CHAPTER 4
RESEARCH METHODOLOGY

4.1 Introduction

This chapter presents the research approach, the design and methods used to address the research problem, as outlined in chapter one. This study has selected mixed-methods to achieve the objectives, as stated in chapter one, through a mainly quantitative approach.

In recent three decades, employing the mixed-methods approach in research in the social sciences has received considerable interest among researchers. The purpose of this design is to generate different but useful data on the same topic. All methods have some limitations, thus, using mixed-methods can help to reduce the biases from any single method. The concept of mixing different methods in collecting data probably began in 1959 when observations and interviews were combined with surveys (Sieber, 1973).

The Triangulation Design is the most common and well-known approach in mixed-methods. It tries to overlap the quantitative and qualitative methods in collecting different types of data to develop a better insight of a phenomenon (Creswell, 2003). It helps to confirm the findings from different data sources by triangulating both broad numeric trends from quantitative research and the detail of qualitative research (Creswell, 2003, Tashakkori & Teddlie, 2003).

As discussed in the previous chapter, one of the fundamental assumptions of the policymakers regarding the trip of children to school in Tehran is the lack of traffic safety influence parental decisions about children's travel to school. However, this proposition is relatively untested. Using Triangulation Design in this study helped to achieve a deeper understanding of the relationship between traffic safety and personal safety with children walking to and from school across different socio-economic areas in Tehran.

The study began with a broad cross-sectional survey of parents and children to examine data from 18 school sites in Tehran across three different income groups. In addition, ad hoc interviews were done with parents and children if they did not answer the open-ended questions properly. This was followed by measuring the representative factors for safety in the built environment around all school sites.

4.2 A conceptual framework

The following conceptual framework explores the contributing urban form, socio-environmental, socio-demographical and socio-economical factors that are considered as barriers to children walking to and from school autonomously. Previous literatures showed different factors impact on children' travel behaviour at different level. Therefore, to understand the relationship between different influential factors and their effects on parental decisions about children' trip to school; the framework moves the research forward on a socio-ecological approach by:

1) Identifying the key factors that may be considered as barriers in the built environment for children walking to and from school from both the children's and the parents' points of view.

2) Highlighting non-urban form factors that may impede children in walking to and from school on their own.

3) Outlining whether the relationships between those influential factors and parental decisions about children's travel to school is modified by socio-economic or socio-demographic factors.

4) Examining if the environmental barriers for children in their walking to and from school vary across different socio-economic areas.

The diagram below shows the hypothesized relationships between variables and parental decisions about the children's mode of transportation to and from school in Tehran (Figure 4.1).

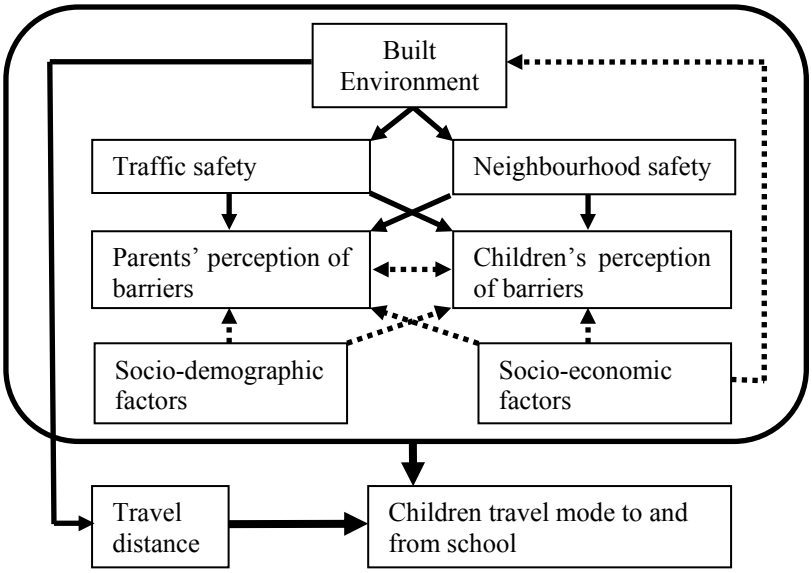


Figure 4. 1: Diagram of the conceptual framework of barriers for elementary-aged children walking to and from school

Solid arrows indicate hypothesized direct effects and dotted arrows indicate hypothesized indirect effects. This conceptual framework of barriers for children in their walking to and from school targets an elementary-aged school population (9-12 years old) because:

1- Due to the educational system in Iran, 11-year-old children often deal with an important change in their school trip after graduating from a nearby primary

school to a secondary school located further away (Department of Education and Training in Tehran, 2006).

2- Obesity is more epidemic within this age group of children in Iran (Moayeri et al., 2006).

3- Different studies about children's travel to school around the world involved children aged from 6 to 12 years in their sample. However, Studies suggested that children should be accompanied while walking on the street until 8 years old, because they do not develop the cognitive skills to think flexibly and strategically until that age (Zeedyk & Wallace, 2003). Therefore, children below 8 years old are not considered as pedestrians.

4- Contemporary policies about children's travel to school in Tehran focus on educating children about traffic safety from an early age but only start practical training from the age of 9 to ensure that they are at a suitable cognitive development level (Department of Traffic and Transportation in Tehran, 2006).

5- The national statistics of car accidents show that the percentage of traffic injuries for younger children is considerable for this age group (Zargar et al., 2003).

The international studies of children's casualties have found that car accidents largely occur during the times that children travel and leave school (Christie et al., 2004). This indicates a need for a further understanding of children's and parents' points of view about the traffic safety and street layouts in the neighbourhoods. Moreover, knowing parental and children's views about traffic safety helps to realize the reasons for the decrease in the rate of children walking to and from school.

The framework assumes that the final decision makers about children's mode of travel to and from school are often parents; however, children's desires may affect the parent's decision making (Kingham & Ussher, 2007). Moreover, children's perceptions of their environment have not been widely assessed (Hume et al., 2005). Therefore, it is very important to know the children's point of view directly and integrate it with their parents' points of view. Children have their own definition of neighbourhood, urban form and modes of travel that is different from adults and does not necessarily match with objective measurements (Ahlport et al., 2008). In this case, children's and parents' perceptions of barriers are very important influential variables in decision making about children's trips to school. It shows that if the perception of parents and children do not improve, we will not see any changes in the children's mode of travel to and from school. This means that factors which are relating to perceptions are on a hypothesized pathway between urban infrastructure, neighbourhood safety, traffic safety and decision-making about the children's mode of travel to and from school. Improving the built environment will improve both the parental and children's perception of safety indirectly (Rodriguez, 2004; Falb et al., 2007).

Parents' and children's points of view about barriers may be affected by other variables. Elements of urban infrastructure, such as block length, complete sidewalks, street width, traffic signs, on street parking, green spaces and commercial floor, may influence neighbourhood safety and traffic safety (Cervero, 2002; Holt et al., 2009; Beck & Greenspan, 2008). Traffic safety and the perception of violence in a neighbourhood have an influence on parents' and children's perceptions. However, we need to know the specific contributing factors to improve their perceptions. Socio-economic factors and socio-demographic factors impact indirectly on parents' and children's points of view. Socio-economic factors may affect urban infrastructures in many ways, e.g. block size, street width, presence of pavements and land use can be

different across different socio-economic areas (Dissanayake et al., 2009). Therefore, they create a series of intervening variables that affect the choice of mode of travel for children on their trip to school. These factors will shape the barriers for children in their walking to and from school or prevent them from walking to and from school independently.

Some parts of the framework are similar to Handy's model (1996) concerning the relationship between the motivation to walk and urban form. The difference is that some other factors also contribute to making a built environment a pedestrian-friendly neighbourhood. Handy's model (1996) suggests a straight relationship between improving urban form and encouraging people to walk.

This framework is derived from McMillan's model (2003) concerning the effects of urban form upon a child's trip to school. The difference is in her behavioural approach, she examined children's travel behaviour through data gathered only from parents. Therefore, cultural factors and parents' attitudes in her model are considered as moderating factors; however, she ignored how children's desires impacted on their parents' decision-making. Moreover, children's modes of travel to school were limited to walking and motorized. She did not distinguish whether or not the children were walking to school with an adult or on their own. Additionally, she did not study the children's trips to school and back home separately. Finally, she did not explore if there was any difference between environmental barriers for children in their walking to school across different income-groups of households.

The conceptual framework presented here suggests that by improving the built environment; parents' and children's perceptions about safety, the presence of violence and traffic, and the conditions for walking in the neighbourhood would certainly improve. Neighbourhood safety can be improved via easy access to public

transportation and the ground floor shops, but not traffic safety. It requires the provision of additional traffic signs, the presence of pavements with sufficient width, applying various changes in street width, separating pedestrian and traffic flows clearly or by providing a low speed traffic zone.

Also, socio-economic and socio-demographic factors such as: household income, age, gender and the number of children in a family, household car ownership, etc. may not be obvious at first and seem to be unrelated in choosing the mode of transportation to school for children. However, they affect both the parents' and children's views about barriers to walking to and from school. Although all these variables affect children's trips to school, their impact does not have the same strength and is not at the same level. The individual factors are also different, concerning the different socio-economic status of the area (Falb et al., 2007; Timperio et al., 2006; Cerin et al., 2009).

4.3 Testing the conceptual framework

This conceptual framework outlines the perceived barriers in the built environment from primary school-aged children and their parents' points of view in Tehran. Furthermore, it shows if these barriers vary according to the demographic characteristics of the households and across different socio-economic status areas. It also includes the identification of other contributing factors towards walking to and from school.

This conceptual framework suggests that multiple factors influence how a trip to school is made. Although not all barriers are directly related to the built environment, improving urban form can help to remove these barriers. Therefore, exploring these factors and understanding how urban form impacts on them will assist in the development of more effective planning programmes and policies.

4.4 Research sample sites

Eighteen schools were recruited from different areas in Tehran as the sample for this study. As mentioned in the previous chapter, only Muslim primary schools were involved in the study because nearly 98% of the population in Tehran are Muslims. Moreover, the study focuses on primary public schools because of their neighbourhood orientation. Additionally, all policymakers who focus on children's trips to school in Tehran have a tendency to work with this age group of children. The reasons are described in detail below:

1- The majority of primary schools in Tehran (more than 80 per cent) are public schools (Department of Renovation and Renewing of the Schools in Tehran, 2007).

2- There are some restrictions that apply to the enrolment of students in public primary schools. Public primary schools attract the students who live in the catchment area or whose parents are working within it. The radius of this area is 500 metres from the main school entrance. Students are enrolled based on their home address or parents' work address.

   Studies showed that efforts to promote walking to school might achieve better near-term success if they focus on students who already live close to school (Martin et al., 2007; McDonald, 2007)

3- Public primary schools do not provide any school bus for students to encourage them to walk.

4- Private schools are provided for high-income people and they can enrol students from a greater distance without any restrictions.

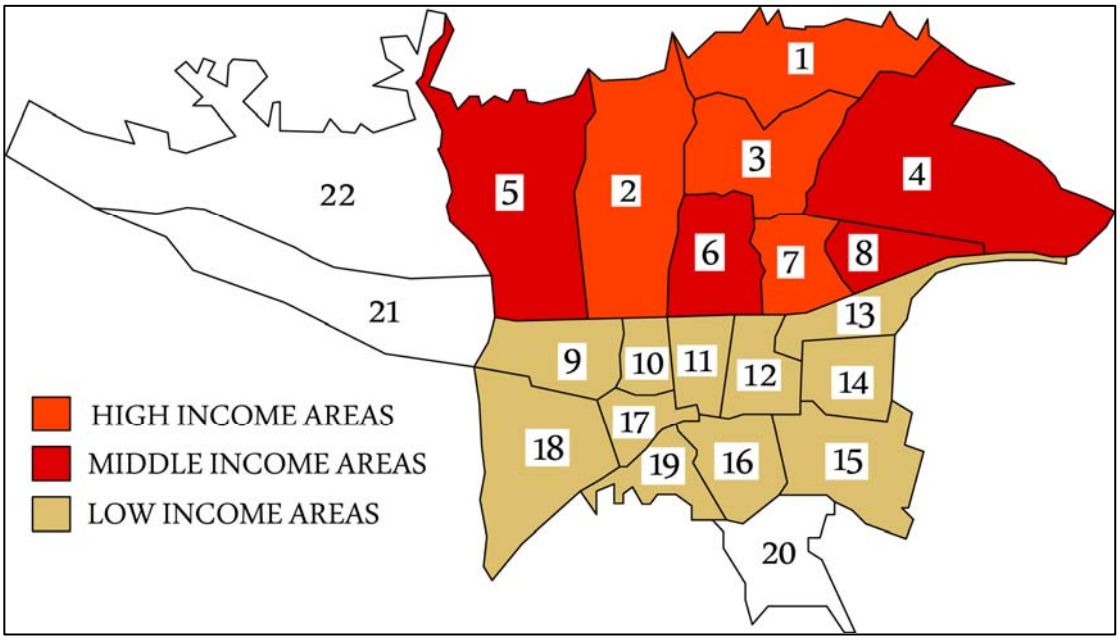
There were attempts to have the distribution of schools recruitment representative of the population of Tehran in terms of income-groups and residential areas as well as

to provide a complete understanding of the research problem. Therefore, five criterias were used for school recruitment, as outlined below:

1- If they have completed the programme of Traffic/Infrastructure improvement around the immediate school environment.
2- School type (one male, one female from each district to be fair in gender, because there are not any co-educational schools in Iran)
3- School location (all neighbourhood public schools are located near local streets, so the location was considered, while selecting the male and female schools in one neighbourhood. They were selected to be close to each other, so in terms of the built environment around them they could be recognized as one school) (Department of Renovation and Renewing of the Schools in Tehran, 2007).
4- School size (number of students in each school; ≤ 450 students) (Department of Education and Training in Tehran, 2007), because the growing size of the school may reduce the option to walk (Willson et al., 2007; Beck & Greenspan, 2008; Ewing et al., 2004).
5- School session (those in the morning session were involved)

A multistage cluster sampling of schools was arranged, based on a complete list of all public primary schools in different areas. This technique to obtain the final sample involves drawing several different samples to minimize the cost of the final data collection (De Vaus, 2002). Multistage cluster sampling is a suitable technique when conducting large area surveys (i.e. city wide). Other techniques of sampling such as a Random Sampling would not meet the goal of the study. Although random sampling can explain the relationship between genders and the built environment in different zones, it does not elucidate on the variety of socio-economic status in the areas. Tehran

is divided into rich, middle and low socio-economic status areas; these are called clusters (Map 4.1.).

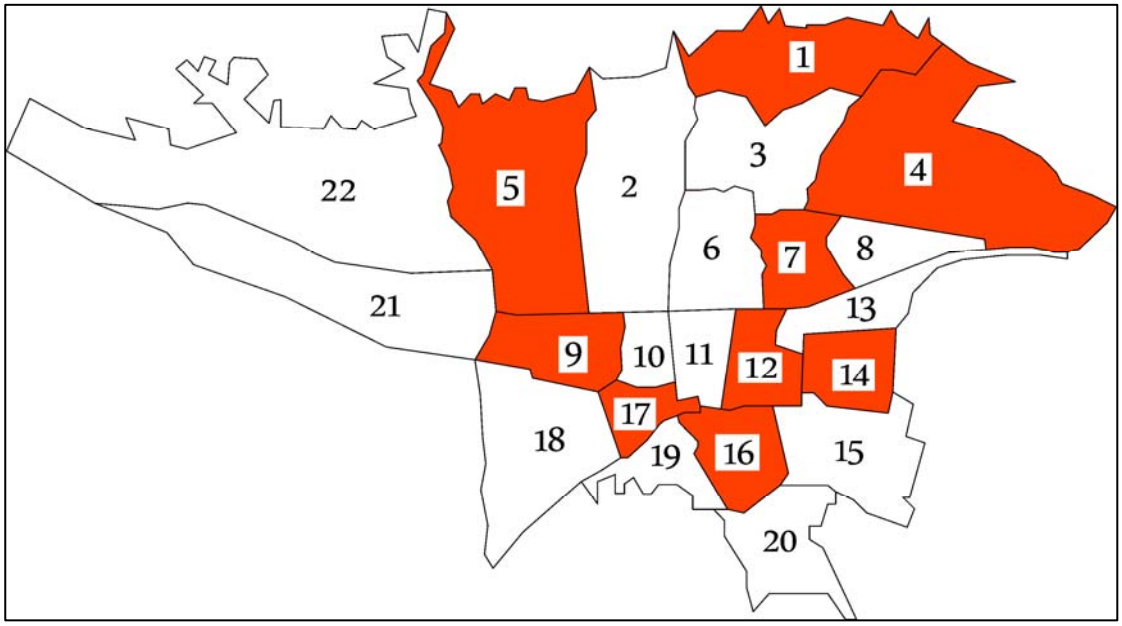


Map 4. 1: Different socio-economic status areas in Tehran,
Source: master plan of Tehran

Each of these areas contains several census districts. Three districts were excluded from the sampling. Two of them do not have any individual Department of Education and Training (district numbers 21 & 22). In addition, there are few primary-aged students who live in them. The third one is not under the supervision of the Department of Education and Training in Tehran (district number 20, it is independent). Districts were selected randomly (Simple Random Sampling) among each cluster so each district had an equal probability of being selected, which enables it to be generalized to the population (Creswell, 2003).

The sampling of the schools was performed within these three different socio-economic status areas (Map 4.2). First the researcher obtained a list of neighbourhoods in each selected district. Then, one neighbourhood was selected by using Simple

Random Sampling (SRS) within each district. A complete list of all the public primary schools in that neighbourhood was then obtained.



Map 4. 2: School catchment areas in Tehran

Schools were divided based on the aforementioned criteria. Finally, two schools were selected from each neighbourhood (one male and one female to be fair concerning gender) using SRS. Schools were recruited based on the approval of the Department of Education and Training of Tehran (Master plan of Tehran, 2006, Creswell, 2007). Approval was also received at the school district level. Due to the regulations in Iran, there was a need to hire a male assistant to conduct the survey in the male schools. A total of 18 schools were randomly selected. If one of the schools in each neighbourhood did not agree to participate in the survey, they were replaced with two other schools (to be close to each other).

It was very difficult to contact schools and gain access to them. When contact was made and interest was expressed, a sample of the agreement letter, a copy of the survey and a description of the study were sent to the school's principal. Follow up phone calls were made to the principal or vice-principal to discuss the study and to obtain

confirmation to participate. When confirmation was received, information concerning the school hours, number of classrooms and students at school were collected to guide data collection scheduling. Written consent was obtained from the children's parent/guardian, and the children gave verbal consent to participate (Cooper et al., 2005).

Children were sampled randomly within schools using the school registers. The sample size required was calculated on the basis of the number of the students in each school and data from a pilot study in the same geographic area (Zaccari, 2003). The aim was to have 95% internal confidence level, with 0.05 significant levels assuming an intra class correlation coefficient of 0.01 and an average size of 30 children for each school (Wen et al., 2008).

There were 658 public primary schools in the nine selected districts, and there were approximately 4,768 students enrolled in grades 3 to 5 in the eighteen selected public primary schools (Department of Education and Training in Tehran, 2006). The students could be selected from any of the 18 schools but equal numbers of male and female. However, those who did not have access to motorized travel mode (car/motorbike) were excluded from the sample, because it would increase the probability of choosing other transportation alternatives (Salon, 2009). The N (number of sample) was determined based on Dillman's (2007) formula below (pp.206).

$$Ns = \frac{(Np)(p)(1-p)}{(Np-1)(B/C)^2 + (p)(1-p)}$$

Where: Ns= Completed sample size needed for desired level of precision

Np=size of population

P=proportion of population expected to choose one of the two categories

B=acceptable amount of sampling error

C=Z statistic associated with confidence level (1.96 correspond to the 95%)

*approximately 15% of population did not have access to car so Np=4053; Ns=351

$$Ns = \frac{(4053)(0.5)(0.5)}{(4052)(0.05/1.96)^2 + (0.5)(0.5)}$$

The precision of the estimates made from the survey depend on the size of the sample and the amount of the clustering, and the item whose value is being measured. The precision of an estimate also depends on the item itself and how even the distribution is across the population. The variability is measured by the rate of homogeneity *(roh)*. The value of *roh* is as a measure of the variability between clusters as compared to the variation within clusters.

Additionally, since the sample was clustered, it was recruited larger according to effect design. The simple formula may be written in the form below:

D=1+ (b-1) roh
D = is known as the design effect
roh = is the rate of homogeneity
b = is the average number of responses to the item per cluster (cluster sample size)
D= 1+ (3-1) 0.3
=1+ (2) 0.3
=1+ 0.6
=1.6

Then, to calculate the sample size, the "design effect" must be multiplied by the required sample size. Therefore, the sample size would be as shown below:

1.6 x 351= 561

4.5 Data collection procedure

Multiple methods of data collection are used to strengthen reliability as well as internal validity. It is good to prevent biases arising from the use of only one method; to triangulate and crosscheck data (from children and parent; objective measurement and perception); to evaluate the usefulness of different methods in data collecting

(qualitative and quantitative) and to strike a balance between traditional and innovative methods (Creswell et al., 2003).

In this study, the researcher collected both types of data (quantitative and qualitative) within one survey instrument. It helped to validate and expand the quantitative findings from the survey by including a few open-ended qualitative questions. All qualitative themes were transferred into quantitative numbers at the analysis stage and merged with the quantitative data to be comparable with the quantitative results in the interpretation sections. The qualitative items are an add-on to a quantitative survey, thus, generally, the items do not result in a rigorous qualitative data set. However, qualitative data can generate interesting quotes that can be used to validate the quantitative survey findings (Creswell, 2003, pg 212).

Data collection included parental survey, children's writing activities and informal interviews with school principals (to get data on school size, school hours, etc.) in 18 schools from different income groups. Photo colour surveys were done of each school site to record the physical aspects of the street layout in the immediate environment of the school to validate the quantitative data from the survey. Additionally, the author measured the urban design elements around the school sites, using the tools that is included urban design elements relating to traffic safety and personal safety in the neighbourhood (see Appendix G). Ad hoc individual interviews were done with children who did not do the survey properly and hesitated to speak in groups or felt shy. This helped to develop the results from the children's self-reported thoughts, and to assess the barriers for them in their walking to school (Creswell, 2007, Yin, 2003). Open-ended questions from parents also clarified the results of the parental survey to understand their perceived barriers for children concerning their trip to school across the different areas (Crump, B., 2008). Telephone interviews were conducted with

parents who did not answer the open-ended questions completely because the researcher did not have direct access to the individuals (Creswell, 2007).

The descriptive data that was gathered from the surveys helped the researcher to explain the children's current travel mode and situation. Moreover, exploratory data helped the author to gather basic maps and other information regarding existing policies about children's travel to school in Tehran. It also helped to get useful relative statistical data about schools', students' distribution within different areas and any regulations regarding primary schools from relevant organizations and departments in Tehran. These organizations can be listed as Municipality, Department of Traffic and Transportation, Department of Education and Training and Department of Renewal and Development of schools in Tehran. Furthermore, the Master plan of Tehran (2006) and Comprehensive Plan of Tehran provided useful data about Tehran's profile and neighbourhood demographics.

Data from the 2002 census allowed the author to collect some demographic information about the children's population for Tehran as well as statistical data about pedestrian injuries (especially children) in car accidents. Details on each type of data and main component are outlined below (Figure 4.2).

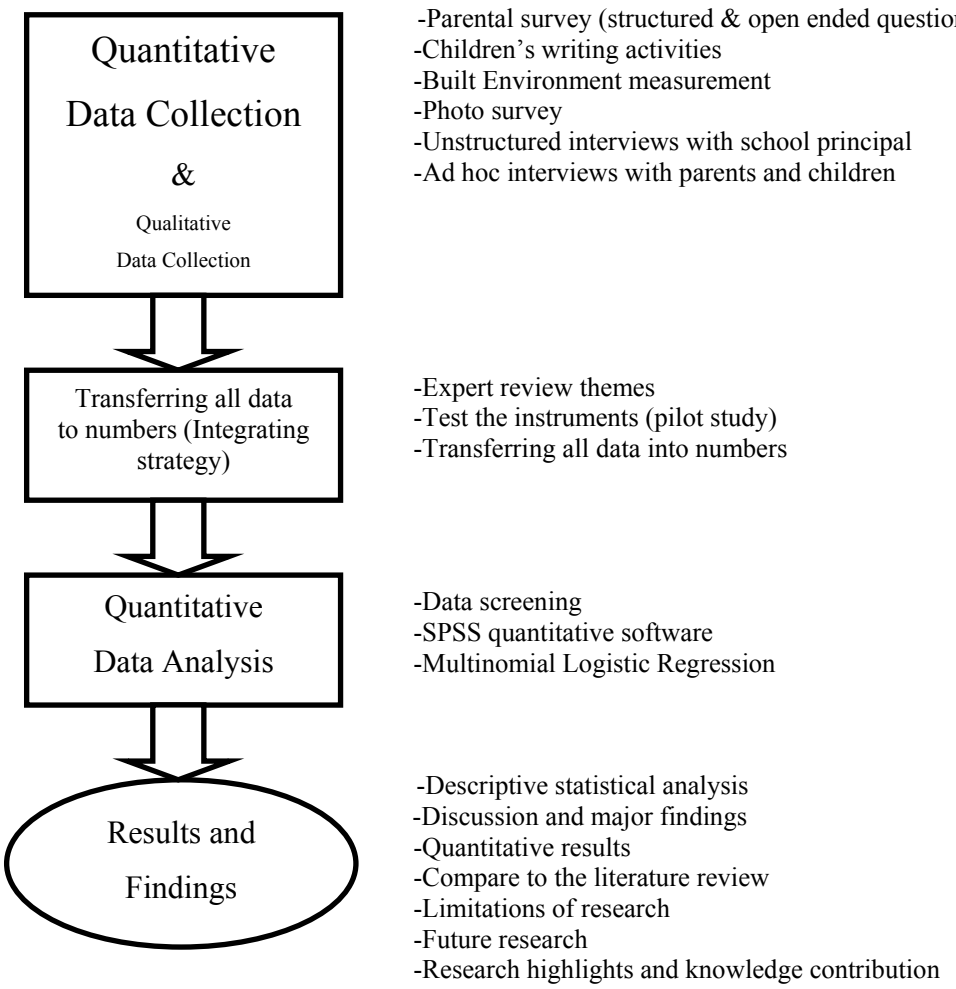


Figure 4. 2: Triangulating Design Mixed Methods Research Design

4.5.1 Parental survey

Data collection was conducted during January and February of 2009. Parents' surveys (N= 561) were distributed to involved children in grades 3-5 at the recruited schools to take home to their parents for them to complete. An attached cover letter explained the purpose and significance of the study and asked parents to participate in the survey of the study. The letter included the researcher's contact number and a brief resume about her (See appendix A).

The parents were asked to complete the survey in respect of the child who brought the survey home (in case they had more than one child). No follow-up was taken to capture non-respondents. Parents returned the completed survey to the school via their

children. With the school's permission a small gift (i.e., a mechanical pencil) was given to the child to thank them for their parent's participation.

The surveys had no identifiers (e.g. Parent's name, address, ID numbers) just a code for the school and district number. The survey questionnaire was designed to be completed within approximately 20 minutes. When possible, validated survey questions from existing instruments were used to develop this multi-parts survey. The survey was developed in both English and Persian, because the official/national and only language in Tehran is the Persian language and people cannot communicate in English (see Appendix A for parent survey instrument). Surveys were prepared in English, translated to Persian, back translated to English and edited to confirm similarity of the two versions. Surveys in both languages were designed for a simple reading level. The Persian version of the survey was pilot tested to evaluate the construct validity of the instruments as well as its rationality in collecting responses. The questions in the questionnaires were assessed in a separate sample of parents (n=86) (De Vaus, 2002). The stages of pilot testing questions were as below:

1- Readability (check to ensure that respondents understand the intended meaning of the questions),
2- Acquiescent response set (in cases where there were disagree/agree format of questions),
3- Ability to measure the key variables of the study,
4- Non-response (the question maybe unclear or similar to a previous one),
5- Redundancy (if two questions measure the same thing),
6- Variation, to ensure that most respondents would not give a similar answer to that particular question.

As well as testing individual questions, the questionnaire as a whole was evaluated regarding:

1- Flow (if questions fit together and transit from one section to another smoothly),
2- Question skips (to ensure the skip patterns do not lead to skipping more questions),
3- Length (if it is too long it can lead to a reduction in the sample size).
4- Respondents' interest and attention (to ensure that respondents did not get bored, because bored respondents will provide unreliable answers).

The parent survey was designed to extract their perception of barriers for children to walk to and from school. As stated previously, it is assumed that parents are the final decision makers in respect of their children's travel patterns to and from school. However, children's level of health and preference may impact on the parental decision (Timperio et al., 2006). Moreover, travel choice is not only a rational procedure to choose the destination, path and transportation mode; rather, it is influenced by peoples' perceptions and habits (Gardner & Abraham, 2007; Saelens et al., 2003). For these reasons the parent's survey in this study initially focuses on:

1- Parents self-report of their child's travel to and from school as well as their own travel mode to work.
2- Parents' perception of safety (violence, traffic) in the neighbourhood around the school.
3- Parents' perception of neighbourhood design features that influence their children walking to and from school.
4- Parents' perception of driving behaviour in the neighbourhood around the school.
5- Parents' feeling about having daily physical activity for their children by walking to school.
6- Parents' perception of suitable age and distance for their child to walk to school.
7- Parents' self-report of their own school travel mode.

8- Parents' perception of their child's walking to school during different seasons.

9- Demographic questions about the household.

The parents' questionnaire ended with an open question where they could state their opinions or suggestions regarding the children's journey to and from school. Open-ended questions were combined with closed-ended questions on the parent's survey to integrate the data (Creswell, 2003).

A total of 561 surveys were returned out of the 673 distributed; an overall survey response of 83%. The response rates by school varied from the lowest, 77%, to the highest of 89%. Although similar distribution procedures were used at each school, the response rate is different across the schools because:

1- Some principals were more cooperative due to their previous experience in conducting surveys at their school and its impact on the number of non-respondents.

It is worth noting that a people participatory approach in research is not common in Iran. Therefore, the principals of schools were worried about cooperating, as were the parents and children, which could impact on the number of non-respondents.

2- School bus riders are another possible source of non-respondents.

Although public schools are not supposed to provide a school bus service, school bus riders made up about 30% of the respondents. Since the survey is more focused on barriers for children in their walking to school, those parents whose children take the school bus may have felt that the survey is not related to them. However, they could be a good source to indicate their reasons for the provision of a private school bus for their children's school trip.

4.5.2 Children's survey

Doing research with children is potentially different from adults. Children are similar to adults but with different abilities, so the methods for collecting data from them should be based on their skills (Christensen, 2004; Morris, 2003). Conducting a structured survey with children is difficult (Hume et al., 2009). Recognizing and benefiting from extra information in the labelled response format requires cognitive processes, which are not developed within children before the age of 10 or 11 (Borgers et al., 2003). The choice of methods not only depends on the age of the children, and the researcher's experience and preference but also on the social status of the research subjects, cultural environment and the physical setting. It also depends on the research questions and the abilities of the researcher (Punch, 2002). The methods can be pictures and diaries, sentence completion and writing (Morrow & Richards, 1996), drawings (Horstman et al., 2008), the draw and write technique (Rollins, 2005) interviewing (Formosinho & Araujo, 2006) and radio workshops (Thomas & O'Kane, 2000).

A common assumption concerning the validity and reliability of data collected from children is that children may lie or confuse reality and fantasy. The *test-retest* method is the only way to check the reliability of single questions. A *test-retest* reliability of questions about children's journey to school was performed among students after two weeks (Timperio et al., 2006; De Vaus, 2002). Therefore, it is necessary to gain information from several points while doing research with children for internal validity and to understand what they say or mean (Sinclair, 2006). The most effective way to carry out research with children is to use traditional and innovative methods together. Using a range of techniques can be an effective way of managing children's different abilities and preferences (Punch, 2002; Sinclair, 2006).

An innovative approach such as using task-based methods can enable children to feel more comfortable with an adult researcher. The task-based methods include: drawings, photographs, diaries, participatory and work sheets with children. Drawings can be creative and fun for children as well as giving them time to think about what they wish to draw. It provides data that is more easily comparable. However, some children are hindered by a lack of artistic ability. Moreover, it is probable that children will copy from friends or from textbooks (Thomas & O'Kane, 2000, Punch, 2002). The photographic technique does not depend on the children's ability and children are less likely to copy their friends or textbook images directly.

However, children provide more detailed information about the research topic by writing a worksheet or composition. It can be simple, open questions of just one page. In addition data can be obtained more quickly and for a greater number of children than by using individual interviews or observation techniques (Driessnack, 2006; Sinclair, 2006).

Furthermore, children in Iran are not capable of drawing creatively because they are learning to copy from a sample rather than using their imagination. Therefore, the drawing technique was not used to gather data from children. In addition, as it was impossible to gain access to the children after school hours or take them out during school time, using photography was not possible.

Using participatory techniques such as spider charts is ideal for allowing children to define the relevant elements of the issue, which is very useful for the initial research stage. The disadvantage of using this technique is that further methods need to be used to discuss in detail (Thamson & O'Kane, 2000). In this study, during the pilot study, children mentioned that filling up the spider chart is tiresome for them. Therefore, for the final administration it was simplified so that they could fill it up in a shorter time.

Children of all three age groups were invited to participate in the survey including children who walked to school as well as those who did not. After explaining the purpose of the study to them, those students who were not interested in participating went back to their classrooms. In other words, students were involved in the study voluntarily; however, the researcher ensured that the number of children met the required sample size (Horstman et al., 2008). As explained before, the required sample size was 561 students. It was decided to oversample by about 20% of the computed number required to compensate for non-responses and missing values. Totally, 673 students (147 in high income, 151 in middle income and 375 in low income) were selected within eighteen schools (see Appendix C-F for Children instrument).

As aforementioned, initially children were asked to complete a simple spider chart. Furthermore, to collect information from a large number of children quickly, worksheets were used as a major technique in this study to obtain data from children. By filling up the spider chart, children provided some detailed information about all factors (urban form and non-urban form) that prevent them from walking to and from school on their own (see Appendix B for Children instrument). In addition, they gave information about those factors that encourage them to walk to and from school independently.

Furthermore, children were asked to write a composition about the journey to school and some of them were interviewed after that to clarify what they meant (Rollins, 2005). Unstructured interviews were used to extract children's views and opinions. The interviews were not audio taped due to the regulations of the Department of Education and Training in Tehran, rather, all interviews were hand written notes (Creswell, 2003). To ensure that the children were calm during data gathering, the researcher reassured them that there were no right and wrong answers.

The response rate was almost 100% (out of 673 students) because the researcher was present while children were doing the writing activities. However, some of the essays were not used in analysis due to poor answers or copying from their friends. Therefore, the population of children ended up as 602. The distribution procedure was similar at each school; however, children's interest in participating was different across schools. The survey was conducted during school hours at each school, and, consequently, children had to miss one subject or not go to the field during break time. Therefore, some children were not willing to participate in the survey and were replaced with other children who were interested in participating.

To enhance their understanding of the given topic of composition, they were asked to answer a few questions within their writing. These related to the mode of transport used by the children and who, if anyone accompanies them to go to and from school. Furthermore, they were asked to mention their favourite travel mode and give the reasons and comments if they are not able to meet this desire. However, they were discouraged to propose unrealistic ways of travelling such as magic carpet, flying horse, etc. Children were further asked if they are allowed to go to and from school alone. Moreover, children mentioned whether they were scared of anything in the built environment or out of it, which prevented them from walking to and from school independently (Hume et al., 2009) (see Appendix A for children's instrument). Their creative writings were transformed to a series of "Yes","No" questions to be able to use the results in statistical analysis (Creswell et al., 2003).

They did "Writing Activities" in a gathering hall, praying room or library of the school (depending on the availability) with the researcher present. With the permission of the school, a small gift (i.e., pencil or ruler) was given to students to thank them for

their participation. Some questions were asked from both parents and children, enabling a linkage between the answers of the child and those of his or her parents.

4.5.3 Urban design measurement

Data was collected on the urban design characteristics and street layout for the immediate environment around the schools (see Appendix G for the measurement tools). Half a kilometre was selected as a reasonable walking radius around each school (with the main entrance as the centre of it) based on the regulations of the Schools Development and Renewal Department in Tehran (McMillan, 2003).

Data was collected in the field at each school site over two days to record urban design elements, which are associated with children walking (based on literature). Urban design measurement at each school site took about 4 hours. The urban design aspects for the whole sample and across the different areas will present in next chapter.

The urban data collection instrument tools included three sections:

1- Traffic safety (complete pavements, street width, traffic signs, speed bump, pavements' width, block length),

2- Personal safety (first floor window facing the street, vacant lots, abandoned buildings, undesirable land uses, mixed land use),

3- Aesthetics (presence of trees, and parks) based on difference between actual neighbourhood urban measurements and people's perception of them.

4.6 Data analysis

Initially, all qualitative data transformed into quantitative numbers in order to be able to compare with the quantitative results in the discussion section of the study. Additionally, to validate and expand the quantitative findings, the researcher collected

both types of data within one survey instrument. Because the qualitative items are an add-on to a quantitative survey, the data generally do not result in a careful qualitative data set. However, they provide the researcher with interesting quotes that can be used to validate the quantitative results (Creswell, 2003).

All data was analysed using the statistical program, SPSS-version 17 for Windows. SPSS was selected because it is a very comprehensive and user-friendly statistical software package for analysing data. Data from almost any kind of file (e.g. Excel) can be imported in SPSS. It enables the researcher to generate tabulated dissertation reports, charts, and plots of distributions and trends, as well as descriptive statistics, and complex statistical analysis.

Comprehensive descriptive data were drawn from the responses. The percentage within the tables did not always equal 100 due to rounding non-responses, and where multiple answers were accepted. Concurrent validity of the measures was established through factor analysis. Reliability of the factors was established through the coefficient alpha.

The majority of the items were measured based on categorical scales (e.g. Yes, No) and a few based on a continuous scale from "Strongly disagree" to "Strongly Agree". There were a few open-ended questions as well.

4.7 Analytical methods

There are various techniques available to analyse the data such as Structural Equation Modelling (SEM). Structural Equation Models are mathematical relationships indicating the hypothesized association between variables. The technique uses both factor analysis and Cronbach's alpha to examine the quality of items in indexes to test directional relationships, especially those with latent variables (Abbe et al., 2007). SEM

considers the corresponding measurement error using items that measure a particular variable imperfectly. Thus, in the SEM approach we gain an increased understanding about how the item loads on the factor, how much remains unexplained, and, finally, how well the data fits the hypothesized model. These measurement errors are very important as they may cause the indicator factor to be underestimated and the impact of the independent variable on the dependent variable to be overestimated, particularly when all coefficients are positive (Abbe, et al., 2007).

Some of the limitations of SEM are that the model is suggested for continuous, and dichotomous with normal latent responses. Any of these conditions may lead to bias in the chi square tests of model fit, parameter estimates and standard error (Skrondal & Rabe-Hesketh, 2005). Moreover, SEM requires a large sample size (i.e. National Survey), generally, several hundred observations are required, as the accuracy of the estimates is affected by sample size; in addition, it is not suitable for stratified sampling. Since the sample of this study was small and clustered, and as much of the data used in the analysis was categorical and probably had non-normal attributes, structural equation modelling was not used.

Another technique that could be used to analyse this data is cluster analysis. This describes the variables and looks for a similarity within a group and if the variables vary across groups. However, this technique cannot interpret data with multiple independent variables, especially when the number of independent variables is more than the number of clustered groups (i.e., in this analysis 3 socio-economic areas, more than 3 independent variables). Therefore, cluster analysis was not used in the analysis.

McFadden (1981) developed the General Extreme Value (GEV) model framework. Since 1985, regression models have been widely used in fields of transportation. These are based on random utility theory (Train, 2003) and are

appropriate for examining the probability of one travel mode over another. Nested Logit Model and Multinomial Logistic Models are two cases of GEV.

The Nested Logit model is special case of GEV model and it is more flexible than the MNL, as it puts alternatives that are correlated in the same group. For example, walking and bicycling are in the "non-motorized" modes group, private car and school bus are in the "motorized" modes group (Ulfarsson & Shankar, 2008). However, it is not suitable for this study. For example a child walking independently and their walking with an adult share some similar unobserved factors; however, they cannot be included in the same category due to the aim of the study. This study seeks the barriers for children in their autonomous walking to and from school. Thus, influential factors which are impacting the probability of a child walking to and from school with an adult relative to their walking on their own, matters. Moreover, this study explores the difference between barriers for children in their walking to school across different income groups. In other words, choosing different types of motorized travel mode relative to walking to school may have different reasons across different income groups.

Multinomial Logistic Models (MNL) is another special case of GEV model. The MNL model explains how the travel mode is chosen from among the alternatives, while characteristics of both alternatives and decision-makers affect the choice. It also leads to a large number of predictions of discrete choice probabilities. The model is the most widely used model due to its simple mathematical structure. In choosing travel mode to school, the characteristic of alternative modes such as convenience and safety as well as attributes of children and their parents such as income and level of parents' education would be affected choices (Ewing et al., 2004, Wen & Koppelman, 2001).

In this study Multinomial Logistic regression models were used to identify the barriers for children in their walking to and from school on their own. This model is

very suitable for categorical data when the transportation alternatives are more than two. It assumes that each individual chooses the alternative that yields the highest pay off in terms of utility. Therefore, it would help to answer the research questions in this study. Travels were limited to walking while being escorted by adults, walking while not being escorted by any adult (walking alone or with their friends), being driven by private vehicles and using school bus. Cycling was not included because nobody was cycling in the sample.

The conceptual model proposed that primary-aged children walking to school is a function of parental decision making, while children's desire may impact on it. Moreover, their decision-making is hypothesized to be influenced by several factors: built environment variables: neighbourhood safety (NS), traffic safety (TS), urban infrastructure (UI) and none-built environment variables: household transportation options (HTO), socio-economic (SE), and socio-demographic (SD).

Variables were included in the analysis selected from parental and children surveys as well as urban design measurement to present perceived and actual safety in the neighbourhood (subjective and objective measurement). Preliminary, cross-tabulations were prepared to show the relationship between independent and dependent variables. Therefore, variables that did not have any significant association with travel patterns were excluded from the model. However, those that theoretically influenced the choice of travel mode to school were included.

Two models were estimated to identify the barriers for children walking to school in different socio-economic areas. The first model (non-urban form model) contained variables from the parents' and children's surveys, excluding urban form variables. The second model (Built Environment model) included the same variables as the first model and urban form variables in order to elaborate the relative influence of urban form

factors when controlling for other factors. The variables considered in the models will be discussed in the next chapter.

The ANOVA test, which is suitable for categorical variables, was used to examine if the differences between environmental barriers for children in their trip to school across three socio-economic areas in Tehran is likely to be due to sampling error or reflect a real difference in the population (De Vaus, 2002). Since there are three socio-economic areas in Tehran, it was not clear which particular income groups have significantly different means. The differences between some groups might be due to sampling error while others might not be. Therefore, one more test was needed – the "post hoc comparison" or "Scheff" (De Vaus, 2002). This enables the identification of which pairs of groups have sufficiently large differences that are unlikely to be due to sampling error. As such the aim of the study was to identify the barriers in the physical environment of the neighbourhood for children walking to and from school; only environmental factors that represented barriers (i.e. correlated negatively with a child's walking to school autonomously) were included in the tests.

Finally, the variables that represented barriers for children in their walking to and from school were organized in the output of Multinomial Regression by groups. It showed the relationships between the variables and the children's mode of travel to school across income groups.

4.8 Model Specification

The conceptual model suggested that the likelihood of a primary school aged child walking to school (without an adult) is a function of parental decision-making. This means that children and their parents, as a family unit n, choose their travel mode, j, to maximize utility, U_{nj}. Assuming $U_{nj} = P_{nj} + \varepsilon_{nj}$ and P_{nj} is parental decision making about the children's travel mode to school and ε_{nj} is distributed iid (independently and

identically distributed) extreme value results in a closed form representation for the probability of choosing each mode, *j*, for each person, *n*. X_i is a vector of the explanatory variables and β_j are the coefficients that are estimated using maximum likelihood estimation. It is:

$$P_r(Y_i = j)n = \frac{\exp(X_j\beta_j)}{\sum_{n=1}^{m}(\exp X_1\beta_1)}$$

In a simple way, parental decision-making (P_{nj}) for each child was hypothesised to be a function of various factors: neighbourhood safety (NS), urban form (UF), socio-economic (SE), socio-demographic (SD) and as suggested in the policies concerning traffic safety in Iran (TS). In this analysis, parents reported the school transportation modes:

$$P_{nj} = \alpha + \beta_1 NS + \beta_2 UF + \beta_3 SE + \beta_4 SD + \beta_5 TS$$

P_{nj} : represents the utility to person *n* of mode *j* ;

α : is an alternative specific constant;

β : regression coefficient

This model represents the probability of a child walking independently to school, which is influenced by each of the predictor variables. The variables were selected from the parents' survey, children's survey and built environment measurements to describe the conceptual model. Some of the variables vary with the choice, such as children and parental level of comfort. Some other variables do not vary with choice; however, they affect the travel mode decision-making and interact with other variables in the model (Train, 2003). This means that choosing children's walking independently among the alternatives may depend not just upon the characteristics of the children and households making the choice but also upon the attributes of walking without an adult. Moreover, the individual characteristics of children and households and walking attributes may interact (Børrestad, 2011).

As discussed in the analytical model and methodology chapter, the factors and survey questions were established on the associations evaluated in the travel safety and children travel pattern literature. Independent variables that related significantly to the dependent variable in the initial cross-tabulations were included (at the 0.05 level). Variables were also included if they were theoretically and empirically related even if they did not have a significant effect on the preliminary model assessment (Giles-Corti & Donovan, 2002; McMillan, 2003; McDonald, 2005).

ANOVA and Scheff were used to test for differences in mean proportions between the three different socio-economic status areas. In these analyses, the unit of analysis was the number of students and parents not the schools. To assess the internal validity of the results; the characteristics of children, parents and physical attributes of the neighbourhoods were compared in the previous chapter (Wen et al., 2008). Although the differences between the groups were statically significant in relation to children's travel modes to and from school, the absolute percentage differences between the groups were small.

Three multinomial models were calculated to recognize the key factors affecting a child's walking to and from school, relative to traffic safety and neighbourhood safety. Walking to school/from school independently was chosen as the reference mode for each set of variables. This means that the influential variables on choosing children's mode of travel to and from school were assessed separately (Muller et al., 2008). The MNL regression model assumes that if any of the transportation alternatives become unavailable, then the probability of the other alternatives would increase. As such, the present analysis is limited by a couple of simplifications of the choice framework. Driven by parents included private car and motorbikes, that were combined to ensure that this mode is available to all students (Salon, 2009). Walking with friends and

walking on their own are combined because adults are not involved; also walking with an adult (parent, grandparent) or elder siblings are combined as well. None of the public schools in Tehran provide a school bus for children's transportation. However, some parents whose houses are close to each other provide private transportation for their children to send them to school. This is considered as a school bus, because usually 4-5 students or more take the same transportation (a taxi or van, based on the number of students) to go to and from school. This alternative was included in the analysis because there is no information on whether the school bus is available to all for the school trip; the researcher assumed it is available (McDonald, 2005). Cycling, skating and using public transportation were excluded from the analysis because nobody chose these particular modes.

The Basic Models (non urban form model) contained variables from the parents and children's surveys that represented each of the variables highlighted in the conceptual model, excluding the built environment variables from the urban design measurements. The model was calculated twice with the same independent variables, but different dependent variables. The first one examined the impact of the independent variables on children's school travel mode to school; the second one examined the affect of the same variables on children's school travel mode from school.

The Expanded Models (built environment model) included the same variables as the first model and neighbourhood safety and traffic safety from the urban design measurements. These models were also calculated twice, the first one evaluated the relative effect of the built environment on child's school travel mode to school; the second one examined the relative effect of the same variables on the child's school travel mode from school when the influence of other factors are controlling. Overall, the expanded models outperformed the basic one in predicting children's walking to school

independently with a substantially higher pseudo-R^2 statistic, the expanded model strengthened the explanatory power of the estimate of mode choice (Cervero, 2002) (Figure 4.2).

Traffic safety is hypothesised to be the only effective factor on the trip to school on foot. However, data shows that neighbourhood safety factors impact on parental decisions about children's modes of travel to school. Studies show that parental concerns and children's perception about personal safety have a great influence on making decisions about children's methods of transportation to and from school (Panter et al., 2010; Farver et al., 2000). Other research revealed that the perception of parents and children concerning traffic safety also impact on the children's active travel mode to school (Bringolf-Isler et al., 2008; Pont et al., 2009). Some studies also conveyed that traffic safety and personal safety have an equal effect on parental decisions about the children's mode of transportation to and from school (Johansson, 2003; Ahlport et al., 2008).

Variables were selected based on the hypothesised association between traffic safety and neighbourhood safety factors and a child's walking to school in the literature on children's travel to school and travel safety (discussed in detail in chapters 2 and 4). Additionally, built environment factors were selected based on the hypothesised relationship between the built environment and traffic safety and neighbourhood safety factors due to the results of previous studies that show an indirect relationship between the built environment and the children's travel mode to school (McMillan, 2003, Hume et al., 2009).

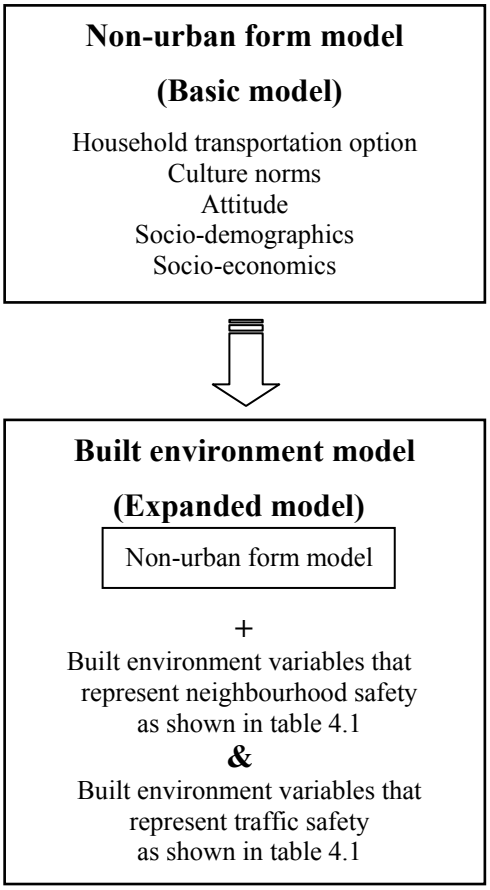


Figure 4. 2:Two initial Multinomial logistic regression models

A mediator is a variable that explains how and why a relationship between independent and dependent variables occurs. A moderator is a variable that affects the direction or strength of a relationship between the independent and dependent variables (De Vaus, 2002). The relationship between independent and dependent variables may change across different categories of moderating variables, (moderate is the synonym of interact) and it is tested in many research studies (Wen et al., 2008; Zhang, 2006). In this study the socio-demographic and socio-economic factors are considered as" moderating factors" in a child' trip to school.

The variables that were taken into account in the analysis are listed in Table 4.1. Their hypothesised relationships with the likelihood to walk to and from school are listed in Table 4.2.

Table 4. 1: The variables taken into account in the analysis

Dependent variable-parents and children survey

MODE- Mode of travel to school
(5-walk with friends, 4-walk alone, 3- walk with parents, 2- walk with elder sibling, 1-private car, 0- school bus)

Independent variables

Neighbourhood safety-Parents survey

ESCORT- you or an adult you know/elder siblings could walk with her/him
(5 point scale, very likely to very unlikely)
MOREPPL- there were more people walking in the neighbourhood
(5 point scale, very likely to very unlikely)
MORECHL- other children walked together to and from school
(5 point scale, very likely to very unlikely)
CBADPPL- if they do not meet undesirable people
(5 point scale, very likely to very unlikely)

Neighbourhood safety-Children survey

KIDABDUC- if child were to walk would they be scared of being abducted
(1=Yes, 0=No)
POLICE- if child were to walk would they like to see police officers (1=Yes, 0=No)

Traffic safety-Parents survey

DRIVECARE- likelihood of allowing a child to walk if people drove more carefully (5 point scale, not very likely to very likely)
TRAFKMH- if child were to walk, would they have to travel on road with traffic >30 km/hr (1=Yes, 0=No)
CROSNOPAV- if child were to walk, would they have to cross a road without painted cross-walks (1=Yes, 0=No)
TRAFLAN- if child were to walk, would they have to cross a road with more than 4 lanes of traffic (1=Yes, 0=No)
WALKNOPAVE- if child were to walk, would they have to walk in road or shoulder because of no pavement (1=Yes, 0=No)
WALKNROWPAV- if child were to walk, would they have to walk in road because pavements are narrow (5 point scale, not true at all to very true)
WALKNOSEP- if child were to walk, would they have to walk in road in which there are bushes/fences to separate traffic and pedestrian (5 point scale, not true at all to very true)
NEIGCHLPED- neighbourhood is not children pedestrian friendly (1=Yes, 0=No)
NOTRAFSIGN-if child were to walk, would they have to cross a road at an intersection that does not have street signal to stop cars (1=Yes, 0=No)

Traffic safety-Children survey

CROSNOZEBRA-if child were to walk would they have to cross a road without having painted cross-walks (1=Yes, 0=No)

Table 4.1: Continued

WALKNOPAV-if child were to walk would they have to walk in road or shoulder because of no pavement (1=Yes, 0=No)
HIGHSPEEDCAR- if child were to walk would they have to cross the road with high speed traffic (1=Yes, 0=No)

Household transportation option-Parent survey (HTO)

DRIVELIC- number of licence drivers in household
DISHMSCH- distance from home to school less than or equal to 1 km (1=Yes, 0=No)

Culture norms-Parents survey (CP)

PARFEELWAK- if encourage their child to walk to school (1=Yes, 0=No)

Culture norms-Children survey (CCHL)

KIDFEELWAK-if child would like to walk to school alone or with friends (1=Yes, 0=No)

Attitude-Parents survey (AP)

INTERACT importance of child interacting with other kids while going to and from school (5 point scale not very important to very important)
HEALTH- walking to school is considered as doing exercise (5 point scale not very important to very important)
SCHLCLOC- school is close enough to walk (5 point scale not true at all to very true)
DRIVECONV-driving is more convenient (5 point scale not true at all to very true)
DRIVEFIT-driving suits my schedule better (5 point scale not true at all to very true)
CLIMAT- children walking to school is difficult when the weather is cold (1=yes, 0=No)
AIRPOLUT-child does not walk to school because of air pollution
DADTRVLMOD- father's travel mode to work

Socio-demographics-Parents and children survey (SD)

KIDSNU- number of children in household
YUNGSIB- presence of younger sibling
OLDSIB- presence of elder sibling
EDUPAR- year of education of parents
GENPAR- gender of parent filling out the questionnaire (1=male, 0=female)
MUMOCUP- mother's occupation (1=working out of house, 0=housewife)
KIDSAGE- age of child involved in the survey
KIDSGEN- gender of child involved in the survey (1=male, 0=female)

Socio- economic-Parent survey (SE)

HOUSINCOM- average monthly household income
HOUSHLDCAR- number of cars in household

Table 4.1: Continued

Urban form variables-Urban design instrument (UF)

SCHLLOC- school location
PR-STPAV- (neighbourhood), QSTPAV (quadrant)-proportion of street segments within ½ km radius of school with pavements
PR-WIN- (neighbourhood), QWIN (quadrant)- proportion of street segments within ½ km radius of school with <50% of houses with windows facing street
PR-NOABBLD- (neighbourhood), QNOABBLD (quadrant)- proportion of street within ½ km radius of school with no abandoned buildings
STWIDTH- (neighbourhood)-QSTWIDTH (quadrant)-average street width of street segments within ½ km radius of school
BKLENGHT-(neighbourhood)- average block length of street segments within ½ km radius of school
PR-SPDBUMP (neighbourhood)- proportion of street segments within ½ km radius of school with speed bumps within ½ km of school
PR-MIXU- (neighbourhood), QMIXU (quadrant)-proportion of street segments with mixed land use within ½ km of school

Neighbourhood indicates that urban form variables is the proportion of all street segments within 1/2 km radius of school, Quadrant
indicates that the urban form variable is the proportion of street segments within 1/2 km radius of school separated into four quadrants.

Table 4. 2: The hypothesized relationship between variables and walking to school

Hypothesized association between independent variable and probability of walking to school independently	
Independent Variable	**Association**
Neighbourhood safety-Parent survey	
ESCORT	+
MOREPPL	- /+
MORECHL	- /+
Neighbourhood safety- Children survey	
KIDABDUC	-
POLICE	+
Traffic safety- Parent survey	
DRIVECARE	+
TRAFKMH	-
CROSNOPAV	-
TRAFLAN	-
WALKNOPAVE	-
WALKNROWPAV	-
WALKNOSEP	-
NOTRAFSIGN	-
NEIGCHLPED	+
Traffic safety-children survey	
CROSNOZEBRA	-
WALKNOPAV	-
HIGHSPEEDCAR	-
Household transportation option-parent survey (HTO)	
DRIVELIC	-

Table 4.2: Continued	+
DISHMSCH	
Culture norms-parents survey (CP)	
PARFEELWAK	##################+
Culture norms-children survey (CCHL)	
KIDFEELWAK	##################-/+
Attitude-parents survey (AP)	
INTERACT	+
HEALTH	+
SCHLCLOS	+
DRIVECONV	-
DRIVEFIT	-
CLIMAT	-/+
AIRPOLUT	-
DADTRVLMOD	-/+
Socio-demographics-parents and children survey (SD)	
KIDSNU	-/+
YUNGSIB	-
OLDSIB	+
EDUPAR	-
GENPAR	-/+
MUMOCUP	-/+
KIDSGEN	- /+
Socio-economic-parent survey (SE)	
HOUSINCOM	-
HOUSHLDCAR	-
Urban form variables-Urban design instrument (UF)	
SCHLLOC	-/+
PR-STPAV	+
PR-WIN	+
PR-NOABBLD	+
STWIDTH	-
BKLENGHT	-
PR-MIXU	+
PR-SPDBUMP	+

(-) equals negative association, (+) equals positive association, (-/+) either negative or positive association

The regression results were used to identify the influential variables on decision-making about children walking to and from school independently. Therefore, those variables that decreased the probability of children walking to and from school on their own, over walking with an adult, and motorized travel modes to school (taking school bus and being driven by parents, with car or motorbike) were considered as impediments.

Furthermore, the data were examined to determine if the inclusion of built environment variables that represented the actual traffic safety and personal safety in the neighbourhood improved the ability of the model to predict the probability of children walking to and from school independently (Cervero, 2002). Eventually, odds ratio (Exp.B) were calculated for statistically significant variables to conclude the magnitude of the impact a variable had on walking to and from school without an adult. The odds ratio was used to see the effect of each variable on travel to school within a model, and to settle how the magnitude of significant variables in the basic model changed by adding built environment variables, which were representative of traffic and personal safety in the neighbourhoods.

Wald test is a way of testing the significance of particular explanatory variables in a statistical model. In logistic regression there is a binary outcome variable and one or more explanatory variables. For each explanatory variable in the model there will be an associated parameter. The Wald test, described by Polit (1996) and Agresti (1990), is one of a number of ways of testing whether the parameters associated with a group of explanatory variables are zero. If for a particular explanatory variable, or group of explanatory variables, the Wald test is significant, then we would conclude that the parameters associated with these variables are not zero, so that the variables should be included in the model. If the Wald test is not significant then these explanatory variables can be omitted from the model.

4.9 Limitations

The most important limitation of this study is like other developing countries; there is insufficient knowledge about Iranian society. The most difficult and complicated process in this study; was finding and accessing books and documents in Iran. The documents and texts relating to children's status, education and transportation were

widely dispersed and because this research is the first in this field in Iran, there is no comprehensive bibliography. The researcher had to look over all bibliographies, biographies, and newspapers, reports and magazines, which were published to find materials pertaining to the status of Iranian children and education. In addition, there are only a few experts and professionals on children and traffic safety.

It should also be considered that a census is taken every ten years in Iran. Therefore, data that came from the census are close to ten years old and no updated data was available. In addition, like other developing countries, data that were collected could be incomplete, incompatible, and inaccurate. Different institutions presented different details on the same issue and almost no updated and complete statistics on the children and traffic in Tehran were available. Furthermore, each institution had their own definitional concept of "children" and traffic safety. Furthermore, available data did not distinguish between either gender or age. Most of the available information excluded the newly established districts, as there is no department of education in these districts.

A fundamental constraint on doing this study was the lack of a clear approach towards issues regarding children's travel to school and traffic in Tehran. The government has some strategies to improve traffic safety around primary schools in Tehran but parents and children are not involved in the process of development. Consequently, people do not feel that their real needs are addressed and they are suspicious of researchers and reluctant to participate in research. Therefore, nothing will take place or change, because people acceptance is a vital element in sustainable mobility (walking is considered as a sustainable transportation mode) (Banister, 2008).

Obtaining permission to conduct a survey in schools was a time-consuming process. Moreover, there were some barriers to get data from children in the schools.

The lack of a suitable place to gather all the children together in most of the schools, and insufficient cooperation from the principal of the school, and inaccessibility to the parents directly are considered as the main barriers when doing this study. Moreover, collecting data from children must be done during school hours and there was no chance of seeing the children after school. More importantly, very limited finances were available for the study; therefore, it forced the researcher to limit the number of respondents and school sites as well.

Finally, the children's mode of transportation to and from school was self-reported. The error and bias associated with self-reported data, particularly among children, is well documented. Moreover, the instrument used in this study, like much other self- reported instruments did not correlate strongly when validated against the objective measures. Other limitations of this study include its cross-sectional design, which makes it impossible to draw causal inferences from the data. However, since the objective of this study was to explore the perceived barriers and improve them, it is not considered as a weakness. Additionally, all children involved in the present study were from urban areas (Tehran). The children of urban Tehran are representative of urban children living in Iran (Jazayeri, 2005). As such the results of the study might only be generalized to urban Tehran, which is the largest metropolitan area of Iran. Therefore, future research should consider exploring the constraints on children walking to and from school in rural areas, which may be different from urban areas (Dalton et al, 2011; Gallimore, et al., 2011).

The strength of this study is its inclusion of both perceived and objective measures of the built environment. Additionally, it examined the influential factors on the modes of transportation for children to go to and from school separately. Moreover,

children's perceptions of the built environment have been assessed, which was not widely undertaken in previous research (Hume at al., 2005; Fusco et al., 2011).

4.10 Conclusion

This study relies on Multinomial Logistic Models developed by McFaddan to understand modes choice for the morning and afternoon school trip for primary school children. The analysis is limited to children 9-12 years old who can walk to and from school autonomously and much of policies debate focuses on this age group. The socio-ecological framework requires a strong understanding of how factors at each level might influence children travel behaviour. The model structure assumes children and their parents, as a family unit, choose their travel mode to maximise utility. With a socio-ecological approach, the representative utility of each mode for each person is a function of trip, child, household, and neighbourhood characteristics. In this model, decision makers can choose between walking with an adult, walking autonomously, school bus and private car.

The framework outlines the structure of relationship between urban form and children travel behaviour, including the identification and role of other influencing factors on a travel decision. As such, there is a need to present the characteristics of children, households, neighbourhoods and their current mode choices. The next chapter presents a comprehensive descriptive data analysis to introduce the survey population. It also provides an overview of built environment elements across different socio-economic areas.