of the activities in that zone and nearby zones is taken into account.

e) <u>Time-space measures</u>

Time-space measures are person based measures [41] in which the distance covered in a certain amount of time is evaluated for the transport user. The limitations in this type of measure include the need for an activity for the person, the time available to him in which he can perform those activities and operation times of the activities and other components of the system of transport. This approach is very useful while analyzing trip-chaining [6]. The contour measures can be combined with space-time measures. Space-time prisms can be made showing the range of travel within a specified time period as shown in figure 2.4.

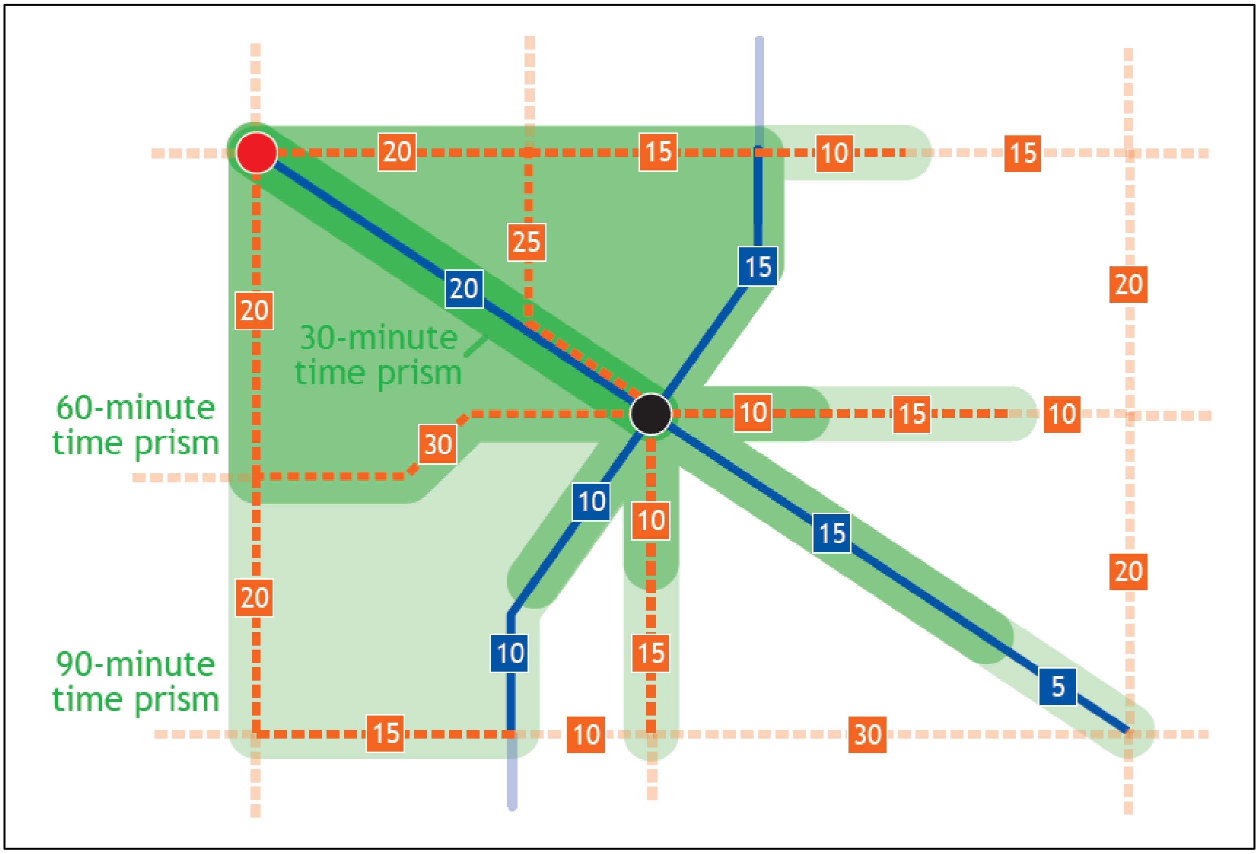

Figure 2.4 Time-space measures [6]

f) <u>Utility measures</u>

These measures are used to evaluate the utility and disutility for the person while accessing certain opportunities. Utility is a benefit which a user gets while accessing an opportunity. Disutility is the demerits of the journey measured in terms of travel cost, effort, travel time etc. This can be measured in monetary terms [6].

g) Network measures

These meaures ae used to analyse the levels of accessibility for movements within a network [29]. These measures are helpful in considering the consequences of network failures. These failures could be in terms of travel time or travel cost.

2.3 Importance of Accessibility

In the modern era, a company or a household can only flourish if it has proper access to resources which are spread out in space and time [7][40].

Transport planners utilized the traditional approaches to solve the problems related to the transportation system. The traditional approach refers to the planning for mobility. However, in order to overcome certain problems faced in the transportation planning area, there is a need to shift from the traditional approach of planning for mobility to planning for accessibility [21].

The conventional way of transportation planning is based on the idea of predicting and providing which is no longer feasible [1]. The traditional approach was based on the supply and demand phenomenon but it should be realized that the demand is increasing at a catastrophic rate and it is nearly impossible to meet the supply needs. It is very difficult to increase the capacity of networks because of the rate at which the demand is increasing. If the equilibrium between supply and demand is not achieved, traffic congestion problems will remain [10]. Moreover, expanding the transportation infrastructure in order to meet the ever increasing demands is considered unfeasible from a financial and environmental point of view [1][2].

The concept of using accessibility in transportation planning would be helpful in resolving the issues faced in the traditional way of urban transportation planning. For different companies and household, accessibility to the places of their desired activity is of main concern. Accessibility concepts provide the opportunity to make trade-off decisions between land-use and transportation policies [15]. This will assist planners in assessing the impacts of certain changes in the land-use and transport systems. Planning would evolve around the accessibility of people and goods towards the desired destination. Depending on the goal of policy makers, conditions of accessibility could be reviewed and alternative solutions could be proposed [14]. Inefficiencies in transport could not be discussed with certain people of the society but details regarding access to desired destination could be discussed with some of the citizens, politicians and firms. In this way accessibility could overcome certain flaws in the traditional transport planning system.

Planning based on traffic and mobility takes into account the movement of vehicles (travel times and travel distances) while accessibility incorporates the concept of interaction between land-use and transportation infrastructure [4][16]. The mobility for a certain place could be high but at the same time accessibility to some of the land-uses within that particular area could be low because of traffic congestion or parking problems.

With the passage of time, rapid motorization and urbanization has taken place. Cities have developed at an enormous rate. This development has taken place as a result of an interaction between land use and transport systems [33].

Attractiveness of a location is based on the accessibility towards it. Locations having higher accessibility are more attractive to people as compared to locations with lower accessibility [42].

This fact can be reiterated with the help of the Land use – Transport feedback cycle as shown in fig 2.5 [42]. The locations of activities (work, shopping, education etc.) are determined by the land use distributions. In order to reach the desired destinations to perform these activities, trips should be made. These trips are made with the help of the transportation system. The decision to pick out a particular destination is based on the accessibility through the transportation system. If the accessibility to the land uses where certain activities take place is not good, steps are taken to make the land use more accessible. An increase in accessibility will increase the attractiveness of the destination.

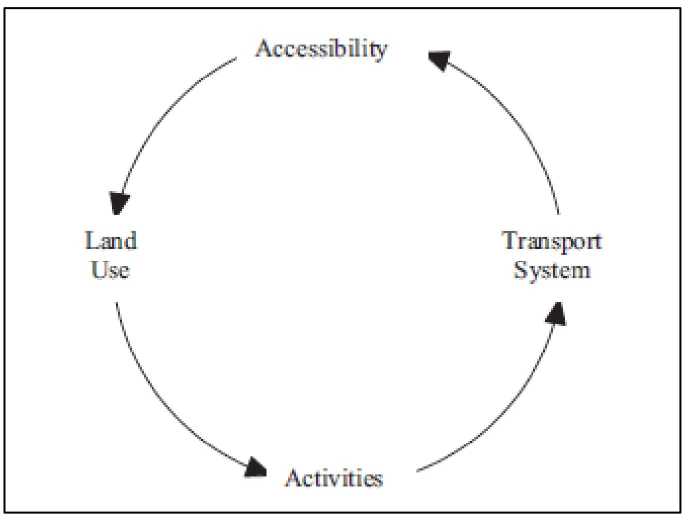

Figure 2.5 Land use – Transport feedback cycle [42]

Importance of accessibility is also highlighted by Zahavi's travel behaviour theory in which the decision process while making a trip was discussed. Decisions on making certain trips depend on accessibility. Within a given time period and budget, a person would always prefer the alternatives having maximum accessibility so that within a short space of time, the individual could perform maximum number of activities [36].

Accessibility towards a particular location plays a key role in the attractiveness of that location. In 2011 [19], stated choice experiment was carried out in Netherlands for the location of offices. It was concluded that the presence of high-speed trains increases the accessibility towards the offices. This makes the location of offices much more attractive.

2.4 Role of parking in transportation system

Parking is considered to be one of the most important parts of the transportation system. Every car driver requires a parking spot at the destination or near to the destination to park the vehicle. In the course of a week, a vehicle occupies several parking spots and spends 23 out of the 24 hours in a day [22].

Available parking spots at a parking facility are limited. The drivers have to compete with each other to get a spot. If a driver is unable to get a parking space, he might have to wait for a certain amount of time which cannot be predicted. Another option for the driver is to look for a parking spot a different parking lot. The search for a parking spot utilizes the valuable time of the driver as well as adds to the unnecessary cruise traffic. Cars cruising for a parking spot further increases the traffic problems including congestion, waste of fuel, air pollution, noise pollution, accidents, hinder the movement of non-motorized forms of transport and restrain accessibility levels [11].

Parking systems play a vital role in the metropolitan traffic systems [43]. After the end of World War-II, there was an increase of epic proportions in the use of automobiles in the United States of America. As a result of this parking became an important of the transportation system. Parking adds to the appearance of city and is considered an essential part of the urban street and transit systems [34].

Parking related problems are not only confined to the city centres but these problems are also evident in the sub-urban areas. A number of cities of the world are in the process of urbanization. These cities are facing huge parking problems which lead to a number of traffic related problems including congestion delays, traffic accidents and degradation of environment. These problems have a huge impact on the lives of the residents of these cities.

Problems caused by parking are of major concern. These problems are the most common faced by the transport planners, designers, policy makers and municipalities [43]. The parking facilities are one of the major sources of cost for a society. Parking problems arise when there is shortage of parking supply and the demand is greater than the supply. Another reason for parking problem might be the inadequate management of the existing facilities.

Parking policies are of utmost importance since the vehicle ownership in the coming years will continue to grow at an enormous rate. Parking policies are also considered to be the link between land use and transport policy [25].

2.5 Link between accessibility and parking

As discussed in the previous sections, accessibility is dependent on certain factors. Amongst these factors was the choice in travel modes.

Taking into consideration the journey by public transport towards a destination, accessibility is affected by different stages of the journey as shown in figures 2.6 and 2.7. It is referred to as the accessibility journey chain. Generally, the total travel time elapsed during the journey from point A to point B is considered while determining the accessibility. However, each link in the accessibility journey chain is equally important. In order to complete the journey, each link of the journey has to be accessible. Different stages in the journey chain are as follows

1. Walk to the bus stop
2. Waiting for the bus
3. Boarding the bus
4. Travelling in bus
5. Getting off the bus
6. Walk towards the destination

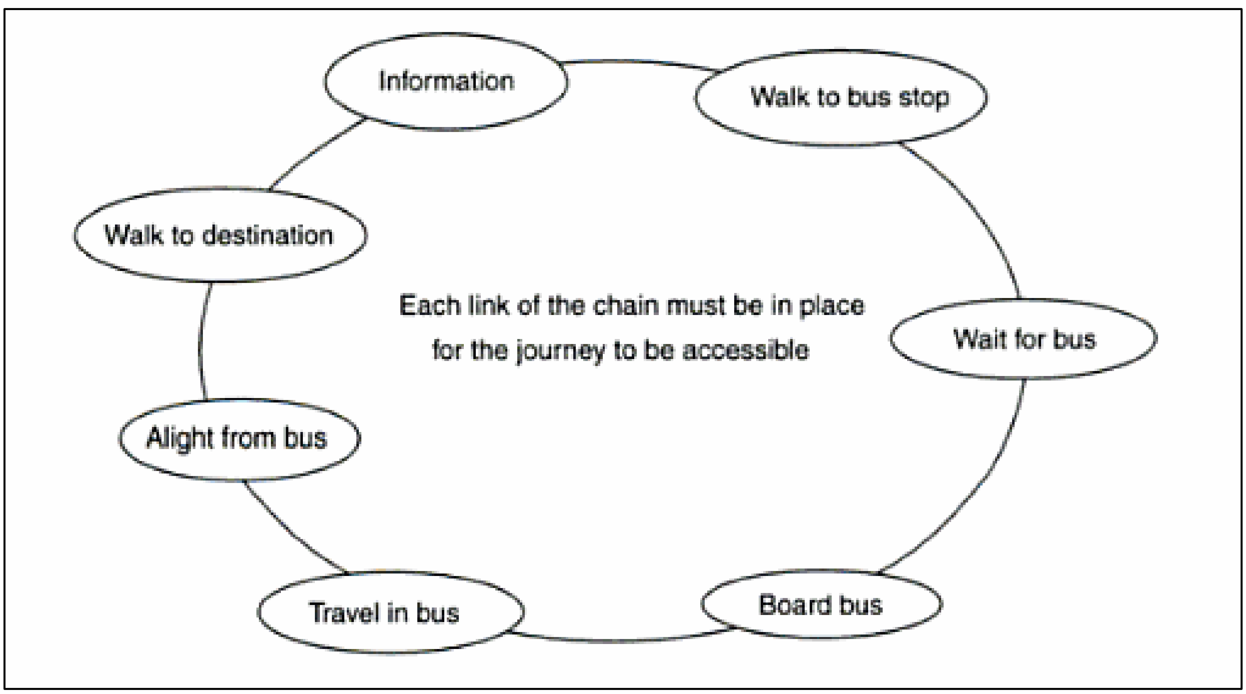

Figure 2.6 Different stages in a bus journey 1 [39]

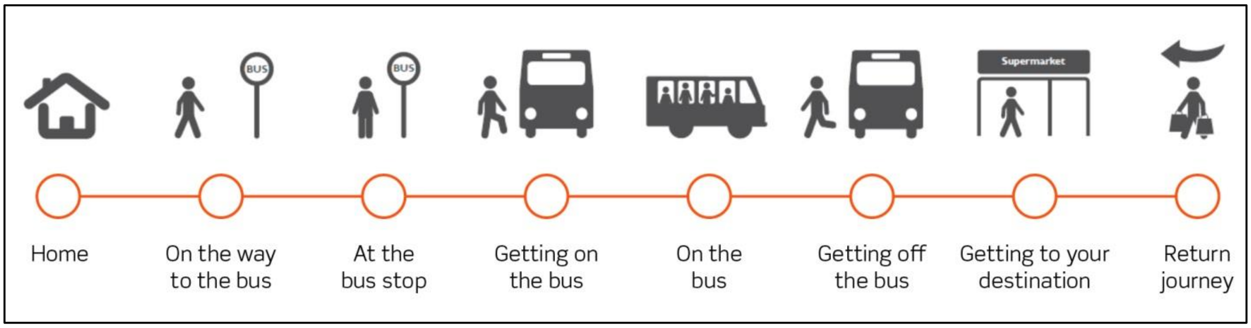

Figure 2.7 Different stages in a bus journey 2 [12]

Similarly, a car journey also has different stages as shown in figure 2.8. These stages are as follows

1. Walk to the car
2. Getting in the car
3. In-vehicle travel time
4. Parking search time
5. Time taken to park the car
6. Getting out of the car
7. Final walk towards the destination

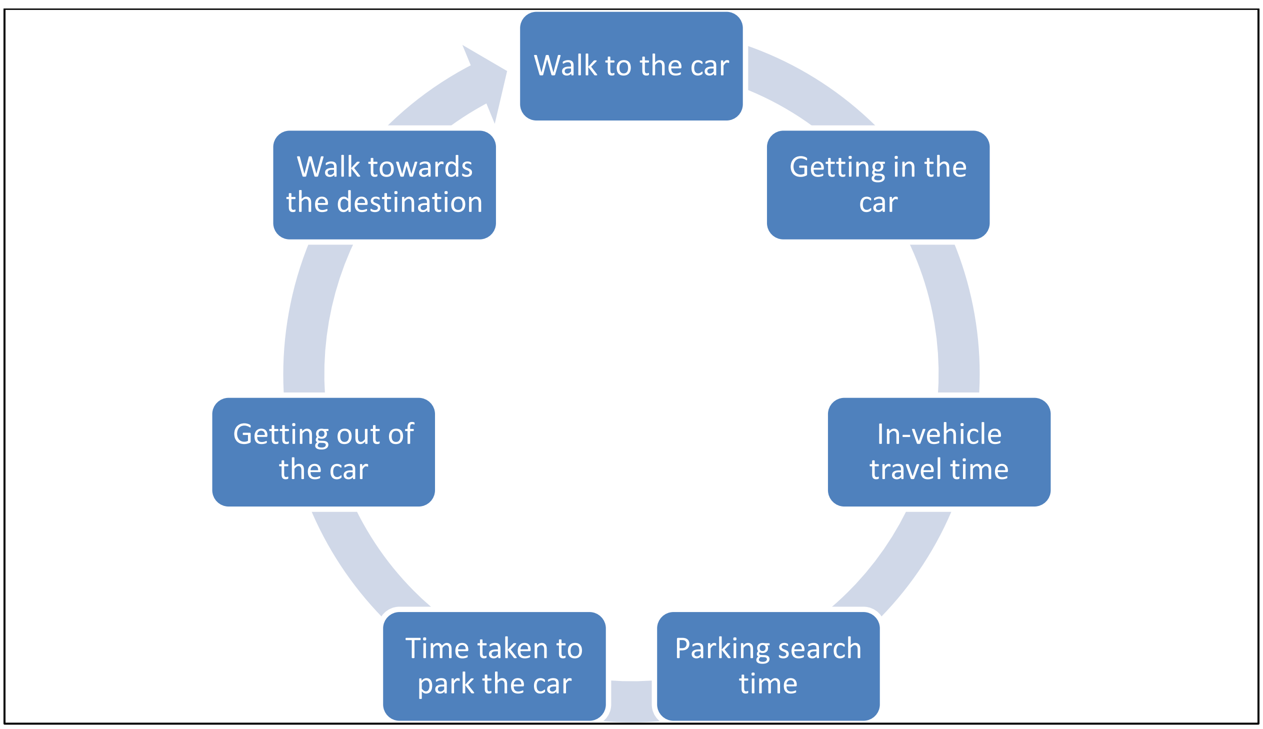

Figure 2.8 Different stages in a car journey

Bus journey	Journey time (min)	Valued at (pence per hour)	Journey cost (pseudo-pence)
Walk to bus-stop	3.0	70	3.5
Wait at bus-stop	4.0	70	4.5
Ride time in bus	17.5	35	10.0
Bus fare (real pence)			8.5
Walk to destination	2.0	70	2.5
TOTAL	**26.5**		**29.0**
Car journey (driver only)			
Walk to car and start	1.5	70	2.0
Ride time in car	14.5	35	8.5
Car running cost			13.0
Park and walk to destination	2.5	70	2.5
TOTAL	**24.5**		**26**

Figure 2.9 Comparative journey times and costs from Bilborough/Wollaton to Nottingham city centre [17]

Barry Hutton [17] differentiates between different stages of the bus and car journey to estimate journey times and costs from Bilborough/Wollaton to Nottingham city centre. However, the walking times, waiting times and parking times are not real. These were assumed since there was no data available.

Accessibility of cars is generally measured in terms of total travel time. However, different stages of the accessibility journey of the car play an important role in the evaluation of accessibility towards destination.

The most important factor while travelling by car in the accessibility journey chain is the parking search time. Vehicles cruising for a parking spot cause unnecessary traffic which adds to the congestion levels as well as the gas emissions [20].

In 2006, [20] conducted a study to evaluate and convert the loss of time suffered by the drivers in the four urban areas of France namely Grenoble (Vaucanson district), Lyon (Presquîle district), Paris (Commerce district and Saint-Germain district). The average search time required to find a parking spot is in Grenoble is 3.3 minutes, in Lyon it is 11.8 minutes, in district Commerce of Paris it is 10 minutes and in the district Saint-Germain of Paris it is 7.7 minutes. Table 2.1 shows the summary of loss time suffered by the drivers.

Table 2.1 Summary of time loss suffered by the drivers [20]

Area	Total time lost	Time loss per hectare	Time loss per authorized space
Lyon, district Presquîle	434h	14h14min	41min
Grenoble, district Vaucanson	157h	6h21min	14min
Paris, district Commerce	462h	9h57min	20min
Paris, district Saint- Germain	294h	13h40min	42min

When the drivers were interviewed, 64% of the total drivers mentioned the fact that they had abandoned their trip at least once, since they did not find a parking space.

As a result of this attractiveness of the desired destinations is reduced, since accessibility towards them is hindered by one of the most important factors affecting accessibility which is convenience in parking.

It was also estimated that almost 70 million hours were lost each year by the drivers in France searching for a parking spot. This resulted in a loss of 700 million € each year for France in terms of congestion, greenhouse effect, noise pollution, insecurity and air pollution [20].

In 2006, Shoup [32] presented a model in which he discussed about the decision of drivers to cruise for a free curb parking space or pay for off-street parking. The results show that the drivers would mostly prefer to cruise for an underpriced or free curb parking space as compared to the off-street parking facilities in which it is obligatory to pay for the parking space. It was proposed to impose a parking fee on the curb parking space in order to eliminate the traffic cruising for parking as well as direct the attention of drivers towards the off-street parking facilities.

In the several studies conducted during the last century [20], the time taken by the drivers to find a free curb parking in the congested city centres of various cities was evaluated. According to these studies, an average cruising time to find a curb space is 8.1 min while on average 30% of the traffic in those cities were cruising to find a parking spot. Tables 2.2 and 2.3 show the details of parking search time and share of traffic cruising for parking in different cities respectively.

Table 2.2 Percentage of traffic cruising for parking in different cities [20]

Year	City	Share of traffic cruising (Percent)
1927	Detroit	19%
1927	Detroit	34%
1960	New Haven	17%
1977	Freiburg	74%
1985	Cambridge	30%
1993	New York	8%
Average		**30%**

Table 2.3 Average parking search time in different cities around the world [20]

Year	City	Average search time (min)
1933	Washington	8.0
1965	London	6.1
1965	London	3.5
1965	London	3.6
1977	Freiburg	6.0
1984	Jerusalem	9.0
1985	Cambridge	11.5
1993	Cape Town	12.2
1993	New York	7.9
1993	New York	10.2
1993	New York	13.9
1997	San Francisco	6.5
2001	Sydney	6.5
Average		**8.1**

When the driver is looking for a parking spot, he creates a parking spiral as shown in figure 2.10. When a driver's quest for a parking spot is less than 15 minutes, the average distance from the final destination is found to be 200m whereas it increases up to 500m if the search for parking spot is more than 15 minutes [20].

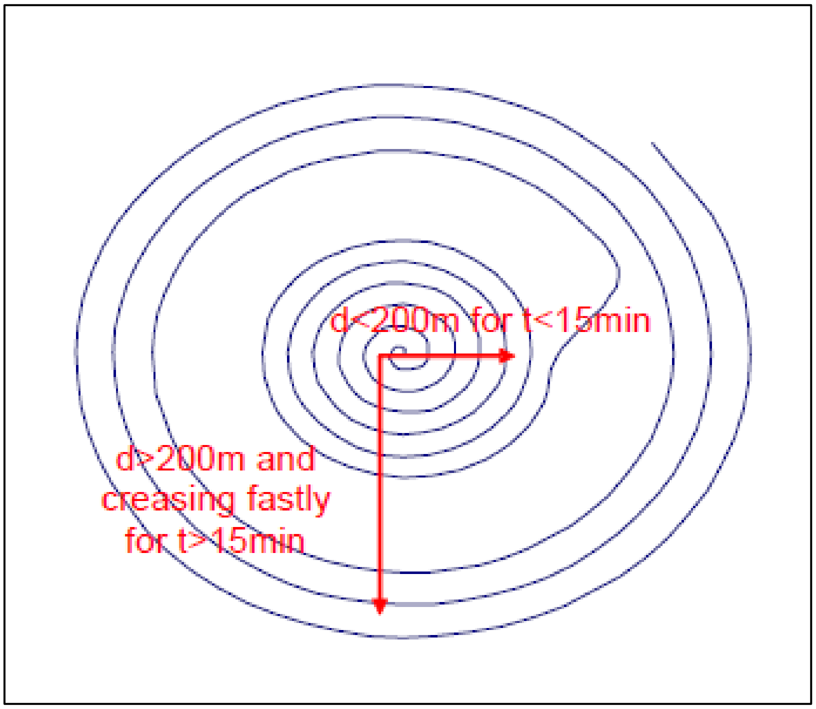

Figure 2.10 The parking spiral [20]

Fabien Leurent, Houda Boujnah [5] presented a model for traffic assignment dealing with choice of route and parking on a transport network having parking facilities. It was assumed that there are two stages in the decision made by the driver while going to a particular place. First is the overall cost of the trip which includes the parking charges and second is the accessibility towards the destination. On the basis of this, parking demand was modeled. The supply of parking depended upon the several characteristics of parking facility which included the type of parking, parking fees, capacity and occupancy of the parking facility as well as the accessibility to the routes leading up to the destination. Trip demand depended upon the information regarding the origin-destination, availability and quality of the parking facilities. This model took into account the role of accessibility while choosing a route and parking facility in order to reach the destination.

The planning of the parking facilities in the cities improves the accessibility and leads to a sustainable transportation system. J. Muska [27] took into account the accessibility factor while calculating the number of parking spaces in residential and non-residential areas. It was calculated on the basis of number of characteristics like job opportunities, land-use, population, accessibility to public transport and non-motorized forms of transport. These standards were based on a zonal approach with a view in mind to improve the accessibility for every type of user.

Parking has a huge impact on the economic growth and development of a country. Accessibility towards destination could be improved by providing on-street parking near the central business districts. High accessibility increases the attractiveness of these locations [34].
Studies also show that availability of parking spots affect the trip maker's decision to travel to a particular place for shopping. The data from Fredericton, Canada was used to analyse the behavior of shoppers. Results revealed that the two most important factors affecting a trip maker's decision were parking convenience and accessibility [18].

According to Greg Marsden [25], special attention should be given to analyse and present the impacts of accessibility caused by different measures of parking restriction on trip makers.

2.6 Conclusions

The answers of the questions stated in the first chapter were found through an extensive research of the literature. These answers are stated as follows

1. **What is the advantage of shifting from planning for mobility to planning for accessibility?**

Mobility analysis only takes the travel parameters such as travel distance and travel speed into account. An increase in mobility for individuals would mean an increase in the travel speed and more number of trips. However, these positive effects would also bring about some negative effects such as traffic congestion, restraining of accessibility and environmental pollution. Accessibility analysis also takes into account the interaction between land-use and transport system. Mobility for some places might be higher but at the same time accessibility for certain land-uses nearby that area maybe lower.

2. **What are the roles of parking and accessibility on the transportation system?**

Transportation plays a vital role in the development of any country. Parking and accessibility are two of the most important components of a transportation system. A restraining in accessibility would lead to many traffic related problems. A sustainable transportation system can be achieved if the accessibility towards various locations is high. Parking has a great impact on accessibility as well. Therefore, it also has an impact on the transportation systems.

3. Does parking have an effect on accessibility?

Parking is one of the major factors influencing the accessibility. It affects the ease of reaching destinations. This means that it affects the accessibility towards destination. The decision of trip makers to a particular destination is dependent on the quality and availability of parking services.

4. How to incorporate parking in the accessibility analysis?

Accessibility by a public transport is evaluated by different stages in the journey by a bus. In order to incorporate parking in the accessibility analysis, similar approach is being utilized by dividing a journey by car into various stages. The travel time from reaching one place to another place is broken down into a number of components which include walk to car, getting in the car, in-vehicle travel time, parking search-time, parking time, getting out of the car and final walk towards the destination. The effect of the last part of the journey is important since with the help of this effect on parking could be evaluated on the overall accessibility towards a destination.

In this chapter various accessibility measures have been discussed. The use utility measures for research would be ideal since the methodology adopted would include the development of a questionnaire. The questionnaire would include the choice task portion of the survey. The choice task of the survey would include choice situations having three alternatives. On the basis of utility and disutility of a certain alternative, the respondents would have to select an alternative. The utility and disutility would be based on their own preference. The utility and disutility would be dependent on the various attributes. The details of these attributes and details of the methodology for the research has been discussed in the coming chapters.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Data Collection

3.1.1 Revealed and Stated Preference Data

The data reflecting the real choice of people in everyday life is referred to as the revealed preference data. Stated preference data is collected by presenting the participants with hypothetical choice situations and they have to choose from those stated hypothetical choices [37].

An example of a survey question would explain the difference between revealed and stated preference data further. The respondent is presented with a question inquiring him about the choice of apartment that he may buy. He is given the options of three apartments having certain attributes and certain attribute levels. This is a hypothetical situation and he has to choose amongst the three apartments base on his personal preferences. The data collected in this scenario is stated preference data. Similarly if the respondent is asked about the characteristics of the apartment that he owns in real life, data collected in this scenario would be revealed preference.

There are a few advantages and a few disadvantages of both the techniques. Advantages of the revealed preference data are that it represents the real-world scenarios. However, the main disadvantage of this study is that it cannot take into account hypothetical choice situations [37]. For instance, there is a grocery store nearby the respondent’s home location. The price and quality of products at the store is good. With revealed preference data, one might not be able to deduce the reaction of the respondents in case the price and quality of products at the store is changed. Only if the respondents are presented with hypothetical situations, useful information regarding the choice of respondents could be obtained.

The main advantage of the stated preference data is that the researcher can present the respondent with the hypothetical situations for certain research purposes. The variation in attributes and levels of attributes could be done while collecting this type of data. The main disadvantage of this type of data is that the respondents might not do what they say in the survey. Some other factors might play a role if they encounter that hypothetical situation in the real world [37].

For this research, stated preference study is most suitable since the respondents would be presented with different accessibility scenarios having certain attributes and attribute levels.

3.1.2 Survey

A stated preference survey would be carried out after the preparation of the survey questionnaire. The main task of the survey would be selection of choice in different accessibility scenarios.

The survey would start off with some general questions asking the respondents about their socio-economic parameters such as age, income level, vehicle ownership etc.

Then they would be asked to select from a set of choices for an accessibility scenario that suits them the best. The main question of the survey could be which accessibility scenario they would select in case they were making a trip for a shopping purpose.

Selection of shopping purpose could yield more fruitful results since the effect of last part of the car journey (Parking search time + Time to park the vehicle + Walk to the destination) could be play a vital role in the selection of a shopping alternative. Whereas, while performing a trip for education or work purpose, one is left with no option but to continue looking for a parking spot and walk more distance after parking.

The survey could be an internet-based questionnaire or face to face interview with the respondents.

The target group for the survey could be the students and staff member UHasselt. Another option is to contact Vrije University in Brussels to set up the survey.

The list of attributes with different levels are shown in the table below

The main question would be **"While going for shopping which of the following three shopping malls would you prefer to go?"**

Table 3.1 List of attributes and levels

Attributes	**Levels**		
Location	City centre	Suburbs	-
Spatial distribution	Spread out	Concentrated	-
No. of shops	175	200	225
Walk towards vehicle	1 min	2 min	3 min
In-vehicle time	15 min	20 min	25 min
Parking search time	2 min	3 min	5 min
Final walk towards destination	2 min	3 min	4 min
Parking charges	1 €	1.5 €	2 €
Parking time limit	60 min	75 min	90 min

With the help of SAS/SPSS a fractional factorial design of using these possible attributes with the levels would be generated. Number of alternative scenarios would be generated based upon these attributes and respondents would be asked to choose the alternative based upon their personal preference.

3.2 Discrete Choice Experiment

Discrete choice analysis deals with modeling the choice available from a set of similar alternatives. A decision on the choice of alternatives by the decision maker would be on the basis of the maximum utility an alternative has in store for him/her [26].

Maximum utility refers to the maximum value that an alternative brings to the respondent. On the contrary disutility refers to the negative aspects a particular alternative brings. This utility will be dependent on the different attributes and their varying levels.

There are many examples of the application of discrete choice modeling in the field of transportation.

Early on these models were used to make choice between travel modes by binary means. Further progress down the years saw the discrete choice modeling being used to model choice of mode having more than two alternatives. It was also applied to model choices between other transport related parameters which included destination of trip, frequency of trip, vehicle ownership and location of residence [26].

The mode choice for work purposes has been extensively modeled using this approach [26]. These models were far more comprehensive as compared to the earlier models since they utilized the socio-economic parameters of the individuals as well. The accuracy of these models was checked by acquiring the data before and after certain changes in the transportation infrastructure.

The discrete choice experiment in this study utilizes the stated preference data collection technique in which respondents choose from a set of hypothetical situations.

3.3 Data Analyses

3.3.1 Multinomial Logit Model

In order to analyze the collected data, a multinomial logit model should be used. This model has been widely used to analyze discrete choice data. These models as stated earlier are based on the fact that probability of choosing an alternative by an individual is based on the utility of that alternative [35]. It is represented by the equation as follows

$$P = \frac{e^{V_i}}{\sum_{j=1}^{V_j} e^{V_i}}$$

Figure 3.1 Multinomial logit model equation [35]

Where,

V_i is the utility of the alternative
P is the probability of choosing the alternative

'V_i', the utility of the alternative, is a function of the socio-demographic parameters and different attributes of the alternative.

3.4 Motivation for adoption of research methodology

An extensive research of the literature prompted to adopt the methodology of conducting a discrete choice experiment by doing a stated preference survey. Furthermore, the analysis would be done by multinomial logit model.

A stated choice experiment was carried out in Netherlands [19]. The aim of the survey was to study the effect of accessibility on the attractiveness of the office locations. After the collection of data random parameter logit model was used which is very similar to the multinomial logit model. Similarly a video based stated preference study was carried out to study the preferences of pedestrians near roundabouts [24]. The methodology adopted was similar as it was a discrete choice experiment with analysis being carried out with the help of multinomial logit model. A similar study was carried out in Manhattan for the proposed changes in lane system for the Lincoln Tunnel [35]. This was a stated preference study and the analysis was carried out with multinomial logit model.
In the light of above studies, research methodology was adopted since this study is also a research for identifying the role of parking towards destination. A stated preference study is preferable since it would include different hypothetical situations which cannot be included in a revealed preference study. The analysis of the collected data would be done multinomial logit models since the discrete choice data is analysed by this model.

CHAPTER 4

EXPERIMENTAL DESIGN

4.1 EXPERIMENTAL DESIGN

In order to set up a stated choice experiment, an experimental design is of paramount importance. Figure 4.1 shows the different stages of the experimental design process.

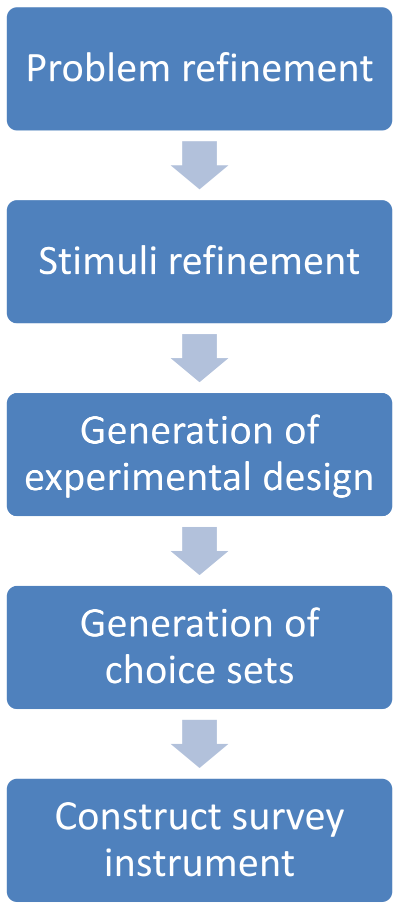

Figure 4.1 Different stages of experimental design [47]

4.1.1 Problem Refinement

Problem refinement is the first step in the preparation of an experimental design. During this stage, knowledge about the main aspects of the research topic and problems associated with it should be gathered. The main purposes and objectives of the study to be carried out should be well defined.

The research topic for the thesis is **"The role of parking in the accessibility of destinations".** Various aspects and problems associated with this research topic have been discussed in the previous sections.

The main objective of the research is to evaluate the role of parking related attributes on the overall accessibility towards a destination.

As discussed in the previous section, a car journey has a number of stages. The last part of the journey includes parking search time, park the vehicle and walk towards the destination. The main aim of this paper would be to evaluate the effect of the last part of the journey on the basis of total travel time. This would help in quantifying the role of parking in the accessibility towards destination.

4.1.2 Stimuli Refinement

Stimuli refinement is the second stage in the preparation of an experimental design. This stage consists of selection of alternatives, attributes and attributes levels.

A scenario was devised in order to conduct the stated choice experiment. In the scenario, the participants were shown three alternatives for non-daily shopping. On the basis of their preference, they were asked to select one of the given three choices. Shopping purpose was selected to determine the effect of last part of the car journey (Parking search time + Walk to the destination). The reason of not using any other trip purpose was that while performing a trip for education or work purpose, one is left with no option but to continue looking for a parking spot and walk more distance after parking.

After devising the scenario, the list of attributes with different levels were selected which are shown in the table below

Table 4.1 Final list of attributes and levels

Attributes	Levels		
Location	City centre	Suburbs	-
Spatial distribution	Spread out	Concentrated	-
Walk towards vehicle	1 min	2 min	3 min
In-vehicle time	15 min	20 min	25 min
Parking search time	2 min	3 min	5 min
Final walk towards destination	2 min	3 min	4 min
Parking charges	1 €	1.5 €	2 €
Parking time limit	60 min	75 min	90 min

4.1.3 Generation of Experimental Design

During this stage, the decision on the type of design to be used is made. The experimental design types include full factorial designs and fractional factorial design.

In a full factorial design, all possible treatment combinations are used. The number of treatment combinations depends upon the number of attributes and the number of attribute levels. Number of treatment combinations is calculated with the help of the following formula.

Number of treatment combinations = Attribute levels^$^{\text{(Number of attributes)}}$

In this case two attributes have two attribute levels namely location and spatial distribution. While the remaining six attributes including walk towards vehicle, in-vehicle time, parking search time, final walk towards destination, parking charges and parking time limit have three levels each.

The total number of treatment combinations for the design with two attributes having two levels and six attributes having three levels can be calculated as follows

Number of treatment combinations = (3^^{6})* (2^^{2})
Number of treatment combinations = 2916

It is not ideal to evaluate all the possible treatment combinations. In order to minimize the number of treatments, fractional factorial design should be used. In a fraction factorial design, only a fraction of total number of treatment combinations is used.

With the help of SPSS, number of treatment combinations for a fractional factorial design was calculated. The number treatment combinations based on the number of attributes and their levels turned out to be 27 for a fractional factorial design.

4.1.4 Generation of Choice Sets

Generation of choice sets was done with the help of SAS using Macros. The code was run on SAS for 27 possible treatment combinations. SAS generated 27 treatment combinations. These 27 treatment combinations were then grouped into 9 groups of 3 treatment combinations. The grouping of 3 treatment combinations is referred to as one choice task. Therefore, 9 choice tasks containing 3 choices each were then generated for the choice task portion of the survey.

4.1.5 Construct Survey Instrument

After the generation of experimental design and choice sets, the last stage is to setup a survey questionnaire. The details regarding the questionnaire have been discussed in the following chapter. The questionnaire is also attached in the appendices portion of the report.

CHAPTER 5

SURVEY QUESTIONNAIRE

5.1 General

The survey questionnaire was generated on Qualtrics. It is an online survey software. With the help of qualtrics, a questionnaire can be generated and distributed. The responses from the participants could also be stored in the online qualtrics account.

The survey questionnaire consists of three portions. The sequential order of the survey is shown in the figure 5.1.

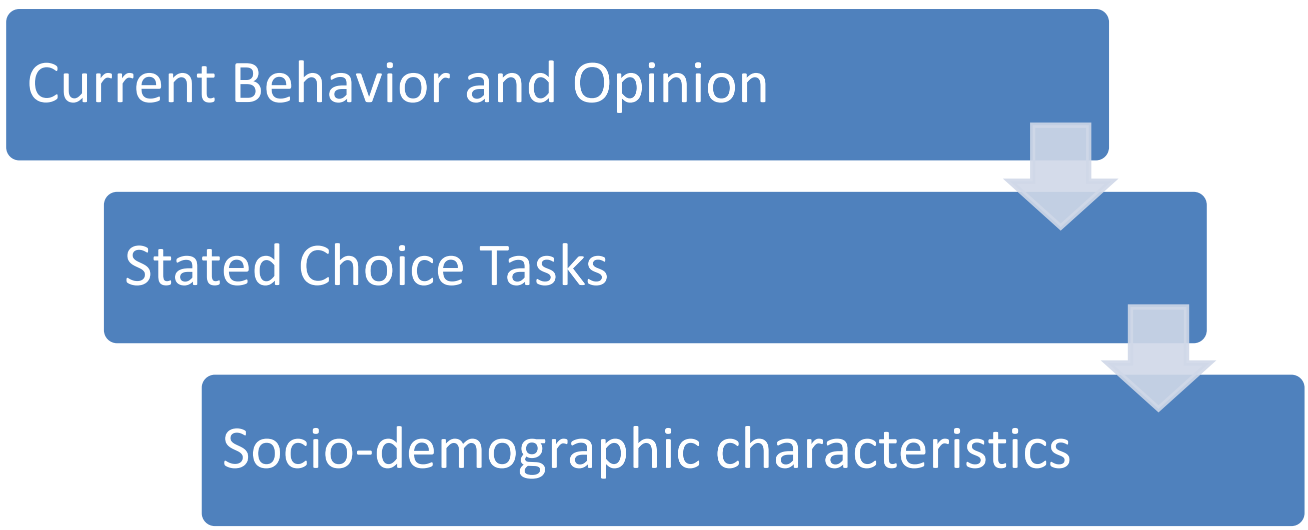

Figure 5.1 Sequential order of the survey

The questions asked in the first two portions of the survey are in the context of non-daily shopping. Non-daily shopping refers to the shopping trips done to buy things like shoes, clothes, electronic items etc. Since these shopping trips are not done very often, the results regarding these could be of significant importance as compared to daily shopping. Daily shopping involves shopping for groceries and eatables. These shopping trips are made on a more regular basis with various travel modes. Therefore, respondents might be indifferent while selecting a particular transport mode while doing daily shopping.

5.1.1 Current Behavior and Opinion

In this portion of the survey, current behavior regarding the travel characteristics while going for non-daily shopping has been inquired. Opinions regarding the importance of various accessibility characteristics and the problems associated with it have also been inquired.

The questions asked during this portion of the survey included the question about the frequency of non-daily shopping, transport mode used for non-daily shopping and average travel time required from home to the shopping area. Importance of characteristics such as level of accessibility, parking search time and final walk time towards destination was also inquired on a four point scale (1=very low importance, 2=low importance, 3=high importance, 4=very high importance). Similarly problems associated with low levels of accessibility, high parking search time and high final walk time towards the destination were also inquired on a four point scale (1=not a problem, 2=minor problem, 3=problem, 4=major problem).

5.1.2 Stated Choice task

In this part of the survey, the respondents were provided with different choice tasks. These choice situations contained three shopping areas having certain characteristics. From the mentioned three shopping alternatives, respondents were requested to choose one which is highly accessible for them. They were also asked to evaluate the accessibility of the three shopping areas that were presented in each question.

Each respondent was presented with three choice tasks. Nine choice tasks for a single respondent are very burdensome. Therefore, each respondent was given three choice tasks instead of nine. The choice task selected for a person was based on the month in which he/she was born. First three choice tasks were reserved for the persons who were born in months Januray-April, second set of three choice tasks were reserved for the persons born between May and August, the last set of three choice tasks were reserved for respondents who were born in months September-December. The question regarding their month of birth was asked upfront. Based on their answer, they were presented with a set of three choice tasks.

5.1.2.1 Description of attributes

The eight attributes used in the choice task portion of the survey are described as follows:

a) Location:

This refers to the place where the shopping area is located i.e city centre or suburb.

b) Spatial distribution:

Spatial distribution refers to the distribution of shops in the area.

Concentrated spatial distribution refers to the high density of shops across a particular area i.e the shops are located very close to each other.

Spread out spatial distribution means the low density of shops across a particular area i.e the shops are located at a distance from each other and are not very close to each other.

c) Walk time to vehicle:

Time taken to reach the vehicle from the home location.

d) In-vehicle time:

This refers to the time elapsed in the car from the home location to the point of start of search for parking.

e) Parking search time:

It is the time elapsed in search for a parking spot.

f) Final walk time:

It is the walk time taken to reach the destination after parking the car.

g) Parking charges:

This refers to the charges for parking the car in a particular shopping area.

h) Parking time limit:

It is the time limit for parking the car in a shopping area.

Table 5.1 represents the example of a choice task situation.

Table 5.1 A choice task situation

Shopping Area 1		**Shopping Area 2**		**Shopping Area 3**	
Location	**City centre**	Location	**City centre**	Location	**Suburbs**
Spatial Distribution	**Concentrated**	Spatial Distribution	**Spread out**	Spatial Distribution	**Spread out**
Walk time to vehicle	**2 min**	Walk time to vehicle	**1 min**	Walk time to vehicle	**1 min**
In-vehicle time	**15 min**	In-vehicle time	**25 min**	In-vehicle time	**20 min**
Parking search time	**3 min**	Parking search time	**5 min**	Parking search time	**5 min**
Final walk time	**3 min**	Final walk time	**2 min**	Final walk time	**4 min**
Parking charges	**1.50 €**	Parking charges	**1 €**	Parking charges	**1.50 €**
Parking time limit	**75 min**	Parking time limit	**60 min**	Parking time limit	**75 min**

After presenting the respondents with a choice task situation, users were asked to evaluate the accessibility conditions of the three shopping areas presented to them in the choice task above. They were asked to evaluate the choice task on a five point scale (1=very poor, 2=poor, 3=fair, 4=good, 5=very good).

5.1.3 Socio-economic characteristics

In this portion of the survey, socio-economic characteristics are inquired of the respondents. This would help in the sample description portion of the analysis. This part of the survey included questions about gender, location of home, city/town of residence, city/town for non-daily shopping, age, occupation, highest level of education and disability.

Data regarding socio-economic characteristics is very useful in the analysis portion. With the help of this data, link between the different socio-economic characteristics and the choices made in the choice task could be studied. Furthermore, these questions are helpful in descriptive statistics and description of the participants in the sample.

The detailed questionnaire has been attached in the appendices.

CHAPTER 6

DATA ANALYSES

6.1 Distribution of online questionnaire

The online questionnaire was distributed amongst the students and staff members of Hasselt University on the 16th of April. The collection of responses from the participants was stopped on 24th of April. By 24th of April, 442 respondents attempted to fill out the questionnaire. However, 187 respondents completely filled it out. Therefore, the drop-out rate for filling out the questionnaire was almost 58%.

6.2 Analyses of Collected data

The data for 187 complete responses from the participants was filtered out from the total of 442 responses. The data of 255 incomplete responses was neglected during the analysis phase. The complete data for 187 respondents was then utilized for the analysis purpose. The analysis of collected data was divided into three parts. Figure 6.1 shows the division of data analysis into three stages.

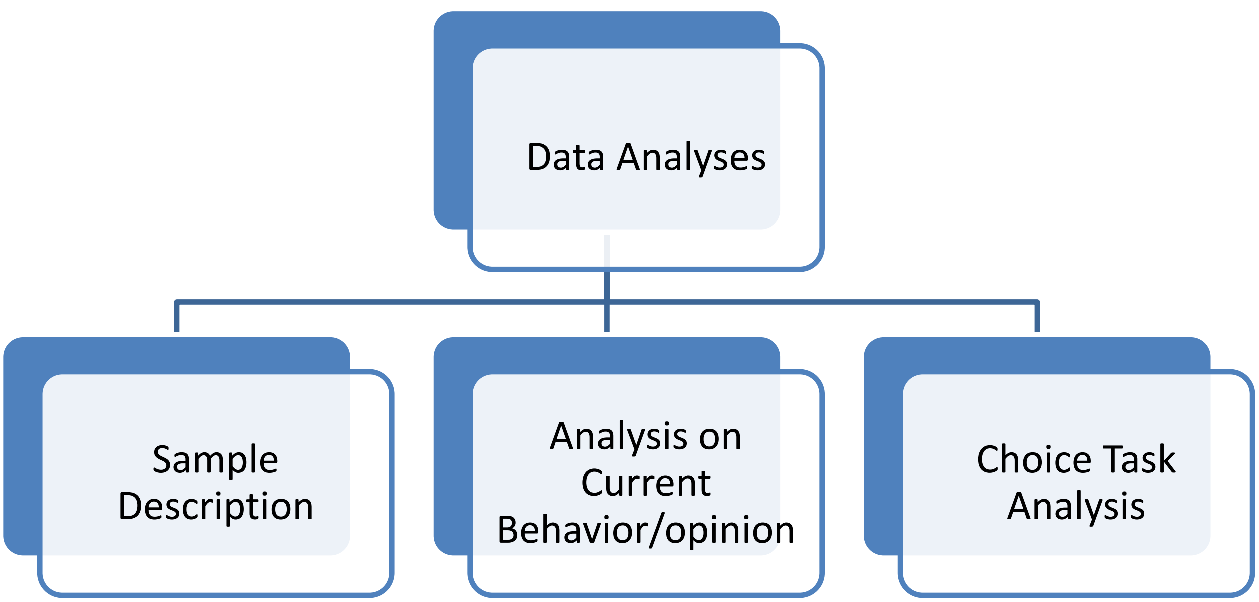

Figure 6.1 Different stages of data analyses

6.2.1 Sample Description

In this portion, different socio-demographic characteristics of the respondents have been discussed. These characteristics include gender, age, home location, education level and occupation.

Out of the 187 respondents, 63% of them are female. Figure 6.2 shows the gender wise distribution of the respondents. According to Belgian population data for 2011, 51% are female and 49% male [46]. The large difference could be justified with the help of a research which was done to see the effect of gender on survey [45]. The survey was carried out amongst the faculty members a university in south eastern part of USA. There were 981 faculty members (353 females and 628 males) who were invited to participate in the survey. 278 faculty members (127 females and 151 males) participated in the survey. This shows that the response rate of females (36%) which was more than the response rate of males (24%). This indicates that generally there is a trend in which females like to participate in the surveys more as compared to males. Perhaps non-daily shopping, also caught the attention of female respondents as this topic holds more importance for women as compared to men.

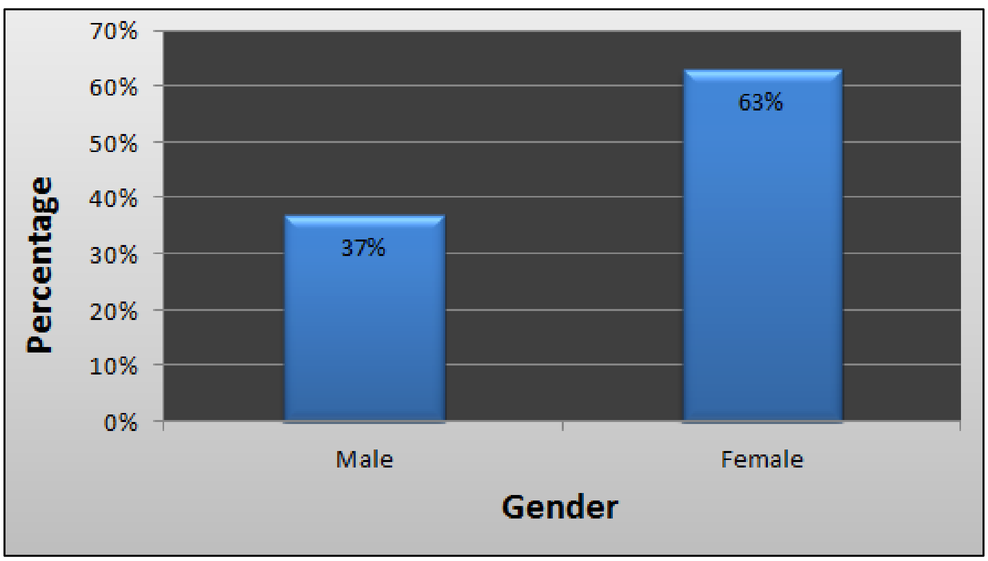

Figure 6.2 Gender-wise distribution of the respondents

Age of the respondents was also inquired in the questionnaire. On the basis of the results, three age categories could be made.

1. 18-30 years
2. 30-60 years
3. More than 60 years

Figure 6.3 shows the distribution of different age categories. It does not come as a surprise that 62% of the respondents fall in the 18-30 years category since the survey was conducted in the university. Most of the students are generally in their early to mid-twenties during the bachelors and masters phases of their education. 32% of the respondents are in the 30-60 age category. This age group would probably comprise of the faculty members.

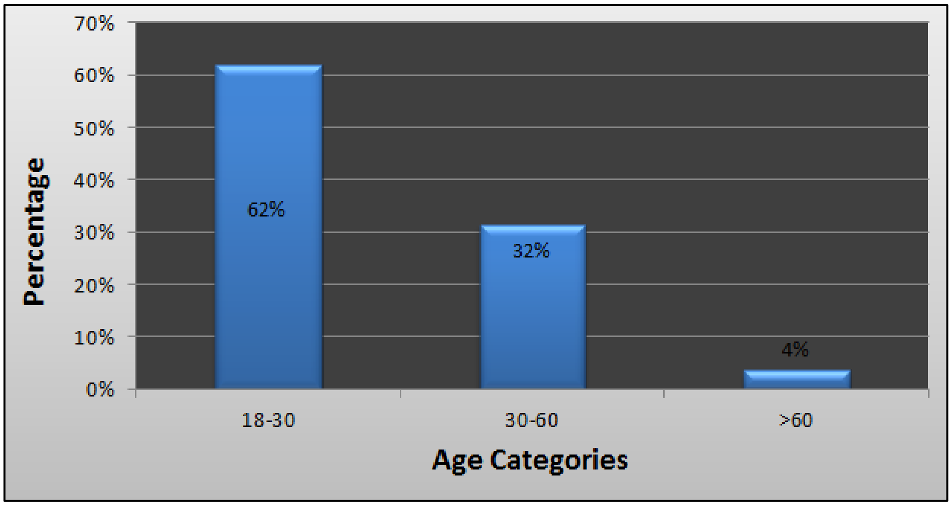

Figure 6.3 Distribution based on age categories

The results for home location can be seen in figure 6.4. There is not much difference between the three categories for home location. However, more respondents hail from rural and sub-urban portion of Belgium which have an equal distribution of 36%. Since the university is situated in Diepenbeek and presence of huge number of hostels in the nearby areas might have resulted in this amount of share.

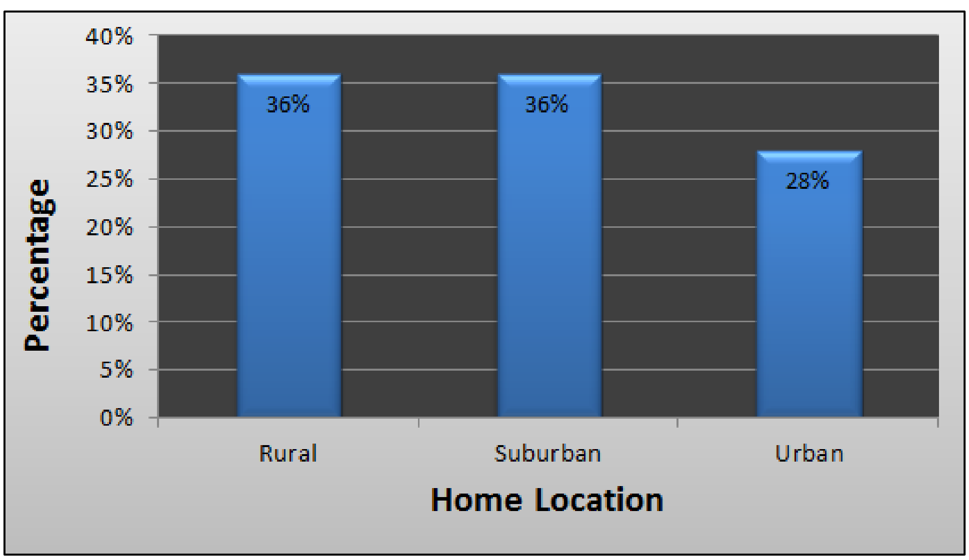

Figure 6.4 Distribution based on home location

As far as occupation is concerned, majority of the respondents are either students or employed. Since the respondents are the students and staff/faculty members of the university, this distribution is quite understandable. The employed category may also include some students who are pursuing a degree as well as working at the same time. Figure 6.5 shows the distribution based on the occupation of the respondents.

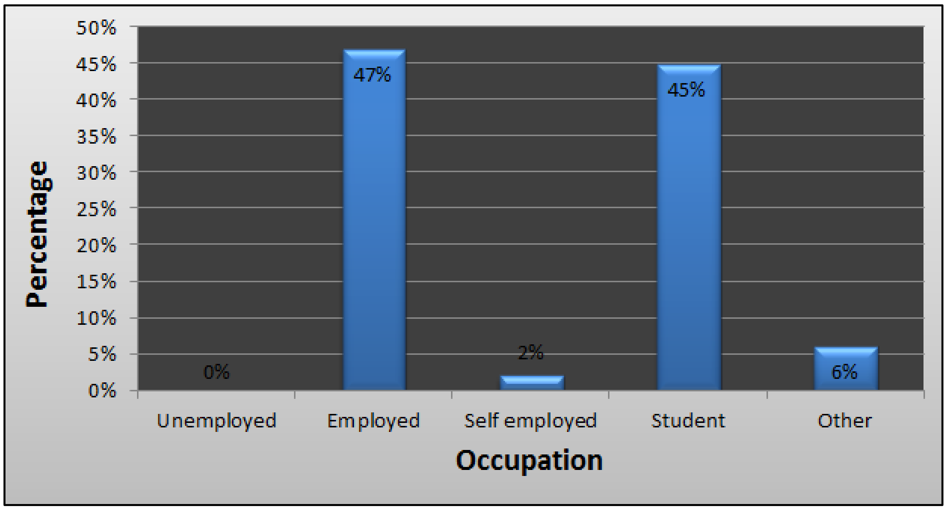

Figure 6.5 Distribution based on occupation

The results for the level of education are shown in figure 6.6. The results are very obvious since the survey was conducted at the university. However, the results are also in compliance with OECD [44]. According to OECD, 71% of the Belgian population has completed a degree equivalent to high school diploma. In this case 97% have a degree which is equal to high school diploma or a degree higher than high school diploma.

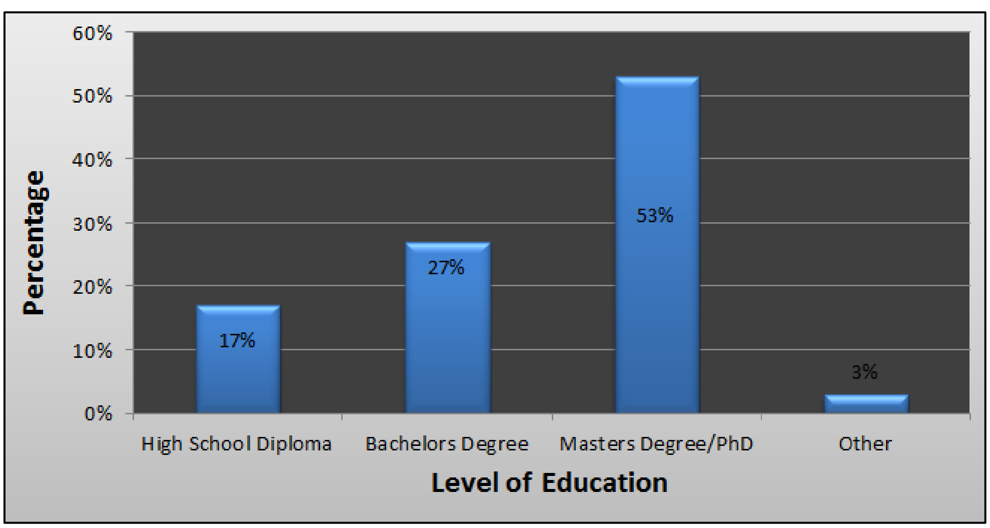

Figure 6.6 Distribution based on level of education

As far as disability is concerned, only 3 out of the 187 respondents indicated that they have any kind of hindrance in movement i.e they are suffering from disability. Figure 6.7 shows the percentage of disabled people amongst the respondents.

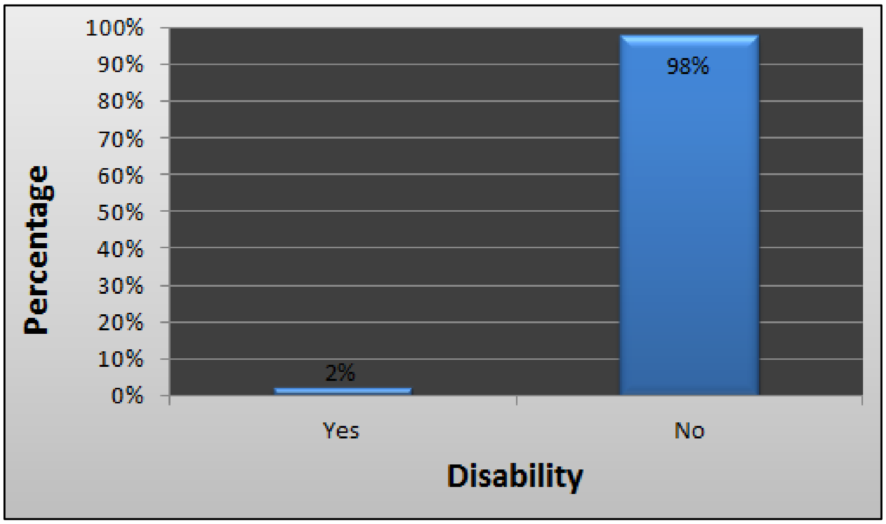

Figure 6.7 Distribution based on disability

6.2.2 <u>Current Behavior/Opinion</u>

In this portion, the current travel behavior and experiences regarding non-daily shopping trips would be analysed.

As far as the frequency of non-daily shopping trips is concerned, there is almost an even distribution amongst the three categories. These three categories include less than once per month (which implies one non-daily shopping trip in 2 months or more than two months), once per month and more than once per month. 37% of the respondents perform a non-daily shopping trip at least once per month. Figure 6.8 shows the distribution of different categories of frequency of non-daily shopping. This is an important result since it points out the fact that each respondent participating in the survey has an experience of non-daily shopping.

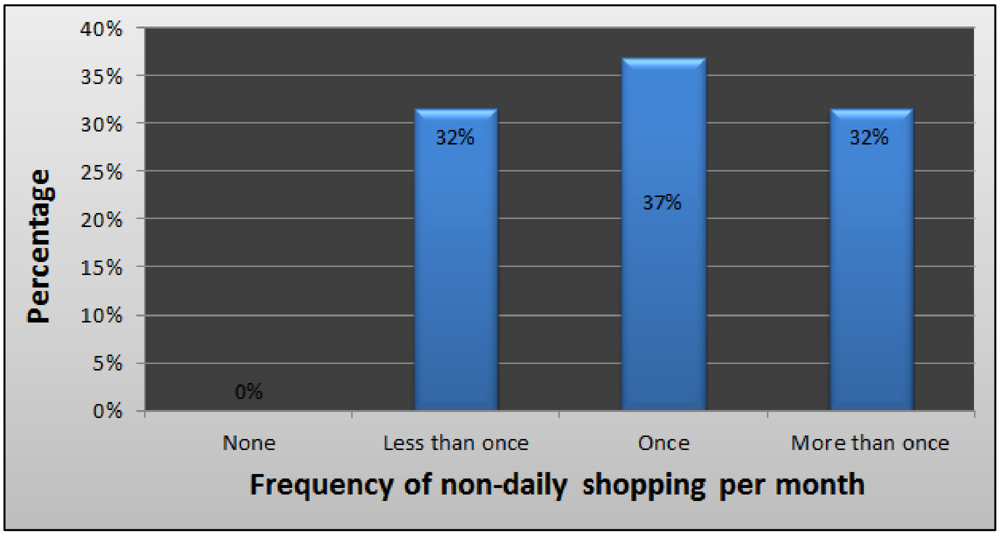

Figure 6.8 Frequency of non-daily shopping per month

The results for different modes used by the respondents while making a non-daily shopping trip are shown in figure 6.9. 67% of the respondents use car as a mode of travel while making a shopping trip. Therefore, there is a good chance that the respondents might have encountered a parking problem while performing a non-daily shopping trip.

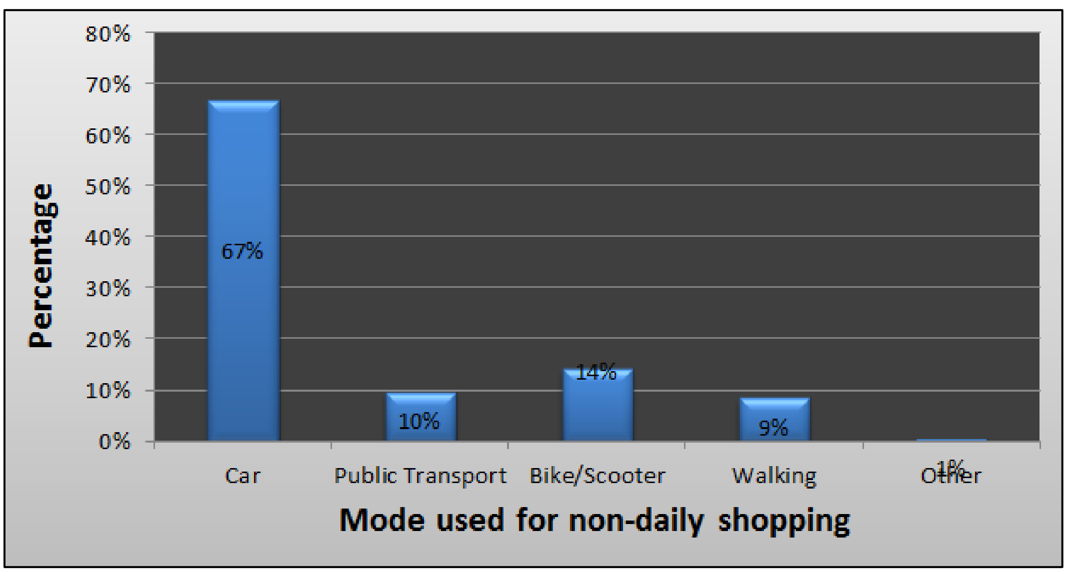

Figure 6.9 Modal split for non-daily shopping

Average travel time while performing a non-daily shopping trip was also inquired of the respondents. Figure 6.10 show the results for the average travel times of the respondents. According to the results 57% of the respondents have an average travel time of 10-20 minutes while performing a non-daily shopping trip. This indicates that probably the respondents prefer to go for shopping in the nearby areas.

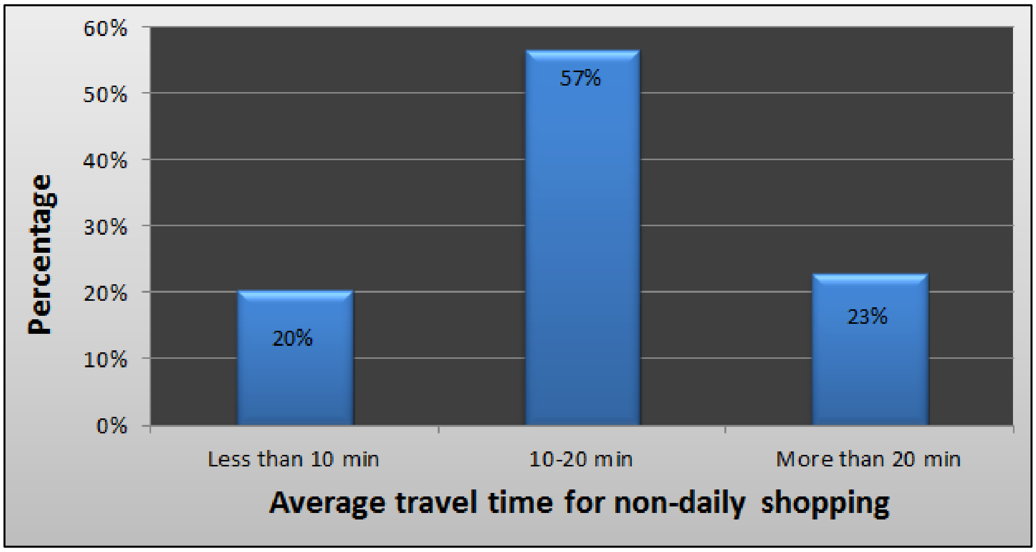

Figure 6.10 Average travel time for non-daily shopping

Figures 6.11 and 6.12 show the results regarding the importance and problems faced due to certain characteristics of accessibility. These characteristics include level of accessibility, parking search time and final walk time towards the destination after parking the vehicle.

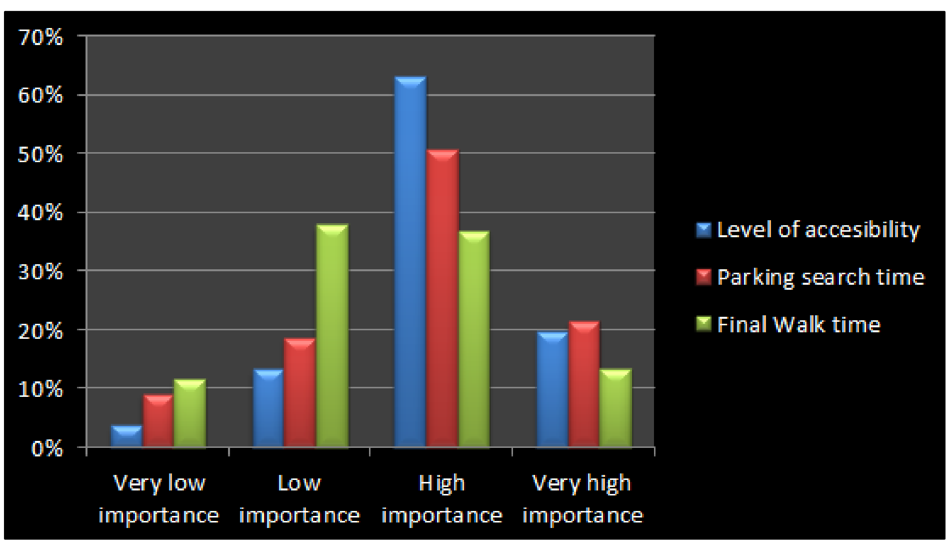

Figure 6.11 Level of importance for different attributes

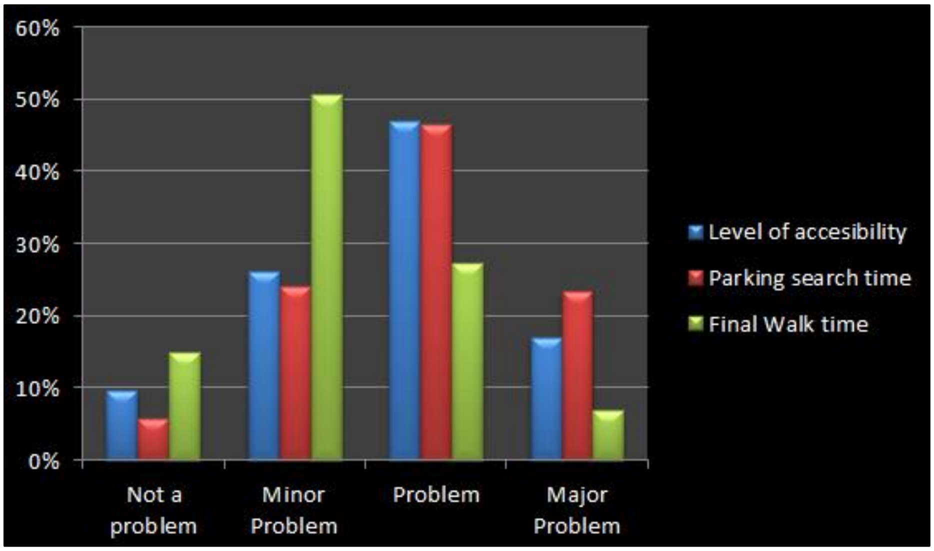

Figure 6.12 Problems caused by different attributes

From figure 6.11, we can see that the majority of the respondents think that level of accessibility and parking search times have high importance. This points to the fact that these two parameters play an important role in their decision making when they choose an area for shopping. Similarly from figure 6.12, it is clear that respondents consider low levels of accessibility and high parking search times as a problem.

From figure 6.12, it is clear that an important parameter of accessibility which is the final walk time towards destination is considered a minor problem by the respondents. Similarly from figure 6.11, it can be seen that the respondents are indifferent between the importance of final walk time. While choosing an area for shopping, 38% respondents think that final walk time is of low importance and 37% respondents think that final walk time is of high importance.

6.2.3 <u>Choice Task Analysis</u>

In order to setup the choice task analysis of the survey, data collected in Qualtrics was saved in the format of SPSS. The SPSS file was then converted into an input file for the software NLogit5.

The output of the discrete choice (multinomial logit) model is shown in figure 6.13. The dependent variable in this case was the choice made by the respondents. With the help of this model, the impact of the different independent/explanatory variables on the dependent variable could be analysed. These independent/explanatory variables include location, spatial distribution, walk time from home to vehicle, in-vehicle time, parking search time, final walk time towards the destination, parking charges and parking time limit.

The values of β coefficients and p-values are important while assessing the impact of a particular variable on a choice situation. From figure 6.13, it can be seen that the p-values are greater than 0.1 for the attributes such as spatial distribution, walk time from house to the vehicle and final walk time from vehicle to the destination. This points to the fact that these attributes do not influence the decision of the people while selecting an alternative for shopping.

The p-values are significant at different levels of significance for location (10%), in-vehicle time (1%), parking search time (1%), parking charges (5%) and parking time limits (1%). The β coefficients for attributes like in-vehicle time and parking search time are negative. This indicates that with the increasing levels of these time related attributes, the influence of these attributes on selection decreases. The β coefficients for attributes like parking charges and parking time limits are positive which indicates that with the increasing levels of these attributes, the influence of these attributes on selection increases. This implies that people are willing to pay more for a parking space if the time required to search for the parking is less. As far as the location is concerned, -1 was denoted as city centre while suburbs was denoted as 1. Therefore, a positive β coefficient points to the fact that respondents are inclined towards suburbs for non-daily shopping.

```
Discrete choice (multinomial logit) model
Dependent variable               Choice
Log likelihood function      -554.47843
Estimation based on N =     561, K =    8
Inf.Cr.AIC  =    1125.0 AIC/N =    2.005
Model estimated: May 11, 2015, 21:02:26
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only    -616.3161  .1003  .0939
Response data are given as ind. choices
Number of obs.=    561, skipped    0 obs
--------+--------------------------------------------------------------------
        |                  Standard            Prob.       95% Confidence
    ICHO|  Coefficient       Error       z     |z|>Z*         Interval
--------+--------------------------------------------------------------------
    CITY|      .08634*       .04953     1.74   .0813      -.01073     .18341
  DISTRI|      .00690        .05383      .13   .8980      -.09860     .11240
   WALKT|     -.04492        .05831     -.77   .4411      -.15921     .06937
     IVT|     -.07196***     .01164    -6.18   .0000      -.09477    -.04915
  SEARCH|     -.31296***     .04278    -7.32   .0000      -.39680    -.22911
 FINWALK|     -.01830        .06327     -.29   .7725      -.14231     .10572
  CHARGE|      .45606**      .22213     2.05   .0401       .02070     .89142
   LIMIT|      .04353***     .00891     4.89   .0000       .02607     .06099
--------+--------------------------------------------------------------------
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
-----------------------------------------------------------------------------
```

Figure 6.13 Output of the multinomial logit model

6.2.3.1 Effect of socio-economic parameters

a) Gender:

For both male and female, the p-values are significant at different levels of significance for in-vehicle time, parking search time and parking time limits. The β coefficients for attributes like in-vehicle time and parking search time are negative. This indicates that with the increasing levels of these time related attributes, the influence of these attributes on selection decreases. The β coefficient for parking time limit is positive which indicates that with the increasing levels of this attribute, the influence of this attribute on selection increases. The p-values are greater than 0.1 for attributes such as location, spatial distribution, walk time to vehicle, final walk time from vehicle to destination and parking charges. Therefore, these attributes have no influence during the selection process for both genders. From table 6.1, it can be seen that there is no clear difference as far as the significance of different attributes in selection is concerned. In-vehicle time, parking search time and parking time limits are significant attributes for both genders during the selection of an alternative for shopping.

Table 6.1 Gender (β coefficients and p-values)

Attributes	**Male**			**Female**		
	β coefficient	**P-values**	**Level of Significance**	**β coefficient**	**P-values**	**Level of Significance**
Location	0.0843	0.2909	-	0.0888	0.1604	-
Spatial Distribution	0.02061	0.8123	-	-0.00121	0.986	-
Walk time to vehicle	-0.02194	0.8145	-	-0.06078	0.4161	-
In-vehicle time	-0.07667	0	1%	-0.06893	0	1%
Parking search time	-0.28867	0	1%	-0.32920	0	1%
Final walk time to destination	-0.05121	0.6147	-	0.00149	0.9853	-
Parking charges	0.53282	0.1356	-	0.40265	0.1569	-
Parking time limit	0.03667	0.0115	5%	0.04786	0	1%

b) <u>Education:</u>

The category for education was divided into two groups for analysis purpose. The two groups are:

1. Masters degree or higher
2. Other

For the first group, the significant attributes influencing the selection include in-vehicle time, parking search time and parking time limit. However, for people having an education level of lower than masters, attributes such as location and parking charges also played an important role in the selection of an alternative for shopping alongside the attributes of in-vehicle time, parking search time and parking time limit. Table 6.2 shows the β coefficients and p-values for both levels of education.

Table 6.2 Level of education (β coefficients and p-values)

Attributes	Masters degree or higher			Other		
	β coefficient	P-values	Level of Significance	β coefficient	P-values	Level of Significance
Location	0.04673	0.5008	-	0.12409	0.0815	10%
Spatial Distribution	-0.01568	0.8351	-	0.0288	0.7101	-
Walk time to vehicle	-0.04953	0.5373	-	-0.03926	0.6451	-
In-vehicle time	-0.08819	0	1%	-0.05467	0.0012	1%
Parking search time	-0.31541	0	1%	-0.31026	0	1%
Final walk time to destination	0.00119	0.9893	-	-0.03529	0.6984	-
Parking charges	0.33246	0.2808	-	0.57594	0.073	10%
Parking time limit	0.04395	0.0004	1%	0.04274	0.0008	1%

c) <u>Age:</u>

The category for age was divided into two groups for analysis purpose. The two groups are:

1. Less than or equal to 30
2. More than 30

The significant attributes influencing the selection for people of ages equal to or less than 30 included in-vehicle time, parking search time, parking charges and parking time limits. However, for people with an age of more than 30, only in-vehicle time, parking search time and parking time limit play a role in the selection of an alternative for shopping. Table 6.3 shows the β coefficients and p-values for both age categories.

Table 6.3 Age (β coefficients and p-values)

Attributes	Age less than or equal to 30			Age more than 30		
	β coefficient	P-values	Level of Significance	β coefficient	P-values	Level of Significance
Location	0.09123	0.1511	-	0.07718	0.3315	-
Spatial Distribution	0.0235	0.7329	-	-0.01732	0.8412	-
Walk time to vehicle	-0.04514	0.5453	-	-0.0442	0.6373	-
In-vehicle time	-0.07341	0	1%	-0.07093	0.0001	1%
Parking search time	-0.31148	0	1%	-0.31629	0	1%
Final walk time to destination	-0.01571	0.8462	-	-0.02067	0.8388	-
Parking charges	0.59668	0.0388	5%	0.25164	0.4719	-
Parking time limit	0.05019	0	1%	0.03374	0.0155	5%

d) <u>Occupation:</u>

The category for occupation was divided into two groups for analysis purpose. The two groups are:

1. Employed/Self employed
2. Other (student, unemployed, retired)

For the first group, the significant attributes influencing the selection include in-vehicle time, parking search time and parking time limit. However, for people in the second group, parking charges also played an important role in the selection of an alternative for shopping alongside the attributes of in-vehicle time, parking search time and parking time limit. Table 6.4 shows the β coefficients and p-values for both occupation categories.

Table 6.4 Occupation (β coefficients and p-values)

Attributes	Employed/Self Employed			Other		
	β coefficient	P-values	Level of Significance	β coefficient	P-values	Level of Significance
Location	0.06632	0.3500	-	0.10143	0.1482	-
Spatial Distribution	-0.0731	0.3424	-	0.09628	0.2065	-
Walk time to vehicle	0.00328	0.9688	-	-0.0906	0.2732	-
In-vehicle time	-0.06674	0.0001	1%	-0.08022	0	1%
Parking search time	-0.28197	0	1%	-0.34499	0	1%
Final walk time to destination	-0.02542	0.7812	-	-0.02485	0.7792	-
Parking charges	0.24663	0.4358	-	0.71713	0.024	5%
Parking time limit	0.04655	0.0002	1%	0.04148	0.0012	1%

6.2.4 Analyses for Evaluation of Accessibility

Respondents were asked to evaluate the accessibility of each shopping area presented to them on a five point scale (1=very poor, 2=poor, 3=fair, 4=good, 5=very good). Figure 6.14 shows that the overall mean value of evaluation for accessibility is 3.20 which is near to fair.

A linear regression model was developed to analyze the role of different attributes in the evaluation of accessibility for a particular area of shopping. The output of the linear regression model is shown in figure 6.15. The dependent variable in this case was the evaluation of accessibility made by the respondents. With the help of this model, the impact of the different independent/explanatory variables on the dependent variable could be analysed. These independent/explanatory variables include location, spatial distribution, walk time from home to vehicle, in-vehicle time, parking search time, final walk time towards the destination, parking charges and parking time limit.

From figure 6.15, it can be seen that the p-values are greater than 0.1 for the attributes such as walk time from house to the vehicle and parking time limit. This points to the fact that these attributes do not influence the evaluation of accessibility by the people.

The p-values are significant at different levels of significance for location (10%), spatial distribution (1%), in-vehicle time (1%), parking search time (1%) and parking charges (1%). The β coefficients for these attributes are negative. This indicates that with the increasing levels of these attributes, the evaluation of accessibility for a shopping area is low. As far as the location is concerned, -1 was denoted as city centre while suburbs was denoted as 1. Therefore, a negative β coefficient points to the fact that in case of a city centre, the evaluation of accessibility for an area of shopping is high. When taking spatial distribution into account, -1 was denoted as concentrated while spread out was denoted as 1. Therefore, a negative β coefficient points to the fact that in case of concentrated, the evaluation of accessibility for an area of shopping is high.

Descriptive Statistics for 1 variables

Variable	Mean	Std.Dev.	Minimum	Maximum	Cases	Missing
EVALUATI	3.208138	.917710	1.0	5.0	639	0

Figure 6.14 Descriptive Statistics (Evaluation)

Ordinary least squares regression ....

LHS=EVALUATI	Mean	=	3.31788		
	Standard deviation	=	.88013		
----------	No. of observations	=	1683	DegFreedom	Mean square
Regression	Sum of Squares	=	118.137	8	14.76713
Residual	Sum of Squares	=	1184.79	1674	.70776
Total	Sum of Squares	=	1302.93	1682	.77463
----------	Standard error of e	=	.84129	Root MSE	.83903
Fit	R-squared	=	.09067	R-bar squared	.08632
Model test	F[8, 1674]	=	20.86452	Prob F > F*	.00000

Model was estimated on May 18, 2015 at 01:25:17 PM

EVALUATI	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
Constant	4.85863***	.26165	18.57	.0000	4.34581	5.37146
CITY	-.03888*	.02182	-1.78	.0748	-.08165	.00389
DISTRI	-.14617***	.02184	-6.69	.0000	-.18897	-.10337
WALKT	-.01981	.02519	-.79	.4316	-.06919	.02957
IVT	-.03919***	.00501	-7.82	.0000	-.04901	-.02937
SEARCH	-.08840***	.01645	-5.38	.0000	-.12063	-.05616
FINWALK	-.10861***	.02512	-4.32	.0000	-.15785	-.05937
CHARGE	-.21657***	.08264	-2.62	.0088	-.37853	-.05460
LIMIT	.00307	.00275	1.11	.2652	-.00233	.00846

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

Figure 6.15 Output of the linear regression model

6.2.4.1 Effect of socio-economic parameters

a) Gender:

For male, the attributes influencing the evaluation of accesibility include spatial distribution, in-vehicle time, parking search time, final walk time to destination and parking charges. However, for females along with these attributes parking time limit also played a role in the evaluation of accessibility. Table ?? shows the β coefficients and p-values for male and female.

Table 6.5 Gender (β coefficients and p-values) – Evaluation of Accessibility

Attributes	Male			Female		
	β coefficient	P-values	Level of Significance	β coefficient	P-values	Level of Significance
Location	-0.04788	0.197	-	-0.03234	0.2237	-
Spatial Distribution	-0.08381	0.0241	5%	-0.18549	0	1%
Walk time to vehicle	0.0071	0.8684	-	-0.03481	0.2565	-
In-vehicle time	-0.04556	0	1%	-0.03497	0	1%
Parking search time	-0.09649	0.0006	1%	-0.08336	0	1%
Final walk time to destination	-0.10643	0.013	5%	-0.10838	0.0004	1%
Parking charges	-0.25009	0.0761	10%	-0.19686	0.05	5%
Parking time limit	-0.00514	0.2747	-	0.00785	0.0188	5%

b) Education:

The category for education was divided into two groups for analysis purpose. The two groups are:

1. Masters degree or higher
2. Other

For the first group, the attributes influencing the evaluation for accessibility include spatial distribution, in-vehicle time, parking search time and final walk time to the destination. However, for people having an education level of lower than masters, along with these attributes parking charges also played an important role in the evaluation for accessibility of an alternative for shopping. Table 6.6 shows the β coefficients and p-values for both levels of education.

Table 6.6 Education Level (β coefficients and p-values) – Evaluation of Accessibility

Attributes	**Masters degree or higher**			**Other**		
	β coefficient	**P-values**	**Level of Significance**	**β coefficient**	**P-values**	**Level of Significance**
Location	-0.03292	0.2903	-	-0.04716	0.1218	-
Spatial Distribution	-0.15261	0	1%	-0.13922	0	1%
Walk time to vehicle	-0.00475	0.8949	-	-0.0374	0.288	-
In-vehicle time	-0.04752	0	1%	-0.02981	0	1%
Parking search time	-0.07445	0.0015	1%	-0.10388	0	1%
Final walk time to destination	-0.11032	0.002	1%	-0.10738	0.0023	1%
Parking charges	-0.19293	0.1011	-	-0.24425	0.0347	5%
Parking time limit	0.00073	0.8515	-	0.00571	0.1388	-

c) <u>Age:</u>

The category for age was divided into two groups for analysis purpose. The two groups are:

1. Less than or equal to 30
2. More than 30

For the first group, the attributes influencing the evaluation for accessibility include location, spatial distribution, in-vehicle time, parking search time, final walk time to the destination and parking charges. However, for people older than 30, spatial distribution, in-vehicle time, parking search time and final walk time to the destination played a role in the evaluation for accessibility of an alternative for shopping. Table 6.7 shows the β coefficients and p-values for both age categories.

Table 6.7 Age (β coefficients and p-values) – Evaluation of Accessibility

Attributes	Age less than 30			Age more than 30		
	β coefficient	P-values	Level of Significance	β coefficient	P-values	Level of Significance
Location	-0.04856	0.0809	10%	-0.02392	0.4896	-
Spatial Distribution	-0.16767	0	1%	-0.11344	0.001	1%
Walk time to vehicle	-0.01689	0.5989	-	-0.02447	0.5405	-
In-vehicle time	-0.03655	0	1%	-0.04340	0	1%
Parking search time	-0.10549	0	1%	-0.06317	0.0154	5%
Final walk time to destination	-0.11953	0.0002	1%	-0.09062	0.0227	5%
Parking charges	-0.23963	0.0231	5%	-0.18745	0.1519	-
Parking time limit	0.00239	0.497	-	0.00472	0.2776	-

d) <u>Occupation:</u>

The category for occupation was divided into two groups for analysis purpose. The two groups are:

1. Employed/Self employed
2. Other (student, unemployed, retired)

For the first group, the attributes influencing the evaluation for accessibility include location, spatial distribution, in-vehicle time, parking search time, final walk time to the destination, parking charges and parking time limit. However, for the second group, spatial distribution, in-vehicle time, parking search time, final walk time to the destination and parking charges played a role in the evaluation for accessibility of an alternative for shopping. Table 6.8 shows the β coefficients and p-values for both occupation categories.

Table 6.8 Occupation (β coefficients and p-values) – Evaluation of Accessibility

Attributes	Employed/Self Employed			Other		
	β coefficient	P-values	Level of Significance	β coefficient	P-values	Level of Significance
Location	-0.04215	0.1835	-	-0.03517	0.2348	-
Spatial Distribution	-0.15431	0	1%	-0.14167	0	1%
Walk time to vehicle	-0.01222	0.7386	-	-0.02783	0.4155	-
In-vehicle time	-0.03894	0	1%	-0.04030	0	1%
Parking search time	-0.08020	0.0008	1%	-0.10355	0	1%
Final walk time to destination	-0.06508	0.0734	10%	-0.14794	0	1%
Parking charges	-0.19926	0.0959	10%	-0.23323	0.0385	5%
Parking time limit	0.00707	0.0741	10%	0.00068	0.8559	-

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 General

Transportation sector is considered to be a backbone for any country. The sector of transportation plays an immense role in the development of a country. With the passage of time, vehicle ownership in the world is increasing. As a result of the rapid increase in vehicle ownership many transport related problems have risen namely traffic congestion, environmental pollution and traffic accidents.

An increase in vehicle ownership also led to an increase in demand for the parking spaces. Due to an increase in demand for the parking spaces, a number of traffic problems related to parking arose. These problems include congestion, accidents and environmental pollution caused by the cruise traffic which is the unnecessary traffic caused by the search for a parking spot.

The transport planners are looking forward to develop a sustainable transport system to overcome these problems. One of the characteristics of a sustainable transport system is the accessibility. Accessibility is the ease with which a person reaches the desired destination. One of the factors affecting accessibility is parking. Parking plays a vital role in the accessibility of destination since it is an integral part of the transportation system.

As discussed in the previous sections as well, the objective of this research is to evaluate the role of parking in the accessibility towards destination. A car journey can be divided into various stages. These stages include walk time to vehicle, in-vehicle time, parking search time and final walk time to the destination. The effect of the last part of the journey has been evaluated in this paper. By analyzing the effect of parking search time and final walk time to the destination, the role of parking in the accessibility of destination was evaluated.

7.2 Conclusions and recommendations

In order to evaluate the role of parking in accessibility, a stated preference survey was carried out. The stated preference survey consisted of a choice task. The choice task situation consisted of three shopping areas for non-daily shopping having certain attributes. Based on these attributes the users had to make a choice between the three shopping areas. The attributes included location, spatial distribution, walk time to vehicle, in-vehicle time, parking search time, final walk time to destination, parking charges and parking time limits. In the next phase, the respondents were requested to evaluate the accessibility of all the shopping areas presented to them in the choice task situation.

The analyses of the choice task portion of the survey revealed that attributes such as location, in-vehicle time, parking search time, parking charges and parking time limits play a major role in the selection of a shopping area. Whereas, spatial distribution, walk time to vehicle and final walk time from the vehicle to the destination does not influence the decision of individuals while selecting an area for shopping. It is not very surprising that final walk time towards the destination is not an influencing factor when it comes to selecting an area for shopping since in the current behavior/opinion of the survey, respondents indicated that high final walk times to the destination are a minor problem and their importance is low while considering an area for shopping. Therefore, the essential components of accessibility according to the choice task analyses are the in-vehicle times and the parking search times. This means that in the context of parking, parking search time is a vital component of the accessibility.

The effect of certain socio-economic parameters on the selection of a shopping area was also studied. The socio-economic characteristics included gender, age, education level and occupation. There was no special effect of these parameters on the overall decision process. The significant attributes in the selection of an area for shopping still remained in-vehicle time, parking search time, parking charges and parking time limits.

During the analyses of evaluation of accessibility, it was revealed that attributes such as location, spatial distribution, in-vehicle time, parking search time, final walk time to the destination and parking charges play a major role in the evaluation of accessibility. Whereas, walk time to vehicle and parking time limit does not influence the evaluation of accessibility of an area for shopping.

There is a difference in importance of attributes during the choice task portion of the survey and the portion regarding the evaluation of accessibility. The major difference is that the attribute of final walk time to the destination is considered important while evaluating the accessibility for a particular shopping area while it is not considered important during the choice situation. The difference might be due to the reason that people analyze both the situations differently. If the respondent was asked to evaluate the accessibility of a shopping area individually, he/she would give importance to the attributes of in-vehicle time, parking search time and final walk time to the destination. When the respondents were presented with three shopping areas simultaneously and asked to select one out of three on the basis of his/her preference, more importance was given to in-vehicle time and parking search time.

The effect of certain socio-economic parameters on the evaluation of a shopping area was also studied. The socio-economic characteristics included gender, age, education level and occupation. The evaluation of accessibility was effected by the parameters of education and age. People having a degree of masters or higher did not consider parking charges to be an important component while evaluating the accessibility of a shopping area. Similarly people with an age of more than 30 did not consider parking charges to be an important factor during the accessibility evaluation of an area. While the location of the shopping area was considered an important factor only by the people under the age of 30.

This paper evaluated the importance of components of parking in the accessibility of evaluation. As discussed earlier, attributes such as in-vehicle time, parking search time and final walk time towards the destination are different stages of a car journey. According to the results, people consider in-vehicle time, parking search time and final walk time towards the destination while evaluating the accessibility for a particular area. Whereas, walk time from home to vehicle is not of much importance. Therefore during future researches, inclusion of parameters such as parking search time and final walk time towards the destination are important in evaluating the role of parking in accessibility.

The division of car journey in various phases would be ideal to evaluate the role of parking in accessibility. During future travel surveys, various classifications could be made regarding the travel time. The total travel time currently is the time taken to reach a particular destination from the place of origin of journey. Division of travel time into walk time to vehicle, in-vehicle time, parking search time and final walk time to the destinations would be helpful in evaluating the role of each phase of journey in the accessibility of destination. The role of parking could be evaluated by studying the effect of last part of the journey on the overall accessibility. Therefore, this research could prove as a frame of reference for transport planners to include various attributes of parking to assess the overall accessibility of the destination.

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APPENDICES

A. QUESTIONNAIRE

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INTRODUCTION

Dear Participant,

Welcome. I am conducting a survey to carry out my research on the topic "Effects of parking on accessibility". The survey would only take 5-10 minutes of your precious time. I request you to fill out the questionnaire. I would be grateful for your cooperation. All the questions are being asked for research purposes only and your answers would be handled with care.

The survey is being carried out to see what preferences you have while going for **non-daily shopping**. Non-daily shopping refers to the shopping trips done to buy things like shoes, clothes, electronic items etc. All the questions asked in this survey are in the context of **non-daily shopping**.

Thank you.

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How often do you go for non-daily shopping per month?

- None
- Less than once
- Once
- More than once

Which transport mode do you mostly use to go for non-daily shopping?

- Car
- Public Transport
- Bike/Scooter
- Walking
- Other

What is the average travel time required from your home to reach the shopping area that you often go to?

- Less than 10 min
- 10-20 min
- More than 20 min

What is the importance of the following characteristics in your opinion when you are choosing an area for shopping?

	Very low importance	Low importance	High importance	Very high importance
Level of accessibility	○	○	○	○
Parking search time	○	○	○	○
Final walk time towards destination after parking the vehicle	○	○	○	○

How would you rate the following problems while going to a shopping area?

	Not a problem	Minor problem	Problem	Major problem
Low levels of accessibility	○	○	○	○
High parking search time	○	○	○	○
High final walk time towards destination after parking the vehicle	○	○	○	○

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GUIDELINES

In this part of the survey, you would be provided with different choice situations. These choice situations contain three shopping areas having certain characteristics.

From the mentioned three shopping alternatives, you are requested to choose one which you think is highly accessible for you. You would be provided with three such tasks. Some characteristics of the shopping alternatives are self explanatory while some others are explained below:

The time attributes represent different stages of a car journey which include walk time from home to vehicle, in-vehicle time, parking search time and final walk time towards destination after parking your vehicle.

Spatial distribution refers to the distribution of shops in the area. **Concentrated spatial distribution** refers to the high density of shops across a particular area i.e the shops are located very close to each other. **Spread out spatial distribution** means the low density of shops across a particular area i.e the shops are located at a distance from each other and are not very close to each other.

Following is a sample question for this portion of the survey. You are requested to answer this question.

Which of the following three shopping areas would you prefer to go for shopping based on the following characteristics?

Shopping Area 1		Shopping Area 2		Shopping Area 3	
Location	City centre	Location	City centre	Location	Suburbs
Spatial Distribution	Concentrated	Spatial Distribution	Spread out	Spatial Distribution	Spread out
Walk time to vehicle	2 min	Walk time to vehicle	1 min	Walk time to vehicle	1 min
In-vehicle time	15 min	In-vehicle time	25 min	In-vehicle time	20 min
Parking search time	3 min	Parking search time	5 min	Parking search time	5 min
Final walk time	3 min	Final walk time	2 min	Final walk time	4 min
Parking charges	1.50 €	Parking charges	1 €	Parking charges	1.50 €
Parking time limit	75 min	Parking time limit	60 min	Parking time limit	75 min

○ ○ ○

How would you rate the accessibility conditions of the three shopping malls with the characteristics as described in the question above?

	Very Poor	Poor	Fair	Good	Very Good
Shopping area 1	○	○	○	○	○
Shopping area 2	○	○	○	○	○
Shopping area 3	○	○	○	○	○

In which of the following ranges is your month of birth?

Note: The choice situations are divided into three sets having three questions each. Depending on your answer, a set of three questions would be selected for you.

- ○ January-April
- ○ May-August
- ○ September-December

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Which of the following three shopping areas would you prefer to go for shopping based on the following characteristics?

Shopping Area 1		Shopping Area 2		Shopping Area 3	
Location	**City centre**	Location	**City centre**	Location	**Suburbs**
Spatial Distribution	**Concentrated**	Spatial Distribution	**Spread out**	Spatial Distribution	**Spread out**
Walk time to vehicle	**2 min**	Walk time to vehicle	**1 min**	Walk time to vehicle	**1 min**
In-vehicle time	**15 min**	In-vehicle time	**25 min**	In-vehicle time	**20 min**
Parking search time	**3 min**	Parking search time	**5 min**	Parking search time	**5 min**
Final walk time	**3 min**	Final walk time	**2 min**	Final walk time	**4 min**
Parking charges	**1.50 €**	Parking charges	**1 €**	Parking charges	**1.50 €**
Parking time limit	**75 min**	Parking time limit	**60 min**	Parking time limit	**75 min**

How would you rate the accessibility conditions of the three shopping malls with the characteristics as described in the question above?

	Very Poor	Poor	Fair	Good	Very Good
Shopping area 1	○	○	○	○	○
Shopping area 2	○	○	○	○	○
Shopping area 3	○	○	○	○	○

Which of the following three shopping areas would you prefer to go for shopping based on the following characteristics?

Shopping Area 1		Shopping Area 2		Shopping Area 3	
Location	City centre	Location	City centre	Location	City centre
Spatial Distribution	Spread out	Spatial Distribution	Concentrated	Spatial Distribution	Spread out
Walk time to vehicle	2 min	Walk time to vehicle	1 min	Walk time to vehicle	2 min
In-vehicle time	25 min	In-vehicle time	20 min	In-vehicle time	15 min
Parking search time	2 min	Parking search time	3 min	Parking search time	2 min
Final walk time	3 min	Final walk time	2 min	Final walk time	4 min
Parking charges	1.50 €	Parking charges	1 €	Parking charges	1 €
Parking time limit	60 min	Parking time limit	75 min	Parking time limit	75 min

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How would you rate the accessibility conditions of the three shopping malls with the characteristics as described in the question above?

	Very Poor	Poor	Fair	Good	Very Good
Shopping area 1					
Shopping area 2					
Shopping area 3					

Which of the following three shopping areas would you prefer to go for shopping based on the following characteristics?

Shopping Area 1		Shopping Area 2		Shopping Area 3	
Location	Suburbs	Location	City centre	Location	City centre
Spatial Distribution	Spread out	Spatial Distribution	Spread out	Spatial Distribution	Spread out
Walk time to vehicle	2 min	Walk time to vehicle	1 min	Walk time to vehicle	3 min
In-vehicle time	15 min	In-vehicle time	25 min	In-vehicle time	25 min
Parking search time	5 min	Parking search time	3 min	Parking search time	2 min
Final walk time	2 min	Final walk time	3 min	Final walk time	2 min
Parking charges	1 €	Parking charges	1 €	Parking charges	1.50 €
Parking time limit	75 min	Parking time limit	60 min	Parking time limit	75 min

How would you rate the accessibility conditions of the three shopping malls with the characteristics as described in the question above?

	Very Poor	Poor	Fair	Good	Very Good
Shopping area 1					
Shopping area 2					
Shopping area 3					

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Which of the following three shopping areas would you prefer to go for shopping based on the following characteristics?

Shopping Area 1	
Location	City centre
Spatial Distribution	Spread out
Walk time to vehicle	1 min
In-vehicle time	15 min
Parking search time	2 min
Final walk time	2 min
Parking charges	1.50 €
Parking time limit	75 min

Shopping Area 2	
Location	Suburbs
Spatial Distribution	Spread out
Walk time to vehicle	3 min
In-vehicle time	20 min
Parking search time	3 min
Final walk time	3 min
Parking charges	1.50 €
Parking time limit	75 min

Shopping Area 3	
Location	City centre
Spatial Distribution	Concentrated
Walk time to vehicle	2 min
In-vehicle time	25 min
Parking search time	5 min
Final walk time	4 min
Parking charges	1 €
Parking time limit	75 min

How would you rate the accessibility conditions of the three shopping malls with the characteristics as described in the question above?

	Very Poor	Poor	Fair	Good	Very Good
Shopping area 1					
Shopping area 2					
Shopping area 3					

Which of the following three shopping areas would you prefer to go for shopping based on the following characteristics?

Shopping Area 1		Shopping Area 2		Shopping Area 3	
Location	City centre	Location	Suburbs	Location	City centre
Spatial Distribution	Spread out	Spatial Distribution	Concentrated	Spatial Distribution	Spread out
Walk time to vehicle	3 min	Walk time to vehicle	2 min	Walk time to vehicle	1 min
In-vehicle time	15 min	In-vehicle time	20 min	In-vehicle time	20 min
Parking search time	5 min	Parking search time	2 min	Parking search time	2 min
Final walk time	4 min	Final walk time	2 min	Final walk time	3 min
Parking charges	1.50 €	Parking charges	1 €	Parking charges	1 €
Parking time limit	60 min	Parking time limit	60 min	Parking time limit	75 min

---

How would you rate the accessibility conditions of the three shopping malls with the characteristics as described in the question above?

	Very Poor	Poor	Fair	Good	Very Good
Shopping area 1					
Shopping area 2					
Shopping area 3					

Which of the following three shopping areas would you prefer to go for shopping based on the following characteristics?

Shopping Area 1		Shopping Area 2		Shopping Area 3	
Location	City centre	Location	Suburbs	Location	City centre
Spatial Distribution	Concentrated	Spatial Distribution	Concentrated	Spatial Distribution	Spread out
Walk time to vehicle	3 min	Walk time to vehicle	3 min	Walk time to vehicle	2 min
In-vehicle time	25 min	In-vehicle time	15 min	In-vehicle time	20 min
Parking search time	3 min	Parking search time	2 min	Parking search time	3 min
Final walk time	4 min	Final walk time	3 min	Final walk time	4 min
Parking charges	1 €	Parking charges	1 €	Parking charges	1.50 €
Parking time limit	75 min	Parking time limit	60 min	Parking time limit	60 min

How would you rate the accessibility conditions of the three shopping malls with the characteristics as described in the question above?

	Very Poor	Poor	Fair	Good	Very Good
Shopping area 1					
Shopping area 2					
Shopping area 3					

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Which of the following three shopping areas would you prefer to go for shopping based on the following characteristics?

Shopping Area 1		Shopping Area 2		Shopping Area 3	
Location	**Suburbs**	Location	**Suburbs**	Location	**City centre**
Spatial Distribution	**Spread out**	Spatial Distribution	**Spread out**	Spatial Distribution	**Concentrated**
Walk time to vehicle	**3 min**	Walk time to vehicle	**1 min**	Walk time to vehicle	**3 min**
In-vehicle time	**25 min**	In-vehicle time	**15 min**	In-vehicle time	**20 min**
Parking search time	**5 min**	Parking search time	**3 min**	Parking search time	**5 min**
Final walk time	**3 min**	Final walk time	**4 min**	Final walk time	**2 min**
Parking charges	**1 €**	Parking charges	**1 €**	Parking charges	**1.50 €**
Parking time limit	**75 min**	Parking time limit	**60 min**	Parking time limit	**60 min**

How would you rate the accessibility conditions of the three shopping malls with the characteristics as described in the question above?

	Very Poor	Poor	Fair	Good	Very Good
Shopping area 1					
Shopping area 2					
Shopping area 3					

Which of the following three shopping areas would you prefer to go for shopping based on the following characteristics?

Shopping Area 1		Shopping Area 2		Shopping Area 3	
Location	City centre	Location	Suburbs	Location	City centre
Spatial Distribution	Spread out	Spatial Distribution	Spread out	Spatial Distribution	Concentrated
Walk time to vehicle	3 min	Walk time to vehicle	2 min	Walk time to vehicle	1 min
In-vehicle time	20 min	In-vehicle time	25 min	In-vehicle time	15 min
Parking search time	2 min	Parking search time	3 min	Parking search time	5 min
Final walk time	4 min	Final walk time	2 min	Final walk time	3 min
Parking charges	1 €	Parking charges	1.50 €	Parking charges	1.50 €
Parking time limit	60 min	Parking time limit	60 min	Parking time limit	60 min

---

How would you rate the accessibility conditions of the three shopping malls with the characteristics as described in the question above?

	Very Poor	Poor	Fair	Good	Very Good
Shopping area 1					
Shopping area 2					
Shopping area 3					

Which of the following three shopping areas would you prefer to go for shopping based on the following characteristics?

Shopping Area 1		Shopping Area 2		Shopping Area 3	
Location	City centre	Location	Suburbs	Location	City centre
Spatial Distribution	Spread out	Spatial Distribution	Concentrated	Spatial Distribution	Spread out
Walk time to vehicle	2 min	Walk time to vehicle	1 min	Walk time to vehicle	3 min
In-vehicle time	20 min	In-vehicle time	25 min	In-vehicle time	15 min
Parking search time	5 min	Parking search time	2 min	Parking search time	3 min
Final walk time	3 min	Final walk time	4 min	Final walk time	2 min
Parking charges	1 €	Parking charges	1.50 €	Parking charges	1 €
Parking time limit	60 min	Parking time limit	60 min	Parking time limit	60 min

How would you rate the accessibility conditions of the three shopping malls with the characteristics as described in the question above?

	Very Poor	Poor	Fair	Good	Very Good
Shopping area 1					
Shopping area 2					
Shopping area 3					

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What is your gender?

- Male
- Female

What is the location of home?

- Rural
- Suburban
- Urban

Which city/town are you currently living in?

Which city/town do you often go to for non-daily shopping?

[ ]

What is your age?

[ ]

What is your occupation ?

- Unemployed
- Employed
- Self employed
- Student
- Other [ ]

What is the highest level of your education ?

- High School Diploma
- Bachelors Degree
- Masters Degree/PhD
- Other [ ]

Do you have any particular difficulty while moving such as disability ?

- Yes
- No

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Thank you very much for filling out the questionnaire. If you have any comments or suggestions regarding the questionnaire, please leave them in the box below.

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We thank you for your time spent taking this survey.
Your response has been recorded.

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B. NLogit5 outputs

1. Output of the multinomial logit model

```
Discrete choice (multinomial logit) model
Dependent variable              Choice
Log likelihood function      -554.47843
Estimation based on N =     561, K =   8
Inf.Cr.AIC  =    1125.0 AIC/N =    2.005
Model estimated: May 11, 2015, 21:02:26
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only    -616.3161  .1003 .0939
Response data are given as ind. choices
Number of obs.=    561, skipped    0 obs
```

ICHO	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
CITY	.08634*	.04953	1.74	.0813	-.01073	.18341
DISTRI	.00690	.05383	.13	.8980	-.09860	.11240
WALKT	-.04492	.05831	-.77	.4411	-.15921	.06937
IVT	-.07196***	.01164	-6.18	.0000	-.09477	-.04915
SEARCH	-.31296***	.04278	-7.32	.0000	-.39680	-.22911
FINWALK	-.01830	.06327	-.29	.7725	-.14231	.10572
CHARGE	.45606**	.22213	2.05	.0401	.02070	.89142
LIMIT	.04353***	.00891	4.89	.0000	.02607	.06099

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

2. Output of the multinomial logit model (Male)

```
Discrete choice (multinomial logit) model
Dependent variable              Choice
Log likelihood function      -212.42928
Estimation based on N =     213, K =   8
Inf.Cr.AIC  =    440.9 AIC/N =    2.070
Model estimated: May 29, 2015, 22:36:31
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only    -233.5703  .0905 .0731
Response data are given as ind. choices
Number of obs.=    213, skipped    0 obs
```

ICHO	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
CITY	.08430	.07982	1.06	.2909	-.07214	.24074
DISTRI	.02061	.08681	.24	.8123	-.14953	.19075
WALKT	-.02194	.09351	-.23	.8145	-.20522	.16134
IVT	-.07667***	.01888	-4.06	.0000	-.11368	-.03966
SEARCH	-.28867***	.06868	-4.20	.0000	-.42328	-.15406
FINWALK	-.05121	.10175	-.50	.6147	-.25063	.14821
CHARGE	.53282	.35707	1.49	.1356	-.16703	1.23266
LIMIT	.03667**	.01451	2.53	.0115	.00824	.06510

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

3. Output of the multinomial logit model (Female)

```
Discrete choice (multinomial logit) model
Dependent variable               Choice
Log likelihood function      -341.44193
Estimation based on N =    348, K =   8
Inf.Cr.AIC  =    698.9 AIC/N =    2.008
Model estimated: May 29, 2015, 22:37:58
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only    -381.9781  .1061 .0957
Response data are given as ind. choices
Number of obs.=   348, skipped    0 obs
```

ICHO	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
CITY	.08880	.06326	1.40	.1604	-.03519	.21279
DISTRI	-.00121	.06870	-.02	.9860	-.13585	.13344
WALKT	-.06078	.07473	-.81	.4161	-.20724	.08569
IVT	-.06893***	.01480	-4.66	.0000	-.09793	-.03992
SEARCH	-.32920***	.05487	-6.00	.0000	-.43675	-.22166
FINWALK	.00149	.08089	.02	.9853	-.15705	.16004
CHARGE	.40265	.28447	1.42	.1569	-.15489	.96019
LIMIT	.04786***	.01131	4.23	.0000	.02569	.07002

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

4. Output of the multinomial logit model (Masters degree or higher)

```
Discrete choice (multinomial logit) model
Dependent variable               Choice
Log likelihood function      -288.27242
Estimation based on N =    297, K =   8
Inf.Cr.AIC  =    592.5 AIC/N =    1.995
Model estimated: May 29, 2015, 23:09:27
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only    -326.1969  .1163 .1042
Response data are given as ind. choices
Number of obs.=   297, skipped    0 obs
```

ICHO	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
CITY	.04673	.06941	.67	.5008	-.08932	.18277
DISTRI	-.01568	.07535	-.21	.8351	-.16337	.13200
WALKT	-.04953	.08029	-.62	.5373	-.20689	.10784
IVT	-.08819***	.01611	-5.48	.0000	-.11976	-.05662
SEARCH	-.31541***	.05854	-5.39	.0000	-.43014	-.20067
FINWALK	.00119	.08853	.01	.9893	-.17233	.17470
CHARGE	.33246	.30828	1.08	.2808	-.27175	.93667
LIMIT	.04395***	.01246	3.53	.0004	.01952	.06838

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

5. Output of the multinomial logit model (Education level lower than masters)

```
Discrete choice (multinomial logit) model
Dependent variable               Choice
Log likelihood function      -264.25904
Estimation based on N =     264, K =   8
Inf.Cr.AIC  =     544.5 AIC/N =    2.063
Model estimated: May 29, 2015, 23:12:02
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only    -289.9545  .0886  .0746
Response data are given as ind. choices
Number of obs.=    264, skipped    0 obs
```

ICHO	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
CITY	.12409*	.07124	1.74	.0815	-.01553	.26372
DISTRI	.02880	.07749	.37	.7101	-.12307	.18068
WALKT	-.03926	.08522	-.46	.6451	-.20628	.12777
IVT	-.05467***	.01693	-3.23	.0012	-.08785	-.02150
SEARCH	-.31026***	.06296	-4.93	.0000	-.43366	-.18686
FINWALK	-.03529	.09108	-.39	.6984	-.21381	.14322
CHARGE	.57594*	.32120	1.79	.0730	-.05360	1.20547
LIMIT	.04274***	.01275	3.35	.0008	.01775	.06774

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

6. Output of the multinomial logit model (Age below 30)

```
Discrete choice (multinomial logit) model
Dependent variable               Choice
Log likelihood function      -339.29199
Estimation based on N =     345, K =   8
Inf.Cr.AIC  =     694.6 AIC/N =    2.013
Model estimated: May 29, 2015, 22:57:45
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only    -378.8821  .1045  .0940
Response data are given as ind. choices
Number of obs.=    345, skipped    0 obs
```

ICHO	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
CITY	.09123	.06355	1.44	.1511	-.03332	.21579
DISTRI	.02350	.06887	.34	.7329	-.11148	.15849
WALKT	-.04514	.07464	-.60	.5453	-.19144	.10115
IVT	-.07341***	.01507	-4.87	.0000	-.10294	-.04387
SEARCH	-.31148***	.05456	-5.71	.0000	-.41842	-.20454
FINWALK	-.01571	.08098	-.19	.8462	-.17442	.14300
CHARGE	.59668**	.28878	2.07	.0388	.03069	1.16267
LIMIT	.05019***	.01164	4.31	.0000	.02738	.07299

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

7. Output of the multinomial logit model (Age above 30)

```
Discrete choice (multinomial logit) model
Dependent variable                Choice
Log likelihood function      -214.52435
Estimation based on N =    216, K =   8
Inf.Cr.AIC  =    445.0 AIC/N =    2.060
Model estimated: May 29, 2015, 22:56:11
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only   -237.0065  .0949 .0778
Response data are given as ind. choices
Number of obs.=   216, skipped    0 obs
```

ICHO	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
CITY	.07718	.07948	.97	.3315	-.07861	.23297
DISTRI	-.01732	.08649	-.20	.8412	-.18684	.15220
WALKT	-.04420	.09376	-.47	.6373	-.22796	.13956
IVT	-.07093***	.01846	-3.84	.0001	-.10710	-.03475
SEARCH	-.31629***	.06906	-4.58	.0000	-.45165	-.18093
FINWALK	-.02067	.10159	-.20	.8388	-.21979	.17845
CHARGE	.25164	.34980	.72	.4719	-.43396	.93723
LIMIT	.03374**	.01393	2.42	.0155	.00643	.06105

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

8. Output of the multinomial logit model (Employed/Self employed)

```
Discrete choice (multinomial logit) model
Dependent variable                Choice
Log likelihood function      -268.66307
Estimation based on N =    270, K =   8
Inf.Cr.AIC  =    553.3 AIC/N =    2.049
Model estimated: May 29, 2015, 23:02:44
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only   -296.3111  .0933 .0797
Response data are given as ind. choices
Number of obs.=   270, skipped    0 obs
```

ICHO	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
CITY	.06632	.07095	.93	.3500	-.07275	.20538
DISTRI	-.07310	.07699	-.95	.3424	-.22399	.07779
WALKT	.00328	.08391	.04	.9688	-.16119	.16775
IVT	-.06674***	.01657	-4.03	.0001	-.09922	-.03425
SEARCH	-.28197***	.06136	-4.60	.0000	-.40223	-.16172
FINWALK	-.02542	.09154	-.28	.7812	-.20484	.15400
CHARGE	.24663	.31650	.78	.4358	-.37370	.86695
LIMIT	.04655***	.01262	3.69	.0002	.02182	.07129

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

9. Output of the multinomial logit model (Unemployed, Student, Retired)

```
-----------------------------------------------------------------------------
Discrete choice (multinomial logit) model
Dependent variable               Choice
Log likelihood function      -283.26959
Estimation based on N =    291, K =   8
Inf.Cr.AIC  =    582.5 AIC/N =    2.002
Model estimated: May 29, 2015, 23:04:59
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only   -319.5018  .1134 .1010
Response data are given as ind. choices
Number of obs.=   291, skipped    0 obs
--------+--------------------------------------------------------------------
        |                Standard            Prob.      95% Confidence
    ICHO|  Coefficient     Error       z    |z|>Z*         Interval
--------+--------------------------------------------------------------------
    CITY|     .10143       .07014     1.45  .1482     -.03605    .23890
  DISTRI|     .09628       .07622     1.26  .2065     -.05310    .24567
   WALKT|    -.09060       .08268    -1.10  .2732     -.25266    .07146
     IVT|    -.08022***    .01667    -4.81  .0000     -.11290   -.04754
  SEARCH|    -.34499***    .06037    -5.71  .0000     -.46330   -.22667
 FINWALK|    -.02485       .08863     -.28  .7792     -.19856    .14886
  CHARGE|     .71713**     .31765     2.26  .0240      .09455   1.33971
   LIMIT|     .04148***    .01277     3.25  .0012      .01645    .06651
--------+--------------------------------------------------------------------
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
-----------------------------------------------------------------------------
```

10. Output of the multinomial logit model (Home location: Rural)

```
-----------------------------------------------------------------------------
Discrete choice (multinomial logit) model
Dependent variable               Choice
Log likelihood function      -201.52765
Estimation based on N =    201, K =   8
Inf.Cr.AIC  =    419.1 AIC/N =    2.085
Model estimated: May 29, 2015, 22:41:33
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only   -220.1735  .0847 .0661
Response data are given as ind. choices
Number of obs.=   201, skipped    0 obs
--------+--------------------------------------------------------------------
        |                Standard            Prob.      95% Confidence
    ICHO|  Coefficient     Error       z    |z|>Z*         Interval
--------+--------------------------------------------------------------------
    CITY|     .05115       .08448      .61  .5449     -.11443    .21673
  DISTRI|     .02124       .09082      .23  .8151     -.15676    .19924
   WALKT|     .02294       .10091      .23  .8202     -.17484    .22072
     IVT|    -.05341***    .01929    -2.77  .0056     -.09122   -.01559
  SEARCH|    -.30744***    .07226    -4.25  .0000     -.44907   -.16581
 FINWALK|    -.06704       .10371     -.65  .5180     -.27030    .13622
  CHARGE|     .33619       .37216      .90  .3663     -.39322   1.06561
   LIMIT|     .04933***    .01494     3.30  .0010      .02004    .07861
--------+--------------------------------------------------------------------
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
-----------------------------------------------------------------------------
```

11. Output of the multinomial logit model (Home location: Suburban)

```
-----------------------------------------------------------------------------
Discrete choice (multinomial logit) model
Dependent variable                Choice
Log likelihood function       -350.71587
Estimation based on N =     360, K =    8
Inf.Cr.AIC  =     717.4 AIC/N =     1.993
Model estimated: May 29, 2015, 22:54:13
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only   -395.2430  .1127 .1027
Response data are given as ind. choices
Number of obs.=    360, skipped    0 obs
--------+--------------------------------------------------------------------
        |                 Standard            Prob.       95% Confidence
    ICHO|  Coefficient      Error       z    |z|>Z*          Interval
--------+--------------------------------------------------------------------
    CITY|     .10584*        .06204     1.71  .0880     -.01576      .22744
  DISTRI|    -.01026         .06782     -.15  .8798     -.14318      .12267
   WALKT|    -.09451         .07254    -1.30  .1927     -.23669      .04768
     IVT|    -.08307***      .01471    -5.65  .0000     -.11191     -.05423
  SEARCH|    -.31974***      .05374    -5.95  .0000     -.42507     -.21441
 FINWALK|     .02365         .08101      .29  .7703     -.13512      .18243
  CHARGE|     .52755*        .28031     1.88  .0598     -.02185     1.07695
   LIMIT|     .04010***      .01118     3.59  .0003      .01820      .06201
--------+--------------------------------------------------------------------
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
-----------------------------------------------------------------------------
```

12. Output of the regression model (Evaluation of Accesibility)

```
-----------------------------------------------------------------------------
Ordinary     least squares regression ............
LHS=EVALUATI Mean                 =         3.31788
             Standard deviation   =          .88013
----------   No. of observations  =            1683  DegFreedom   Mean square
Regression   Sum of Squares       =         118.137          8       14.76713
Residual     Sum of Squares       =         1184.79       1674         .70776
Total        Sum of Squares       =         1302.93       1682         .77463
----------   Standard error of e  =          .84129  Root MSE          .83903
Fit          R-squared            =          .09067  R-bar squared     .08632
Model test   F[  8,  1674]        =        20.86452  Prob F > F*       .00000
Model was estimated on May 18, 2015 at 01:25:17 PM
--------+--------------------------------------------------------------------
        |                 Standard            Prob.       95% Confidence
EVALUATI|  Coefficient      Error       z    |z|>Z*          Interval
--------+--------------------------------------------------------------------
Constant|    4.85863***      .26165    18.57  .0000     4.34581     5.37146
    CITY|    -.03888*        .02182    -1.78  .0748     -.08165      .00389
  DISTRI|    -.14617***      .02184    -6.69  .0000     -.18897     -.10337
   WALKT|    -.01981         .02519     -.79  .4316     -.06919      .02957
     IVT|    -.03919***      .00501    -7.82  .0000     -.04901     -.02937
  SEARCH|    -.08840***      .01645    -5.38  .0000     -.12063     -.05616
 FINWALK|    -.10861***      .02512    -4.32  .0000     -.15785     -.05937
  CHARGE|    -.21657***      .08264    -2.62  .0088     -.37853     -.05460
   LIMIT|     .00307         .00275     1.11  .2652     -.00233      .00846
--------+--------------------------------------------------------------------
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
-----------------------------------------------------------------------------
```

13. Output of the regression model (Evaluation of Accesibility-Male)

```
-----------------------------------------------------------------------------
Ordinary     least squares regression ............
LHS=EVALUATI Mean                 =        3.20814
             Standard deviation   =         .91771
----------   No. of observations  =            639  DegFreedom   Mean square
Regression   Sum of Squares       =        44.6805          8        5.58507
Residual     Sum of Squares       =        492.637        630         .78196
Total        Sum of Squares       =        537.318        638         .84219
----------   Standard error of e  =         .88429  Root MSE          .87804
Fit          R-squared            =         .08315  R-bar squared     .07151
Model test   F[  8,   630]        =        7.14236  Prob F > F*       .00000
Model was estimated on May 29, 2015 at 10:40:21 PM
--------+--------------------------------------------------------------------
        |                Standard            Prob.      95% Confidence
EVALUATI|  Coefficient      Error       z    |z|>Z*        Interval
--------+--------------------------------------------------------------------
Constant|   5.40674***      .44450    12.16  .0000     4.53554   6.27793
    CITY|   -.04788         .03711    -1.29  .1970     -.12060    .02485
  DISTRI|   -.08381**       .03715    -2.26  .0241     -.15662   -.01099
   WALKT|    .00710         .04285      .17  .8684     -.07688    .09108
     IVT|   -.04556***      .00856    -5.32  .0000     -.06234   -.02879
  SEARCH|   -.09649***      .02804    -3.44  .0006     -.15144   -.04154
 FINWALK|   -.10643**       .04285    -2.48  .0130     -.19041   -.02245
  CHARGE|   -.25009*        .14098    -1.77  .0761     -.52642    .02623
   LIMIT|   -.00514         .00470    -1.09  .2747     -.01435    .00408
--------+--------------------------------------------------------------------
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
-----------------------------------------------------------------------------
```

14. Output of the regression model (Evaluation of Accesibility-Female)

```
-----------------------------------------------------------------------------
Ordinary     least squares regression ............
LHS=EVALUATI Mean                 =        3.38506
             Standard deviation   =         .84980
----------   No. of observations  =           1044  DegFreedom   Mean square
Regression   Sum of Squares       =        82.1687          8       10.27109
Residual     Sum of Squares       =        671.038       1035         .64835
Total        Sum of Squares       =        753.207       1043         .72215
----------   Standard error of e  =         .80520  Root MSE          .80172
Fit          R-squared            =         .10909  R-bar squared     .10221
Model test   F[  8,  1035]        =       15.84198  Prob F > F*       .00000
Model was estimated on May 29, 2015 at 10:39:11 PM
--------+--------------------------------------------------------------------
        |                Standard            Prob.      95% Confidence
EVALUATI|  Coefficient      Error       z    |z|>Z*        Interval
--------+--------------------------------------------------------------------
Constant|   4.52530***      .31884    14.19  .0000     3.90039   5.15022
    CITY|   -.03234         .02658    -1.22  .2237     -.08443    .01976
  DISTRI|   -.18549***      .02658    -6.98  .0000     -.23759   -.13339
   WALKT|   -.03481         .03068    -1.13  .2565     -.09494    .02532
     IVT|   -.03497***      .00608    -5.75  .0000     -.04689   -.02305
  SEARCH|   -.08336***      .02000    -4.17  .0000     -.12256   -.04417
 FINWALK|   -.10838***      .03054    -3.55  .0004     -.16824   -.04852
  CHARGE|   -.19686**       .10043    -1.96  .0500     -.39369   -.00002
   LIMIT|    .00785**       .00334     2.35  .0188      .00130    .01440
--------+--------------------------------------------------------------------
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
-----------------------------------------------------------------------------
```

14. Output of the regression model (Evaluation of Accesibility-Masters degree or higher)

```
-----------------------------------------------------------------------------
Ordinary     least squares regression ............
LHS=EVALUATI Mean                  =         3.31089
             Standard deviation    =          .91239
----------   No. of observations   =             891  DegFreedom   Mean square
Regression   Sum of Squares        =         70.5607           8       8.82008
Residual     Sum of Squares        =         670.324         882        .76000
Total        Sum of Squares        =         740.884         890        .83245
----------   Standard error of e   =          .87178  Root MSE          .86737
Fit          R-squared             =          .09524  R-bar squared     .08703
Model test   F[  8,   882]         =        11.60531  Prob F > F*       .00000
Model was estimated on May 29, 2015 at 11:10:58 PM
--------+--------------------------------------------------------------------
        |                  Standard            Prob.      95% Confidence
EVALUATI|  Coefficient       Error       z    |z|>Z*         Interval
--------+--------------------------------------------------------------------
Constant|   5.07746***      .37245    13.63  .0000     4.34747   5.80745
    CITY|   -.03292         .03113    -1.06  .2903     -.09394    .02810
  DISTRI|   -.15261***      .03109    -4.91  .0000     -.21354   -.09167
   WALKT|   -.00475         .03594     -.13  .8949     -.07519    .06570
     IVT|   -.04752***      .00714    -6.66  .0000     -.06151   -.03354
  SEARCH|   -.07445***      .02344    -3.18  .0015     -.12040   -.02851
 FINWALK|   -.11032***      .03578    -3.08  .0020     -.18045   -.04020
  CHARGE|   -.19293         .11769    -1.64  .1011     -.42359    .03773
   LIMIT|    .00073         .00391      .19  .8515     -.00694    .00840
--------+--------------------------------------------------------------------
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
-----------------------------------------------------------------------------
```

16. Output of the regression model (Evaluation of Accesibility-Lower than Masters degree)

```
-----------------------------------------------------------------------------
Ordinary     least squares regression ............
LHS=EVALUATI Mean                  =         3.39903
             Standard deviation    =          .88519
----------   No. of observations   =            1035  DegFreedom   Mean square
Regression   Sum of Squares        =         83.1112           8      10.38890
Residual     Sum of Squares        =         727.088        1026        .70866
Total        Sum of Squares        =         810.199        1034        .78356
----------   Standard error of e   =          .84182  Root MSE          .83815
Fit          R-squared             =          .10258  R-bar squared     .09558
Model test   F[  8,  1026]         =        14.65987  Prob F > F*       .00000
Model was estimated on May 29, 2015 at 10:58:57 PM
--------+--------------------------------------------------------------------
        |                  Standard            Prob.      95% Confidence
EVALUATI|  Coefficient       Error       z    |z|>Z*         Interval
--------+--------------------------------------------------------------------
Constant|   5.04990***      .33448    15.10  .0000     4.39432   5.70547
    CITY|   -.04856*        .02782    -1.75  .0809     -.10308    .00596
  DISTRI|   -.16767***      .02790    -6.01  .0000     -.22236   -.11298
   WALKT|   -.01689         .03212     -.53  .5989     -.07984    .04605
     IVT|   -.03655***      .00639    -5.72  .0000     -.04907   -.02403
  SEARCH|   -.10549***      .02097    -5.03  .0000     -.14659   -.06439
 FINWALK|   -.11953***      .03208    -3.73  .0002     -.18240   -.05667
  CHARGE|   -.23963**       .10550    -2.27  .0231     -.44641   -.03286
   LIMIT|    .00239         .00352      .68  .4970     -.00450    .00928
--------+--------------------------------------------------------------------
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
-----------------------------------------------------------------------------
```

17. Output of the regression model (Evaluation of Accesibility-Age below 30)

```
-----------------------------------------------------------------------------
Ordinary     least squares regression ............
LHS=EVALUATI Mean                 =        3.18827
             Standard deviation   =         .85686
----------   No. of observations  =            648  DegFreedom   Mean square
Regression   Sum of Squares       =        38.7822           8       4.84778
Residual     Sum of Squares       =        436.249         639        .68271
Total        Sum of Squares       =        475.031         647        .73421
----------   Standard error of e  =         .82626  Root MSE          .82050
Fit          R-squared            =         .08164  R-bar squared     .07014
Model test   F[  8,    639]       =        7.10084  Prob F > F*       .00000
Model was estimated on May 29, 2015 at 10:56:57 PM
--------+--------------------------------------------------------------------
        |                Standard            Prob.      95% Confidence
EVALUATI|  Coefficient      Error       z    |z|>Z*        Interval
--------+--------------------------------------------------------------------
Constant|   4.53053***      .41314    10.97  .0000     3.72079   5.34027
    CITY|   -.02392         .03462     -.69  .4896     -.09176    .04393
  DISTRI|   -.11344***      .03452    -3.29  .0010     -.18111   -.04578
   WALKT|   -.02447         .03997     -.61  .5405     -.10280    .05387
     IVT|   -.04340***      .00794    -5.47  .0000     -.05896   -.02784
  SEARCH|   -.06317**       .02607    -2.42  .0154     -.11426   -.01208
 FINWALK|   -.09062**       .03977    -2.28  .0227     -.16856   -.01268
  CHARGE|   -.18745         .13082    -1.43  .1519     -.44386    .06896
   LIMIT|    .00472         .00435     1.09  .2776     -.00380    .01324
--------+--------------------------------------------------------------------
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
-----------------------------------------------------------------------------
```

18. Output of the regression model (Evaluation of Accesibility-Age above 30)

```
-----------------------------------------------------------------------------
Ordinary     least squares regression ............
LHS=EVALUATI Mean                 =        3.18765
             Standard deviation   =         .87788
----------   No. of observations  =            810  DegFreedom   Mean square
Regression   Sum of Squares       =        54.8834           8       6.86042
Residual     Sum of Squares       =        568.593         801        .70985
Total        Sum of Squares       =        623.477         809        .77068
----------   Standard error of e  =         .84253  Root MSE          .83783
Fit          R-squared            =         .08803  R-bar squared     .07892
Model test   F[  8,    801]       =        9.66455  Prob F > F*       .00000
Model was estimated on May 29, 2015 at 11:03:49 PM
--------+--------------------------------------------------------------------
        |                Standard            Prob.      95% Confidence
EVALUATI|  Coefficient      Error       z    |z|>Z*        Interval
--------+--------------------------------------------------------------------
Constant|   4.25659***      .37500    11.35  .0000     3.52160   4.99159
    CITY|   -.04215         .03169    -1.33  .1835     -.10426    .01996
  DISTRI|   -.15431***      .03148    -4.90  .0000     -.21601   -.09261
   WALKT|   -.01222         .03660     -.33  .7386     -.08396    .05953
     IVT|   -.03894***      .00727    -5.36  .0000     -.05319   -.02469
  SEARCH|   -.08020***      .02385    -3.36  .0008     -.12695   -.03346
 FINWALK|   -.06508*        .03635    -1.79  .0734     -.13632    .00616
EVALUATI|  Coefficient      Error       z    |z|>Z*        Interval
   LIMIT|    .00707*        .00396     1.79  .0741     -.00069    .01483
--------+--------------------------------------------------------------------
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
-----------------------------------------------------------------------------
```

19. Output of the regression model (Evaluation of Accesibility-Employed/Self Employed)

```
--------------------------------------------------------------------------------
Ordinary      least squares regression ............
LHS=EVALUATI Mean                    =        3.43872
             Standard deviation      =         .86534
----------   No. of observations     =            873  DegFreedom   Mean square
Regression   Sum of Squares          =        69.0984           8       8.63730
Residual     Sum of Squares          =        583.873         864        .67578
Total        Sum of Squares          =        652.971         872        .74882
----------   Standard error of e     =         .82206  Root MSE          .81781
Fit          R-squared               =         .10582  R-bar squared     .09754
Model test   F[  8,    864]          =       12.78125  Prob F > F*       .00000
Model was estimated on May 29, 2015 at 11:07:53 PM
--------+-----------------------------------------------------------------------
        |                  Standard            Prob.       95% Confidence
EVALUATI|  Coefficient       Error        z    |z|>Z*         Interval
--------+-----------------------------------------------------------------------
Constant|    5.36955***      .35886     14.96  .0000      4.66619   6.07290
    CITY|    -.03517         .02960     -1.19  .2348      -.09320    .02285
  DISTRI|    -.14167***      .02993     -4.73  .0000      -.20033   -.08301
   WALKT|    -.02783         .03418      -.81  .4155      -.09481    .03915
     IVT|    -.04030***      .00679     -5.94  .0000      -.05360   -.02700
  SEARCH|    -.10355***      .02230     -4.64  .0000      -.14726   -.05983
 FINWALK|    -.14794***      .03425     -4.32  .0000      -.21508   -.08081
  CHARGE|    -.23323**       .11268     -2.07  .0385      -.45408   -.01238
   LIMIT|     .00068         .00376       .18  .8559      -.00668    .00804
--------+-----------------------------------------------------------------------
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
--------------------------------------------------------------------------------
```

20. Output of the regression model (Evaluation of Accesibility-Unemployed, Student, Retired)

```
--------------------------------------------------------------------------------
Ordinary      least squares regression ............
LHS=EVALUATI Mean                    =        3.36484
             Standard deviation      =         .88146
----------   No. of observations     =            603  DegFreedom   Mean square
Regression   Sum of Squares          =        32.1505           8       4.01881
Residual     Sum of Squares          =        435.584         594        .73331
Total        Sum of Squares          =        467.735         602        .77697
----------   Standard error of e     =         .85633  Root MSE          .84992
Fit          R-squared               =         .06874  R-bar squared     .05619
Model test   F[  8,    594]          =        5.48039  Prob F > F*       .00000
Model was estimated on May 29, 2015 at 10:49:45 PM
--------+-----------------------------------------------------------------------
        |                  Standard            Prob.       95% Confidence
EVALUATI|  Coefficient       Error        z    |z|>Z*         Interval
--------+-----------------------------------------------------------------------
Constant|    5.15560***      .45366     11.36  .0000      4.26645   6.04475
    CITY|    -.00061         .03719      -.02  .9868      -.07350    .07227
  DISTRI|    -.17749***      .03793     -4.68  .0000      -.25183   -.10315
   WALKT|     .04204         .04293       .98  .3275      -.04210    .12618
     IVT|    -.02482***      .00852     -2.91  .0036      -.04151   -.00813
  SEARCH|    -.06979**       .02800     -2.49  .0127      -.12466   -.01492
 FINWALK|    -.05755         .04321     -1.33  .1829      -.14224    .02714
  CHARGE|    -.25767*        .14234     -1.81  .0702      -.53665    .02130
   LIMIT|    -.00890*        .00473     -1.88  .0600      -.01818    .00038
--------+-----------------------------------------------------------------------
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
--------------------------------------------------------------------------------
```

21. Output of the regression model (Evaluation of Accesibility-Home location-Rural)

```
-----------------------------------------------------------------------------
Ordinary     least squares regression ............
LHS=EVALUATI Mean                   =        3.36484
             Standard deviation     =         .88146
----------   No. of observations    =            603  DegFreedom   Mean square
Regression   Sum of Squares         =        32.1505           8       4.01881
Residual     Sum of Squares         =        435.584         594        .73331
Total        Sum of Squares         =        467.735         602        .77697
----------   Standard error of e    =         .85633  Root MSE          .84992
Fit          R-squared              =         .06874  R-bar squared     .05619
Model test   F[  8,    594]         =        5.48039  Prob F > F*       .00000
Model was estimated on May 29, 2015 at 10:49:45 PM
--------+--------------------------------------------------------------------
        |                  Standard            Prob.       95% Confidence
EVALUATI|  Coefficient       Error       z    |z|>Z*          Interval
--------+--------------------------------------------------------------------
Constant|   5.15560***      .45366     11.36  .0000      4.26645    6.04475
    CITY|   -.00061         .03719      -.02  .9868      -.07350     .07227
  DISTRI|   -.17749***      .03793     -4.68  .0000      -.25183    -.10315
   WALKT|    .04204         .04293       .98  .3275      -.04210     .12618
     IVT|   -.02482***      .00852     -2.91  .0036      -.04151    -.00813
  SEARCH|   -.06979**       .02800     -2.49  .0127      -.12466    -.01492
 FINWALK|   -.05755         .04321     -1.33  .1829      -.14224     .02714
  CHARGE|   -.25767*        .14234     -1.81  .0702      -.53665     .02130
   LIMIT|   -.00890*        .00473     -1.88  .0600      -.01818     .00038
--------+--------------------------------------------------------------------
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
-----------------------------------------------------------------------------
```

22. Output of the regression model (Evaluation of Accesibility-Home location-Sururban/Urban)

```
-----------------------------------------------------------------------------
Ordinary     least squares regression ............
LHS=EVALUATI Mean                   =        3.29167
             Standard deviation     =         .87871
----------   No. of observations    =           1080  DegFreedom   Mean square
Regression   Sum of Squares         =        102.704           8      12.83799
Residual     Sum of Squares         =        730.421        1071        .68200
Total        Sum of Squares         =        833.125        1079        .77213
----------   Standard error of e    =         .82583  Root MSE          .82238
Fit          R-squared              =         .12328  R-bar squared     .11673
Model test   F[  8,   1071]         =       18.82406  Prob F > F*       .00000
Model was estimated on May 29, 2015 at 10:43:42 PM
--------+--------------------------------------------------------------------
        |                  Standard            Prob.       95% Confidence
EVALUATI|  Coefficient       Error       z    |z|>Z*          Interval
--------+--------------------------------------------------------------------
Constant|   4.67685***      .31873     14.67  .0000      4.05215    5.30156
    CITY|   -.06104**       .02688     -2.27  .0232      -.11372    -.00836
  DISTRI|   -.13542***      .02672     -5.07  .0000      -.18779    -.08305
   WALKT|   -.04525         .03104     -1.46  .1450      -.10609     .01560
     IVT|   -.04760***      .00616     -7.72  .0000      -.05968    -.03552
  SEARCH|   -.09702***      .02023     -4.80  .0000      -.13666    -.05737
 FINWALK|   -.13115***      .03083     -4.25  .0000      -.19158    -.07072
  CHARGE|   -.21249**       .10149     -2.09  .0363      -.41141    -.01357
   LIMIT|    .00977***      .00336      2.91  .0037       .00318     .01635
--------+--------------------------------------------------------------------
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
-----------------------------------------------------------------------------
```

C. Experimental Design (SAS and SPSS)

1. **SPSS**

	Card ID	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10
1	1	1	2	1	3	2	2	1	1	2	3
2	2	1	2	2	3	3	1	2	1	3	1
3	3	2	1	2	3	1	1	1	2	2	2
4	4	2	1	2	2	2	2	1	2	3	1
5	5	1	1	1	2	1	3	3	2	2	3
6	6	2	1	3	2	2	1	3	1	2	1
7	7	1	1	3	2	3	1	2	2	1	2
8	8	2	2	1	2	2	3	2	3	1	1
9	9	1	1	2	2	1	2	2	1	1	3
10	10	1	1	3	3	3	3	1	3	2	1
11	11	2	1	1	1	3	1	2	3	2	3
12	12	1	1	2	1	1	3	3	3	3	1
13	13	1	2	3	1	1	2	2	2	2	1
14	14	1	1	3	1	2	2	1	3	1	2
15	15	1	1	1	2	3	3	1	1	3	2
16	16	2	1	1	3	1	2	2	3	3	2
17	17	1	1	2	3	2	1	3	3	1	3
18	18	1	1	1	1	1	1	1	1	1	1
19	19	1	2	1	1	2	1	3	2	3	2
20	20	1	1	3	3	2	3	2	2	3	3
21	21	1	1	2	1	2	3	2	1	2	2
22	22	2	1	3	1	3	2	3	1	3	3
23	23	1	2	2	2	3	2	3	3	2	2
24	24	1	2	3	2	1	1	1	3	3	3
25	25	2	2	3	3	1	3	3	1	1	2
26	26	1	1	1	3	3	2	3	2	1	1
27	27	2	2	2	1	3	3	1	2	1	3

2. SAS

```
OPTIONS MAUTOSOURCE;

%LET PATH = C:\Users\uhstudent\Downloads\ali;
libname CASE "&PATH";

%mktex(3**6 2**2, n=27)

title "Design (3**6) x (2**2)";
proc print;
run;

/* investigate interactions */
data recoded;
  set design(rename=(x1 = A x2 = B x3 = C x4 = D x5 = E x6 = F x7 = G x8 = H));
/* change 1/2/3 coding to -1/0/1 coding */
  array cols{8} A B C D E F G H;
  do i = 1 to 8;
     if cols{i} = 1 then cols{i} = -1;
     else if cols{i} = 2 then cols{i} = 0;
     else cols{i} = 1;
  end;
run;

%let n = 8; /* ADAPT TO NUMBER OF ATTRIBUTES */
%let nint = %sysfunc(comb(&n,2));

%let length1 = %eval(2 * &n);
%let length2 = %eval(3 * &nint - 1);
```

```
data _null_;
   length letters $ &length1 interactions $ &length2;
   array alfabet{26} $ _TEMPORARY_ ('A' 'B' 'C' 'D' 'E' 'F' 'G'
                                    'H' 'I' 'J' 'K' 'L' 'M'
                                    'N' 'O' 'P' 'Q' 'R' 'S' 'T'
                                    'U' 'V' 'W' 'X' 'Y' 'Z');
   /* effects */
   do i = 1 to &n;
      letters = trim(left(letters))||" "||alfabet{i};
   end;
   /* interactions */
   do i = 1 to &n;
      do j = (i+1) to &n;
         interactions = trim(left(interactions))||" "||trim(left(alfabet{i}))||trim(left(alfabet{j}));
      end;
   end;

   call symput('effects',letters);
   call symput('interactions',interactions);
run;

data interactions;
   set recoded;
   array effects{&n} &effects;
   array int{&nint} &interactions;
   do i = 1 to (&n -1);
      do j = (i+1) to &n;
         counter = j + (i-1)*&n - i*(i+1)/2;
         int{counter} = effects{i} * effects{j};
      end;
   end;
   drop i j counter;
run;
```

```
/* Controleren correlaties */
options orientation=landscape;
ODS NOPROCTITLE;

proc corr data = interactions noprob nosimple outp = correlaties;
  var &effects &interactions;
run;

ODS RTF file = "&PATH\design_Ali_raza.rtf";
title "Correlations (3**6) x (2**2) 27 runs";
proc tabulate data = correlaties;
  where _TYPE_ = "CORR";
  var &effects &interactions;
  class _NAME_/order=data;
  table _NAME_="",(&effects &interactions)*sum="";
run;
title;
ODS RTF close;

/* Grouping of profiles in 9 sets */
/* Determine choice sets of alternatives */
%choiceff(data=design, /* candidate set of alternatives */
          model=class(x1-x8 / sta), /* model with stdz orthogonal coding */
          nsets=9, /* number of choice sets */
          flags=3, /* 3 alternatives, generic candidates */
          seed=2015, /* random number seed */
          maxiter=100, /* maximum number of designs to make */
          options=relative, /* display relative D-efficiency */
          beta=zero) /* assumed beta vector, Ho: b=0 */
```

```
proc print;
  var x1-x8;
  id set;
  by set;
run;
/*
proc print data=bestcov label;
  title 'Variance-Covariance Matrix';
  id __label;
  label __label = '00'x;
  var x:;
run;
title;
*/
/* Check voor dubbels */
%mktdups(generic, data=best, factors=x1-x8, nalts=3)

/* Change 1/2/3 coding to -1/0/1 coding */
data best;
  set best(rename=(x1 = A x2 = B x3 = C x4 = D x5 = E x6 = F x7 = G x8 = H));
  array cols{8} A B C D E F G H;
  do i = 1 to 8;
     if cols{i} = 1 then cols{i} = -1;
     else if cols{i} = 2 then cols{i} = 0;
     else cols{i} = 1;
  end;
  drop i;
run;
```

```
/* Number the profiles within each set according to increasing profile numbers */
proc sort data = best;
  by set index;
run;

data best;
  set best;
  by set index;
  retain subset;
  if first.set then subset = 1;
  else subset + 1;
  drop design prob _f1 _f2;
run;
```

```
/* Format variables and label variables */
proc format;
  value forma -1 = "City centre"
               0 = "Suburbs";
  value formb -1 = "Spread out"
               0 = "Concentrated";
  value formc -1 = "1 min"
               0 = "2 min"
               1 = "3 min";
  value formd -1 = "15 min"
               0 = "20 min"
               1 = "25 min";
  value forme -1 = "2 min"
               0 = "3 min"
               1 = "5 min";
  value formf -1 = "2 min"
               0 = "3 min"
               1 = "4 min";
  value formg -1 = "1 €"
               0 = "1.5 €"
               1 = "2 €";
  value formh -1 = "60 min"
               0 = "75 min"
               1 = "90 min";
run;

data CASE.ChoiceDesign;
  set best;
  format A formA. B formB. C formC. D formD. E formE. F formF. G formG. H formH.;
  label A = 'Location' B = 'Spatial distribution'
        C = 'Walk towards vehicle' D = 'In-vehicle time'
        E = 'Parking search time' F = 'Final walk towards destination'
        G = 'Parking charges' H = 'Parking time limit';
run;
```

```
OPTIONS ORIENTATION = PORTRAIT;
ODS RTF file = "&PATH\WZ_design_macro.rtf";
title "Final design (3**6) x (2**2) fractional factorial with macros";
proc print label;
  var A B C D E F G H;
  id set;
  by set;
run;
title;
ODS RTF CLOSE;

/* Export the design to txt and Excel */
PROC EXPORT DATA= CASE.ChoiceDesign
            OUTFILE= "&PATH\design_macro.txt"
            DBMS=DLM REPLACE;
     DELIMITER='3B'x;
     PUTNAMES=YES;
RUN;

PROC EXPORT DATA= CASE.ChoiceDesign
            OUTFILE= "&PATH\design_macro.xls"
            DBMS=EXCEL REPLACE;
     SHEET="design";
RUN;
```

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The role of parking in the accessibility of destinations

Richting: **Master of Transportation Sciences-Mobility Management**
Jaar: **2015**

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