A Geographical Study of School Attendance Areas Using the Multiplicatively Weighted Voronoi Method: A Case of Rasht City, Iran

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Abstract

Like other Iranian cities, school boards have not created official attendance areas for schools at any education level of Rasht City to allocate students to schools within their local areas. In the absence of guidance from education authorities, parents are the main decision makers in choosing schools for their children. This is also the case for the selection of public female junior high or PFJH schools in Rasht City. Although this might invoke images of freedom under the current system, many female students go to school outside their local areas. To understand how this happens the research purpose was to analyze the parental choice system in order to detail its shortcomings and how they generate longer and inconvenient commutes to schools. To solve the problems the research aimed to replace the parental choice with defined school attendance areas that allocate students to the closest possible school on foot as much as possible.

Multiplicatively weighted Voronoi diagram (MWVD) was the method for the construction of attendance areas given its utility in demarcating spaces so that all journeys within them are closest to a chosen point. It concluded that the projected school attendance areas can result in shorter and more convenient commutes on foot. This can nearly eliminate the need to travel by vehicle for the overwhelming majority of students and make their journeys more convenient.

Key words: commute time and distance, commuting inconvenience, Iran, multiplicatively weighted Voronoi diagram, public female junior high (PFJH) school, Rasht City, school attendance area.

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Introduction

1.1 Problem Statement

In most countries, especially the more developed ones, the policy of attendance areas give first preference to students that enrol from a given local area for the most moderate and convenient commute times. In such cases, education boards delimit attendance areas for schools according to a number of criteria that includes not only the proximity of the student's residence, but also school size, and accesses to safe transportation. Implicit in such policies is the assumption that most schools have relatively high levels of academic competence and afford adequate access to educational equipment or facilities. This system of homogenous schools, roughly equivalent in performance, in turn allows parents to more easily choose from schools within the local area making proximity considerations the driving factor for their choice of schools.

There are numerous examples of schools in developed countries with defined attendance areas that give an enrolment preference to students nearest by. In Vancouver, Canada, for example, school administrator guide and direct student enrolment with centralized attendance area policies and clear school boundaries. For an even more convenient school choice within the local area, a district boundary map of Vancouver is available for parents to view at the Vancouver School Board for more information (Vancouver School Board, http://www.vsb.bc.ca/schools/boundaries/default.htm). In addition, the school board recommends parents contact their local school directly to ensure that their specific address is within the attendance area of the school. Education department policy in Ireland is also designed to ensure each child attends the schools closest to his or her parents' place of permanent residence (Scoil Naomh Fiachra School's Enrolment Policy available at: http://homepage.tinet.ie/~clontubrid/about_us/). In New Zealand, proofs of residence within attendance areas are required for student enrolment at Havelock North Intermediate School (Havelock North Intermediate School Enrolment Information available at:

http://www.hni.school.nz/). The first priority for enrolling in Highcliff, a school in England, is also living within a short commute of the school. There delimited areas are clearly illustrated by the school with an online map available for viewing by prospective students and their families. Such detailed descriptions of schools boundaries down to street names with perfectly displayed maps of attendance area are available online in many schools' websites (Highcliff School Admission, http://www.highcliffe-jun.dorset.sch.uk/admission.htm).

In the case of Iran, however, without attendance areas for schools which clarify the student residential-based enrolment area for each school, Iranian parents have become the decision makers of public school selection. In the parental-based school selection, parents seeking better often have no choice but to send children to schools outside the local area. This has resulted in commutes that are longer than necessary for students who journey on foot or on city's public and private transport.

Despite the relative ease of getting to school in developed countries, a daily journey to the city in Iran is highly inconvenient for students and their families. Without the access to a school bus or carpooling, most students have to travel longer distances on foot from their homes to catch taxis and other means along main streets. Not only do such vehicles add to the considerable cost families of sending their children to the schools, they are also less safe. Daily travel in taxis or rented buses also means higher exposure to the risk of injury and even death. The consequence of lengthy journeys to city schools on foot and rented vehicles also decreases time and energy for homework or other activities following school.

In order to solve the problems that students face in their daily commutes to schools in Iran, delimiting attendance areas are needed for the schools at any level of lower public education. The proposal of this research is that an attendance area system can enforce the choice of schools within more local areas. Also that it is a step toward obliging the Education Ministry to supply schools with the tools and educational supplies needed for better quality schools. To increase the convenience of journeys to schools, it focuses on methods that can produce the greatest possible reduction in current commuting time and distances.

1.2 Research Purpose

Without guidance from the school boards or attendance areas parents are the central decision makers in the choice of public schools in Iran. Although this might invoke images of freedom under the current system many student go to schools outside their local areas. To understand how this happens, the research chose public female junior high (PFJH) schools. The proposal of this research is that an attendance area system can enforce the choice of schools within more local areas. The research purpose was to analyze the parental choice system to detail

its shortcomings and how they generate longer and inconvenient commutes to PFJH schools. This can prove the necessity of eliminating parental choice from school selection in the study area. To solve the problems the research aimed to replace the parental choice with defined school attendance areas that allocate students to the closest possible PFJH school on foot as much as possible.

Though study of parental choice and the construction of attendance area are necessary for elementary and high schools, the research focused on PFJH schools. Since there are larger numbers of elementary schools in the city, it would have made data collection a more difficult and overly time consuming process. Given the limitations of studying elementary aged students the research focused on the next youngest group on the compulsory education level, junior high school students. As the environment around schools is often more unsafe for female students and public schools outnumber private ones, the focus of research was on public female junior high schools of Rasht.

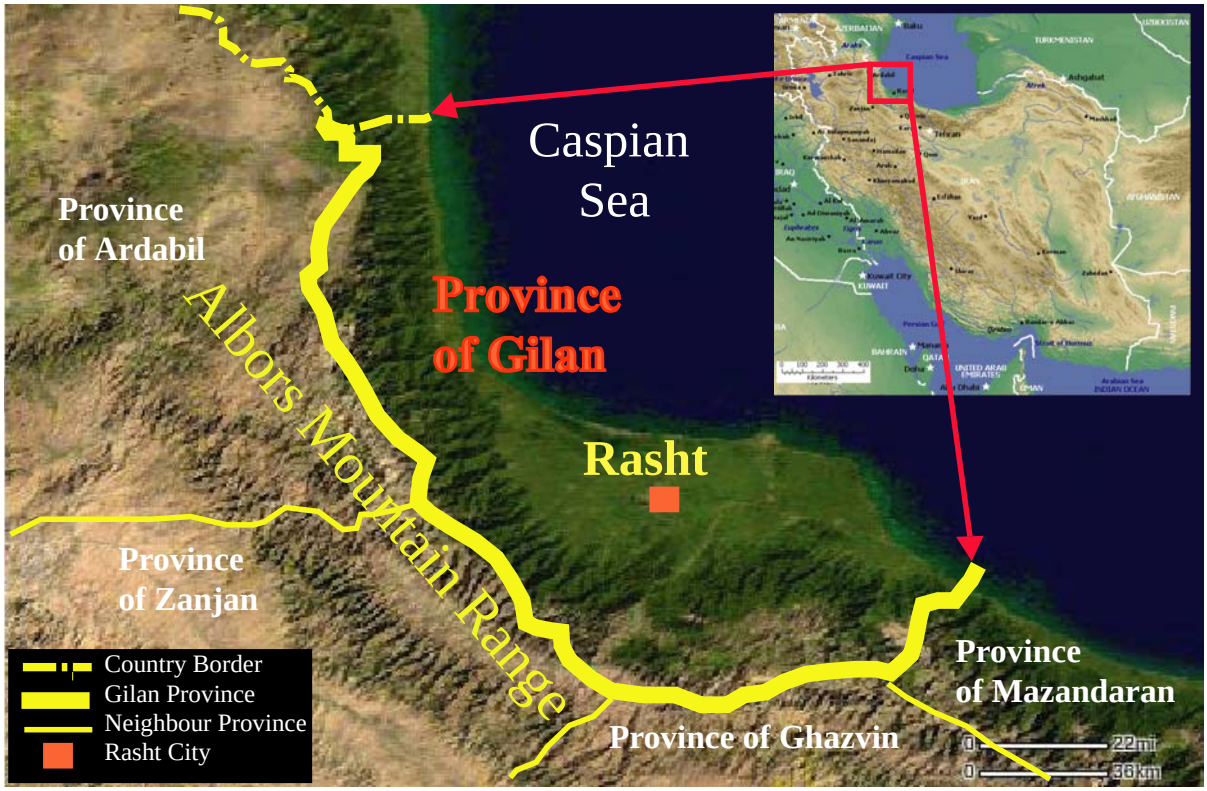
Once a system is in place that directs parents to choose from schools closer to their homes, government funding can address the need of funding to standardize the quality of schools within the constructed attendance areas.

1.3 Study Area

The study area of this research includes the junior high schools of Rasht City located in northern part of Iran in Gilan Province, Rasht County Figure 1-1 shows location of Gilan province and Rasht City in Iran. A very brief review of Rasht topography, climate and population can be useful in determining what kind of conditions and obstacles that Iranian students face when commuting to schools. What follows is an overview of these areas for more detail.

The Province of Gilan is located in the Gilan Plains between the Alborz Mountain Range and the Caspian Sea in the Northern region of Iran. With a population of 2,241,896 in 1996 (SCI, 1997a) and an estimated population of 2,410,523 in 2005 (SCI, 2005b), Gilan covers an area of 13,952 sq. km (SCI, 2003a). It also shares borders with Ardebil on the west, Mazandaran on the east, and the Ghazvin and Zanjan provinces to the south. Its location in the moderate climactic region of Iran also makes this region the wettest and most fertile part of Iran. As such it also home to major agricultural products like rice, silk cocoons and tea.

Based on the newest administrative divisions in 1996, Gilan is broken into 16 counties. The counties by name are Astara, Astaneh Ashrafiyeh, Amlash, Bandar Anzali, Talesh, Rasht, Rezvanshahr, Rudbar, Rudsar, Siyahkal, Shaft, Somesara, Fuman, Lahijan, langrud, and Masal (IMPO, 1996b). Within these counties are also a total of 44 different cities and towns. Of these



2005, ESRI, Earthsat

Figure 1-1 A satellite image showing location of Gilan Province and Rasht City in Iran.

16 counties, Rasht is by far the most populous. Of the total population of Gilan province, an estimated 806,364 lived in Rasht County in 2003 representing fully 33.4% of the total Gilan region population while 640,652 reported in the 1996 census (SCI, 2005a). There are other reasons for Rasht City's popularity within the province, as well. Rasht residents, for example, can easily enjoy beautiful green surroundings with easy access to the booming metropolis of Tehran (Figure 1-2).

According to a National Census 417,748, people were living in Rasht city as of 1996. Recent estimation shows that Rasht currently has 519,481 residents (SCI, 2005a). Rasht is situated in a plain at a distance of 30 km from the Caspian Sea nestled within the slopes of the Northern Alborz Mountain Range. It has a land height that is -9.6 meters lower than the open seas.

As such, the climate of Rasht is both humid and unstable. It's aptly known as "The City of Rain" throughout Iranian. The average minimum and maximum temperatures reported over a 30 year of period from 1966 to 1996, for example, were between 11° C and 20° C, with high humidity levels of up to 93% (SCI, 2003a). Dominant wind currents from the Caspian Sea blow from the northeast to the southwest. These winds carry vapour and humidity towards the plains causing heavy and prolonged rainfalls in Rasht and throughout the Gilan region. Thus the average rainfall in Rasht reported in the 30 year of period mentioned was 1,401 mm per year with a maximum 170 mm a day. This is far higher than the average rainfall for the rest of Iran of 364.6 mm per year. Although such heavy rainfall can make commutes both extremely difficult and inconvenient, they nevertheless play an important economic role in a country with such limited arable land.

The size and strategic location of the city near the invaluable fertile plains of the North also make Rasht one the most important rural trade centres of the region and country as well. Less than 10% of the land in Iran is arable. Thanks to heavy rainfall, the advantage afforded by a wet climate is that places like Rasht are also home to the most fertile lands in the country. The public outdoor market districts with traditional bazaars have long functioned as the preferred centre of trade for the region. This fact has also made Rasht City the ideal locale for the purchase and sale of surplus products by villagers residing in the city hinterlands. Most of the industrial and commercial facilities of the province are also centralized within Rasht. In addition to this high concentration of private sector facilities, Rasht also serves as the centre for essential provincial public services and administrative branch offices.

Such factors have accounted for the constant growth in the city's population overtime. Although just 109,491 people resided there in 1956, the population more than quadrupled five decades later to 417,478 people in 1996. While the city covers an area of just 41 sq km, its

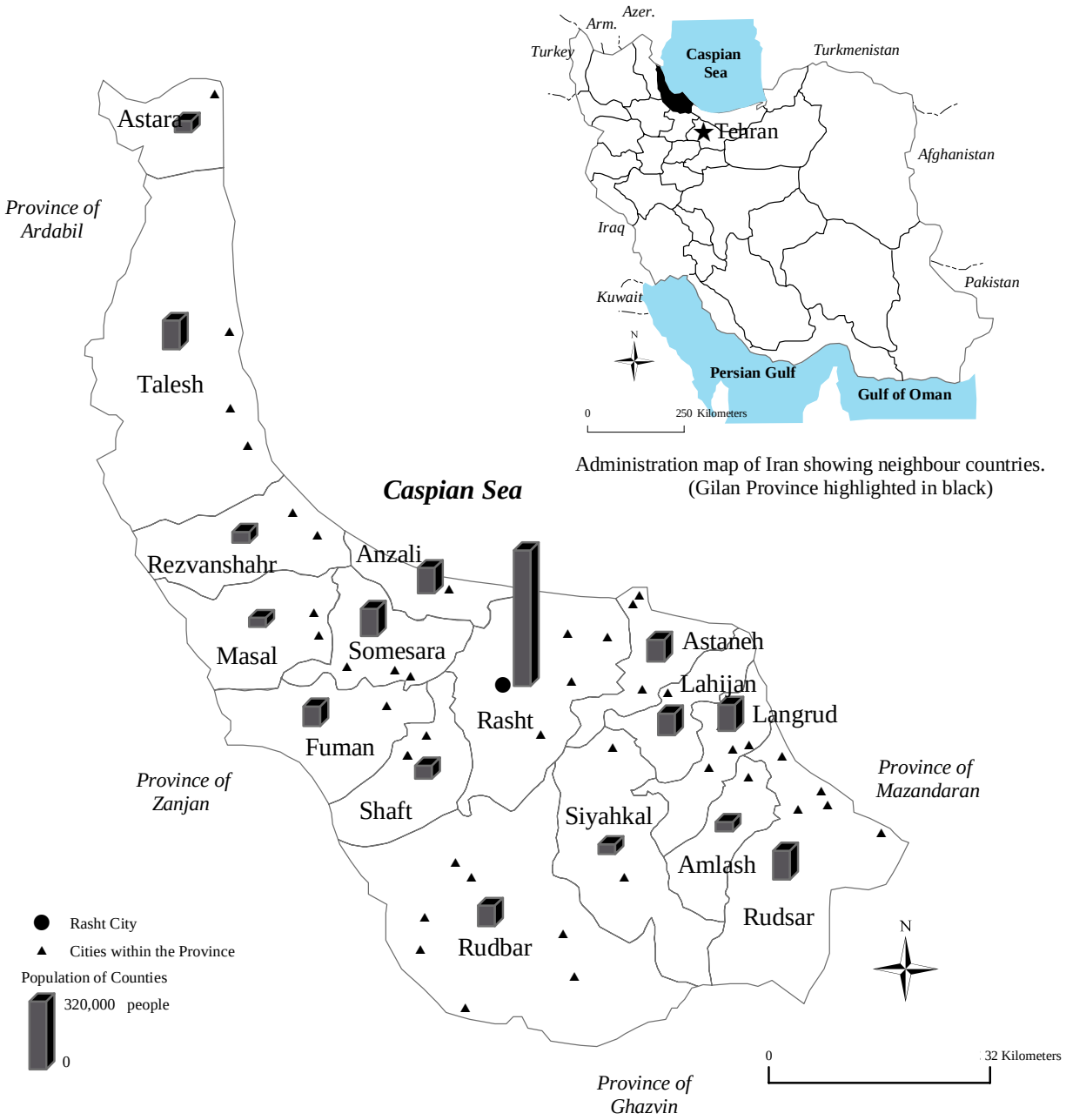


Figure 1-2 Gilan Province map showing cities and counties by name and population in 1996.

explosion in population growth over time has resulted in a relatively high population density of 9,555 per sq km, when compared with the average density of just 3,003 per sq km for all of Gilan in 1994 (IMPO, 1996a).

Any discussion of current population growth trends can also be helpful in understanding whether or not overcrowding in schools is a factor in the current inconvenient commutes to schools outside local areas. Research into population statistics revealed that this was simply not so in the case of the studied area.

Following the population explosion of cities in previous decade's government national birth control plans successfully lowered annual growth. As a result, population numbers in Iran have been decreasing for a number of years. This is also true for Rasht. Despite the rapid growth of Rasht in past decades, the city has recently experienced a drop in population growth after coordinated government efforts to curb the rampant growth of its cities. Figure 1-3 shows the population growth on a macro scale of Iran, on a provincial scale for Gilan, and on a city scale showing population statistics for Rasht. On all the three population scales, population growth has been declining since 1986. Like the rest of Iran increases in population growth in Rasht slowed after 1986. As seen in the figure, while population growth peaked in Rasht city throught to 1986, it slowed again following the sucessful implementation of national family planning programs. Hence, population growth slowed for to just 3.21 % between the years of 1986-91 (SCI, unknown year) and to a mere 2.73% in 1991-1996 (SCI, 2005a).

Overcrowding or lack of access to neighborhood schools is not responsible for the longer commutes that students face given the trend of a falling student population. Due to the drop in population growth in Iran over the last two decades, the school-aged population has also been declining for junior high levels in Rasht city. Figure 1-4 indicates student attendance at junior high schools of entire country. As the population increased, the number of junior high students rose to 5,294,672 in the 1998-1999 school year for both genders and then dropped to 4,953,894 for the 2001-02 school year (Ministry of Education 1997, 1998, 1999, 2000, 2001, 2002). The reduction in people throughout Iran from 1986, also naturally translated to decreases in the number of students in schools. As Figure 1-5 shows Rasht city has in fact been losing the number of female students at its female junior high schools in recent years. The number of students, for example, plummeted from 19,357 in the 1997-98 school year to just 16,393 students in 2003/2004 school year. In other words in this period of seven years, from 1997 to 2004, the number of female junior high students dropped by around 3,000. It is also notable that during these years, two schools with a total capacity of 700 had to be closed for lack of attendance (Ministry of Education, 2004). Although the expected benefit of this loss of population might be increased accessibility to schools, students still have commutes which are longer than necessary.

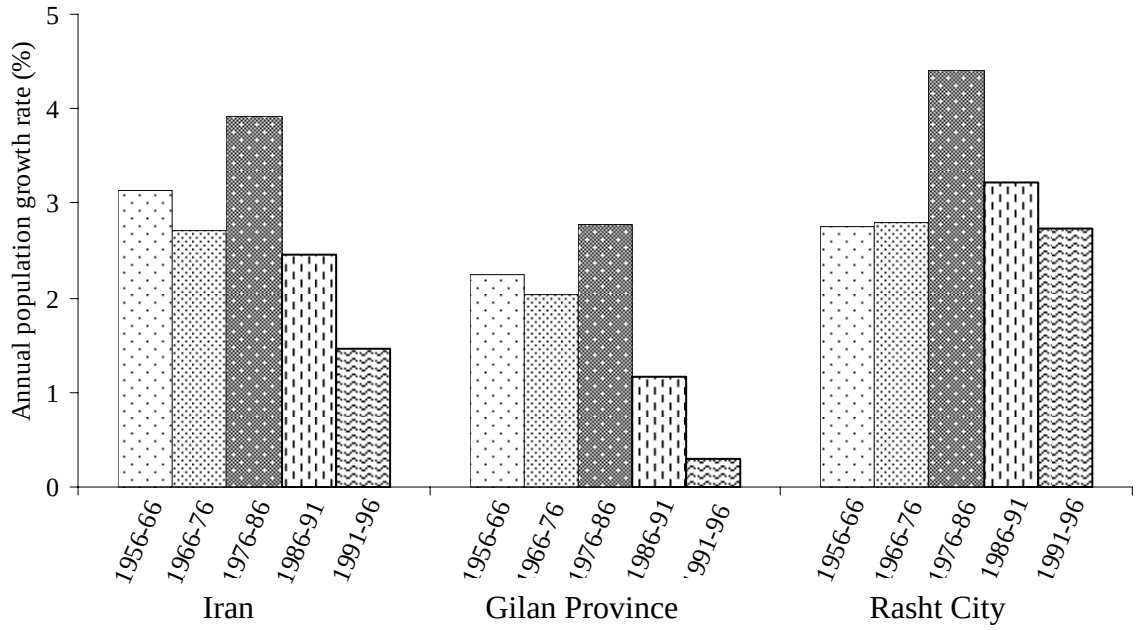


Figure 1-3 Annual population growth rates for Iran, Gilan Province and Rasht City from 1956 to 1996.

Source: Statistical Centre of Iran

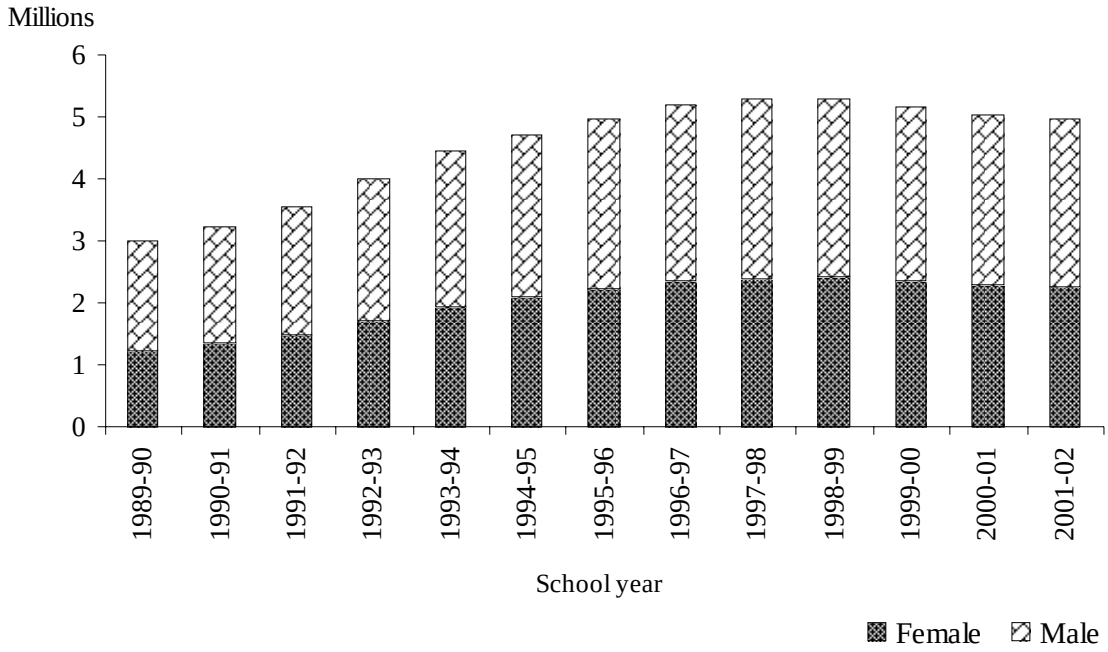


Figure 1-4 Total numbers of students at junior high schools in Iran from 1989 to 2002 for both genders.

Source: Iran Ministry of Education and Training

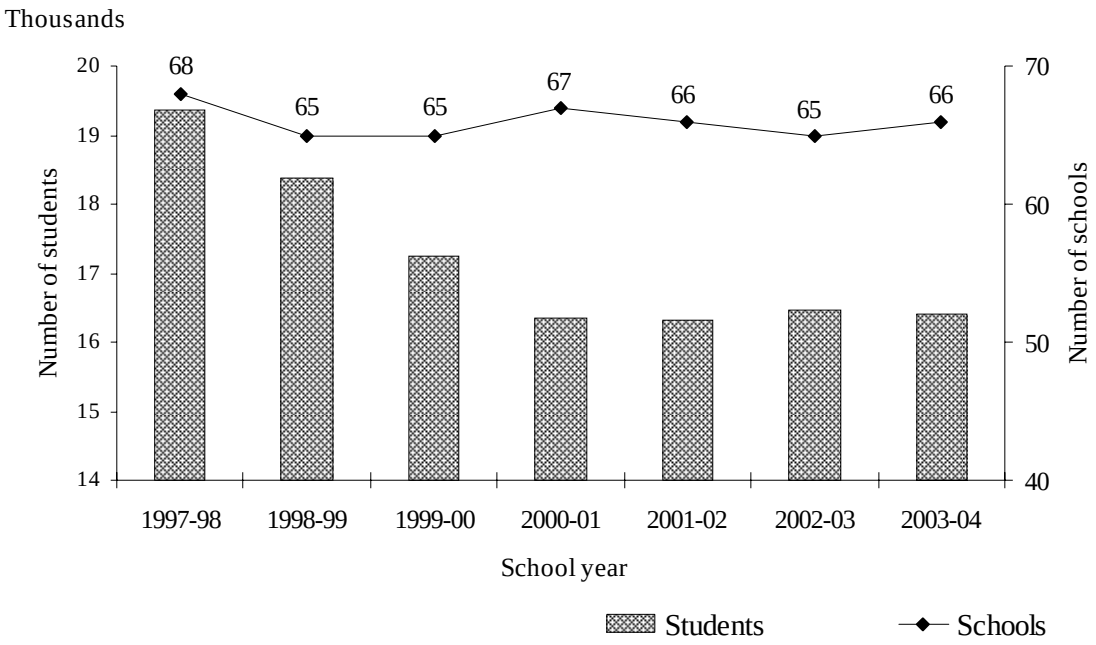


Figure 1-5 Total numbers of students at public and private female junior high schools in Rasht City from 1997 to 2004 by number of schools.

Source: Education Office of Rasht

We also can rule out a lack of school space problem in searching for approaches to reducing commutes. This was due to the fact that despite the increased room in schools that resulted from fewer students, (at least 1,400 considering the school closures mentioned above), many parents continued to choose a school outside of their residential areas. To address this lack of guidance, the research focus is on delimiting attendance areas for the public female junior high schools of Rasht.

Figure 1-6 shows the location of the Rasht public female junior high (PFJH) schools along with the city's land use patterns. All PFJH schools of Rasht are located within residential areas highlighted in pink on the map. The residential areas of Rasht are surrounded by farmlands and rice fields. In accordance with Rasht City urban planning, growth is mainly concentred towards the southeast. This part of the city is almost solely by occupied industrial facilities and along with some higher educational buildings. Even though this land use pattern of Rasht has restricted the growth of residential areas to the southeast on the city's outskirts, the number of new residents settling in this part of city has been increasing steadily. This has also resulted in longer commute to the nearest schools for its residents.

There were 85 public junior high schools with a total student population of 26,873 for the 2003-2004 school year. Since schools are separated for male and female students, these students attend the 40 male-only and 45 all female junior high students scattered throughout the city (Table 1-1).

Most schools in Iran have to overcome the obstacle of a limited number of constructed educational structures by alternate use of the same building in alternating periods throughout the day to maximize scant resources. This is also true for the study area. In the case of the PFJH schools of Rasht, there is a two shift structure in which shared use of the same school building takes place by two autonomous schools. This means that students enrolled in a particular school have to attend in either morning or afternoon shift that alternate from week to week (Photo 1-1). Though schools occupy the same building and utilize the same resources, they are completely autonomous with separate principals, and their own set of teachers and administrative staff.

The arrangement of shared educational facilities also characterizes the 45 Rasht PFJH schools chosen for the purpose of delimitation. These PFJH schools utilize 26 educational buildings. While there are seven schools that own buildings for exclusive use, the remaining 38 schools share 19 educational buildings in morning and afternoon shifts that alternate weekly. These schools are referred to as either Shift 1 or Shift 2 for ease of identification. These 19 buildings include Amupur, Etminan, Mohseni, Asghari, Narjes, Azarbani, Engelab, Lotfi, Valiasr, Balalzadeh, Ghods, Azadi, Felestin, Aban, Anvar, Esmat, Sadigeh Kobra, Tohid, and Rahzahra. School names correspond to the shift they occupy, Amupur 1 and Amupur 2, for

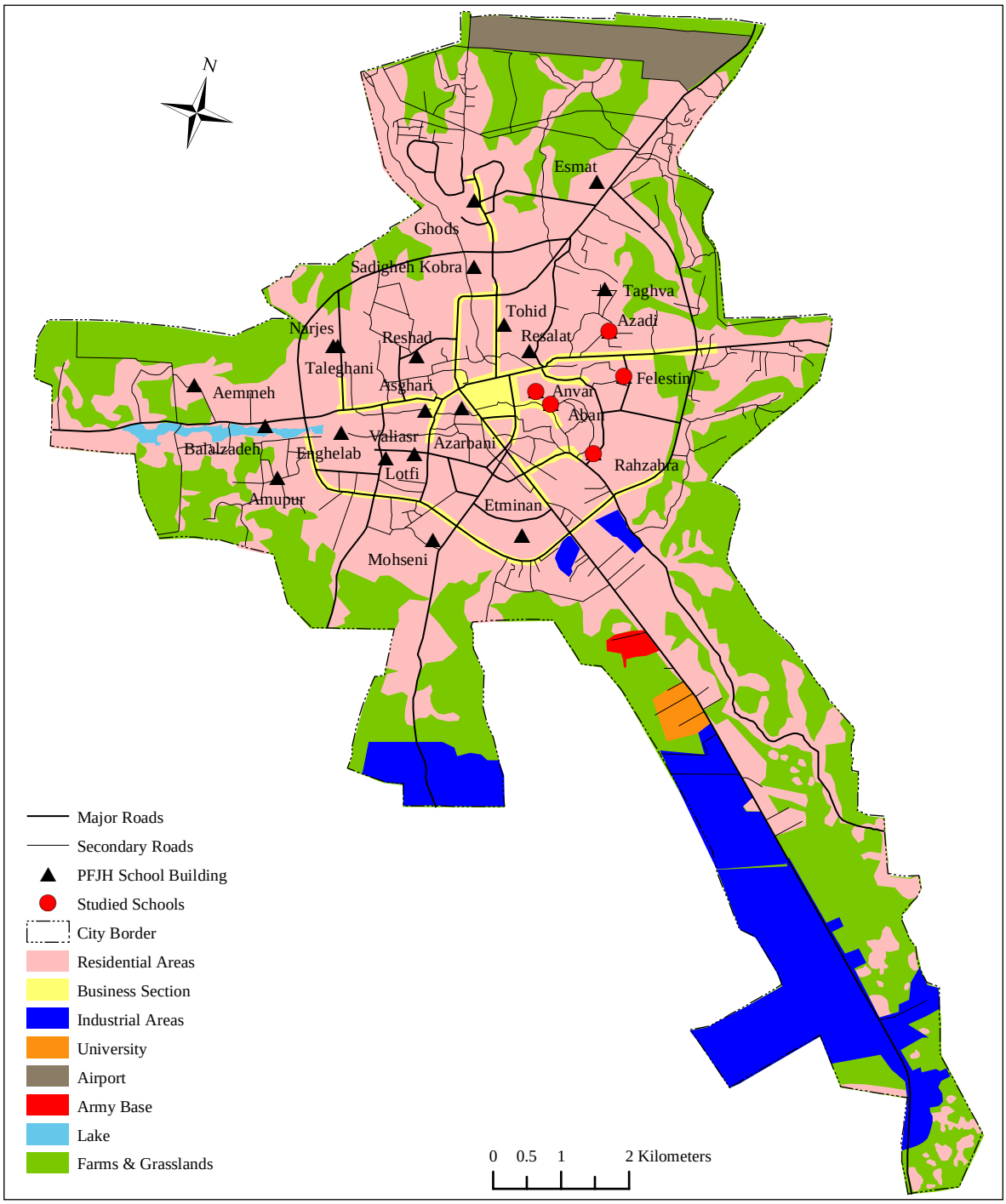


Figure 1-6 Location of Rasht PFJH school buildings in 2004 by name and the city land use pattern.

Table1-1 Number of students in Rasht City public junior high schools based on school shifts and gender for the 2003-2004 school year.

	Total	One shift	Two shifts	Female school			Male school		
Number of schools				**Total**	**One shift**	**Two shifts**	**Total**	**One shift**	**Two shifts**
	85	19	33	45	7	19	40	12	14
Number of students	26,873	5,766	21,107	13,929	2,174	11,755	12,944	3,592	9,352

Source: Education Office of Rasht

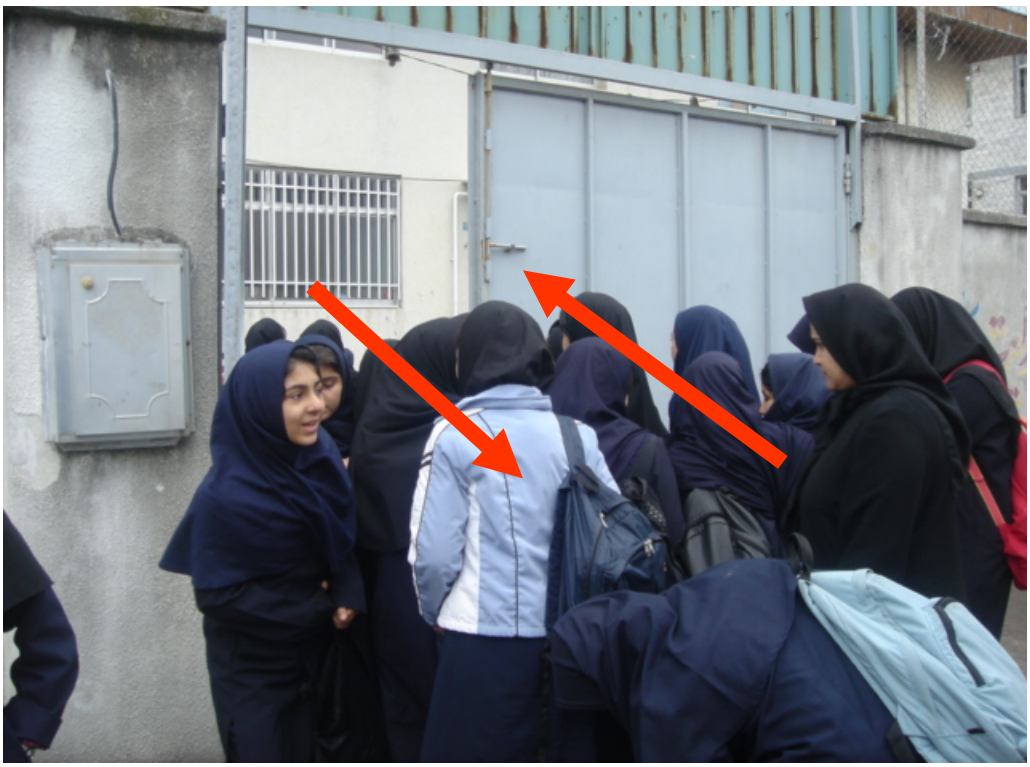


Photo 1-1 An illustration of the two shift time concept.
(Morning shift students of Anvar 1 are leaving, as afternoon shift students of Anvar 2 are waiting to enter.)

Photo taken by the author in September 2004

example. In doing so, seven morning shift schools were excluded from the Shift 2 since these schools were unavailable to students for the second afternoon shift time slot. These schools include Reshad, Taleghani, Aemmeh, Fajr, Taghva, Shahed, and Resalat. In conducting spatial analysis for the purpose of research, two special schools of Fajr and Shahed were excluded since their populations included enrolled students from outside the study area (Table 1-2).

In order to focus on student commuting distances and examine if delimited boundaries can minimize their travel time and distance for students at Rasht's schools, five PFJH schools- Aban, Anvar, Azadi, Felestin and Rahzahra, were chosen from Shift 1 for more detailed study. These five sampled schools also have diverse features that make them good representations of the whole to fit the goal of generalizing any results. The five schools are located on both main roads and secondary routes, have differing reputations, and enrol students from both the central of the city and suburban parts of the city. While Rahzahra and Felestin are located on main routes, while Azadi, Aban and Anvar, are located on secondary routes. Aban and Anvar are the two most popular schools in the study area. Since Shifts 1 and 2 student populations encounter the same environment and hazardous difficulties in commuting and generalization of the results of the research from either shift was possible, the five schools were chosen by random sampling from Shift 1 PFJH schools.

A look at the declining population growth at these schools lends strong support to the conclusion that commuting problems are not linked with overpopulation. Table 1-3 shows how number of students has dropped down in the five studied schools for first year students. The decline in class sizes is another illustration. While the average class size of students enrolled three years ago that are now in their final year at PFJH schools was 493, the current class size is only 362 for the 2004-2005 school years.

Although expected result of a declining number of new students is better access to the schools, commuting longer distances more than necessary is still a major problem. Despite a drop in number of students, the research will show that it has also not resulted in easier access to PFJH for students in the case of the studied schools. Since the schools differ in how reputable they are, parents have to look for the best possible schools for their children outside of their local area. For those who live far from well-known schools this often means a long commute to school. Aban and Anvar are good illustrations. These schools are popular despite the inconvenience of the commute and its location away from student's neighbourhoods. Aban, for example, moved10 years ago for use of a newer building away from a previous location with better accessibility for students. In the new location many students have to walk more than 10 minutes from the main road to get the school. Like the rest of Iranian schools, no free school bus services are available for students attending Anvar and Aban. Nevertheless they remain popular, however, solely

Table 1-2 Number of students in Rasht City PFJH schools according to school shifts for the 2003-2004 school year.

Shift 1		**Shift 2**	
School name	**Number of students**	**School name**	**Number of students**
Amupur **1**	451	Amupur **2**	552
Etminan **1**	423	Etminan **2**	433
Mohseni **1**	433	Mohseni **2**	423
Asghari **1**	400	Asghari **2**	403
Narjes **1**	363	Narjes **2**	386
Azarbani **1**	363	Azarbani **2**	357
Enghelab **1**	286	Enghelab **2**	407
Lotfi **1**	297	Lotfi **2**	327
Valiasr **1**	207	Valiasr **2**	238
Balalzadeh **1**	203	Balalzadeh **2**	125
Reshad	326	Ghods **2**	442
Taleghani	247	Azadi **2**	348
Aemmeh	211	Felestin **2**	336
Ghods **1**	420	Aban **2**	210
Azadi **1**	328	Anvar **2**	206
Felestin **1**	336	Esmat **2**	206
Fajr	547	Sadigheh Kobra **2**	169
Aban **1**	326	Tohid **2**	189
Anvar **1**	236	Rahzahra **2**	211
Esmat **1**	219		
Sadigheh Kobra **1**	243		
Tohid **1**	201		
Taghva	332		
Shahed	300		
Rahzahra **1**	249		
Resalat	211		
Total	8,158	**Total**	5,968

Source: Education Office of Rasht

Table 1-3 Number of students and classes in the studied PFJH schools by grade for the 2004-2005 school year.

Studied schools	Number of students in each grade				Number of classes in each grade				Average students in each class			
	First	Second	Third	Total	First	Second	Third	Total	First	Second	Third	Average
Aban	109	86	112	307	3	2	3	8	36.3	43.0	37.3	38.3
Anvar	37	68	70	175	2	2	2	6	18.5	34.0	35.0	29.1
Azadi	65	80	96	241	2	3	3	8	32.5	26.6	32.0	30.1
Felestin	85	119	123	327	3	3	3	9	28.3	39.6	41.0	36.3
Rahzahra	66	63	92	221	2	2	3	7	33.0	31.5	30.6	31.5
Total	362	416	493	1,272	12	12	14	38	30.1	34.6	35.2	33.4

Source: Education Office of Rasht

because of their quality teachers and staff. Thus, even though students have access to schools closer to their residence, parents choose to enrolment these schools outside their local areas and must rent vehicles for the commute.

1.4 Research Methodology

In addition to using related census data published by Statistical Centre of Iran and data provided by the Education Office of Rasht and the schools, the author conducted field work to acquire the first hand data needed for the research. Most of the essential data and information for the research related to the students' location and their daily travels to schools. Since neither census data nor the education office provided these kinds of data, the author had to collect them by fieldwork.

Fieldwork was conducted in three parts; observation, interviews and questionnaires. In order to get a general overview on the junior high schools of Rasht and students' commute to schools, the author visited some schools, observed their facilities, interviewed a number of staff from the Education Office and at the studied schools. These observations and interviews did not provide enough of the detailed data necessary for the research. Thus, a questionnaire inquiry, which included 18 questions, was undertaken for more comprehensive data and information about the five studied schools. In addition to information on commutes, questionnaires were necessary for determining the criteria used by parents and students to acquire home addresses for information about school choice. A translated questionnaire from Persian to English is attached to the thesis.

To provide essential data on selection criteria by parents and current student commutes, including commuting means and the distance from schools, 1,271 questionnaires were distributed by hand to all students for the five PFJH schools of Aban, Anvar, Azadi, Felestin and Rahzahra. After getting permission from the Education Office of Rasht for the research query on the students, each questionnaire leaflet was printed out in three A4 size pages, and then the school staff was asked to kindly distribute the questionnaires between the students, class by class. Students, in turn, were requested to return them in one week. The leaflet, also, gave the readers a brief outline of the research project. Since some questions were related to students and some to parents, both parents and students were requested to answer them. Considering the delay in getting them back, the returned questionnaires were then collected after 10 days by the author, school by school. Of the total, students returned a majority (73%), representing 919 questionnaires. Although some questions were not answered or were left incomplete, most were carefully answered (Table 1-4).

Table 1-4 Number of distributed questionnaires and returned completed questionnaires for the five studied PFJH schools in 2004-2005 school year.

Studied schools	**Number of students in 2004-2005 school year**	**Number of distributed questionnaire**	**Number of returned questionnaire**
Aban	307	307	250
Anvar	175	175	65
Azadi	241	241	194
Felestin	327	327	221
Rahzahra	221	221	189
Total	1,271	1,271	919 (72.3%)

Once the author acquired the home addresses of students from the returned questionnaires, it was then possible to construct a map showing the spatial distribution of students to the five PFJH schools. The data were then analyzed from a spatial point of view to show the necessity of establishing school boundaries for all of Rasht and to reduce the commuting inconveniences.

In order to delimit school attendance areas the research utilized the multiplicatively weighted Voronoi diagram or MWVD method and applied a specialist packaged called WVD18 (Mu, 2004) for the construction of polygons that would represent the attendance areas for each school. Each polygon was then constructed in relation to the number of students to represent the weighted factor (because of lack of data the author could not consider other factors such as school-aged population density around each school in weighting the school attendance areas). Giving this approach, larger schools tended to have larger attendance areas and vice versa for smaller schools. Once the boundaries that would represent each school attendance area were completed, they were analyzed spatially using Arc/Info, software of the Geographical Information System (GIS). In order to examine if the delimited boundaries minimized travel times and distances for students at schools, the five studied schools were again analyzed for more detailed study.

1.5 Research Significance

This research is the first analyses of the parental-based school selection in Iran and constructing school attendance areas for the Iranian schools. The parental-based system of school selection has never been studied in Iran and school attendance areas have never been implemented in Iranian education system. As another significance of this research, students can benefit by commuting shorter distances with more safety through the constructed attendance areas.

The creation of an official school area, which allocates female students to the nearest possible public junior high school, can result in minimizing the travel time and distances of the current inconvenient and often hazardous commutes. The research assumed that the allocation of students within a defined school attendance area based on proximity of student's residences to schools and school size (number of students) will eliminate as much as possible any travel by vehicle and in addition reduce overall commute times on foot in the study area.

Instead of a random spatial distribution of students throughout Rasht that is driven simply by individual parental choice, delimitation can provide a more organized student spatial distribution among the schools that also takes into account the importance of a shorter journey for female students.

Chapter Two

Literature Review

2.1 Introduction

As stated the major goal of this study is to construct attendance areas that will allow the shortest possible commutes to the PFJH schools of Rasht City. Invariably any approach must be backed by rational principles that best aid in achieving it. To ensure the soundness of the chosen principles a review of current literature is necessary to find the best possible ones. What follows is an analysis of accumulated research on this topic. Following a brief review of the most viable principles, this study will also give the necessary support for why the MW-Voronoi was the chosen method for attendance areas, concluding that it can best combat the dilemma of the uncomfortable and often hazard ridden commutes of Iran.

2.2 Complexity of Parental-based Selection of Schools and Its Impact

The lack of a consensus and wide variety of responses in studies is a clear indication of the complexity of the school selection process. Bastow (1991), for example, lists factors such as school accessibility to public transportation, journey safety, discipline, the child's preference, good examination results, caring teachers, sound management, a good head teacher, and denominational characteristics. In addition, the other investigated factors include; the quality of facilities, the presence of siblings and other relatives attending the school. The ethnic composition of schools has also been noted as a rejecting factor in school choice in many studies such as those done by Bagley (1996), the Organization for Economic Cooperation and Development (OECD) in the Netherlands, Holme (2002), Barrow (2000), and Lee et al. (1996). Gender and single-sex schools are also cited as other factors for school selection by parents (Stilman and Maychell, 1986). School proximity, a disciplined environment, and acceptable academic standards (Thomas and Dennison 1991, Adler et al. 1989, Coldron & Boulton 1991, Lawton 1992, Jowett 1995, Gewirtz et al., 1995) are the other effective factors studied by

researchers (as cited in Parsons et al., 2000).

School selection remains a subjective and complicated practice for parents, especially when schools are not equal. Bagley et al. (2001) suggests that in rejecting schools the issues parents consider revolve mainly around transport, the other pupils, and the school environment. In making selections for or against particular schools, some parents do make use of available published information though there is some discussion in the literature about how accurately this is applied. Hammond and Dennison (1995) point out that in making choices parents often feel that there is no alternative but to pay attention to league table performances, given there was little other reliable information to go on. Taylor (2002) found that examination results were referred to by 70% of parents. He also noted that the most important factors in the process of choice overall are the need for a good learning environment, a caring and happy one, good management and a strong policy on discipline. In addition, he noted the importance to parents of good facilities in the school, plenty of resources for students, and school safety. Ball et al. (1995) adds that parental choice involves considering such factors as the distance, available transport, the school hierarchy, and even reputation.

The one theme that endures throughout the literature is that choice matters to most parents, but that the processes involved is neither a standard nor a simple one. Ball et al. (1995) breaks down parental decision making in terms of long narratives or a complex social calculus of compromises and constraints. According to his research, it results from the inherent complexity of individual understandings of their social worlds, as well as practical considerations. Ball (2003) also concluded that there are class differences within the school choice data, with the middle class choosing more proactively than working class families.

Thus, school choice is a complex set of strategic positive and negative decisions, made on the basis of information, and often misunderstandings and perceived myths. Whilst some findings from research on choice indicate some homogeneity, there seems to be little agreement on what is truly important (Glatter et al., 1997).

Studies that focus on the consequences of the flight from local schools in search of the best schools also illustrate the major disadvantages of school choice. Howe et al. (2002) offer a detailed discussion on the drawbacks of parental school choice. According to their research given the broad character of school choice, it can also lead to options of public schools beyond neighbourhood boundaries with a negative impact on students. Moreover how the schools with the most resources will gain too many students, leaving the students that cannot choose or simply do not wish to behind in the worse ones. Such schools thus become engaged in a competition to gain more funding, rather than working cooperatively to assist each other.

Skandera and Sousa (2001) offer more detailed criticism of schools choice. They explain

that critics of school choice express disapproval in two ways. The first way they disapprove is by pointing out that only the best and brightest students will benefit from the ability to choose schools, leaving underprivileged students to continue to falter. The second criticism states that the students left behind might then cause problems at the schools in which they remain. In such schools, not only will resources become strained but teachers will not be able to meet the needs of those students left behind.

Some researches also suggest crucially that parental choice is the factor that increases the distance of commutes to schools (SDG, 2001). A study showed that in parental choice, working mothers may choose primary schools that have nurseries or after-school clubs that may not be their nearest primary school thereby increasing the distance their children have to travel. In addition, parental choice of school can also increase the expenses on schools. Currently, the Seattle Public Schools (USA) spends $1200 per student per year to transport them to schools (Gleave, 2001).

Gerwitz et al. (1995) and Gorard (1997) also concluded that under the current housing market and education market conditions, choice can not produce equitable outcomes. This is true since some are better placed than others to express preferences and negotiate themselves through the system (Whitty et al., 1998) positioning themselves in advantaged locations. Clearly, some parents actively make choices, yet the question remains as to how strongly residence is associated with that decision making process. The National Union of Teachers in England believes that school choice rests with those who have the power to make choices. In addition, that the government seems obsessed with the concepts of parent power and choice, even though divisions in social class made the idea of school choice and parent power an illusion. They wanted the government to put equality back on the agenda as a priority (NUT, 2005).

2.3 Equal Access to Schools

A review of dilemmas facing public educators in developed countries reveals combating the problems of equal access to be central in ensuring that constructed attendance areas can effectively benefit all students. According to Roeder (2002), district policy makers and administrators in urban/suburban districts with many schools and diverse neighbourhoods should consider drawing attendance boundaries to allocate poor children more equitably across schools regardless of school size in order to address underlying issues related to student performance. In the last decade, critics have emphasized the persistence of substantial inequalities in the education received by both high and low-income students, stressing the continued need to allocate low-income students more equitably throughout school districts (Orfield, 2001).

Although this reform effort faces a number of challenges in an era of policy change, it remains one of the primary means of assuring equal access to high-quality educational environments, and supporting the educational experiences of students from disadvantaged backgrounds (Welner, 2001).

2.4 Size of School Districts

In the abundance of literature and research that has been devoted to school district size, it remains that there is no universal agreement on the ideal size for districts. In an American economy of scale study conducted by Imerman and Otto (2003) using schools and districts of the state of Iowa proposed that school districts should not fall below 750 enrolled students. A study conducted by Cox (2002), involving the state of Utah's school districts, on the other hand, indicates that school districts should enrol at least 1,000 students. Arkansas' Governor Mike Huckabee has proposed to merge or consolidate any school district with fewer than 1,500 students, which would eliminate 233 of Arkansas' 310 school districts. Still another study on the consolidation of New York State's school districts offered to consolidate districts with fewer than 500 students (Duncombe et al., 1995).

As evidenced by the conflicting literature cited here, there is no consensus as to the optimal size of school districts. However, what the literature does reveal is that small school districts have many advantages over larger school districts. This fact is widely reported in the literature pertaining to student achievement differences among the varying district sizes.

Research that has been conducted in the past decade has also focused on the relationship between the size of a district and student achievement. Cotton's research in USA (1996) indicates that the states with the largest school districts have the worst achievement, effectiveness, and social outcomes. There are also studies on the impact of poverty in relation to the size of districts. Walberg (as cited in Lawrence et al., 2002) found a direct, negative relationship of the states with large district size and test results, as a district's size increases, student achievement decreases. Florence Webb, in a 1971 Education Research Service study of 26 reports completed between 1939 and 1969, found that there was a strong, consistent negative correlation between district size and student achievement in low income populations (as cited in Cox, 2002).

Other than student achievement, the review of the literature and research also indicates other advantages of small districts. Williams (1990) writes in his working paper on the dimensions of education about recent research on the advantages of small districts. They include local control, possible close relations among professionals, parents, students and community, and the opportunity for many students to participate in school activities.

Along with the many positives of small districts, there are also disadvantages noted in the literature. In report on declining school enrolment, Schwartzbeck (2003) notes that small school districts are more likely to have buildings with features in less than adequate conditions and lower budgets. Moreover, the decreased access to quality teachers often means fewer educational resources, less specialized courses and services.

Williams (1990) covers an array of advantages of larger school districts. His list of advantages includes the fact that; larger districts have greater total resources, curricula can be standardized, administrators may command larger salaries with more professional staff, teachers may receive better pay and improved fringe benefits, and finally that members of large school boards may exercise a greater power base in matters of educational policy and financial management.

Although Galles and Sexton (1995) echo this sentiment, their research also reveals the critical flaw of the bigger is better approach in terms of the level of education that results. Though they concluded that teachers and administrators have used the bargaining advantages of larger districts to extract better terms from school boards, geographically restricted competition allows them to capture those gains for themselves rather than passing them on to their customers in terms of higher quality education.

Thus in the extensive literature there are no clear-cut guidelines with respect to the definitions for optimum district size. Given the available evidence, however, on the advantages of smaller school districts over larger ones, this research also adopted principle that the smallest possible attendance areas are best when possible for the studied schools.

2.5 Non-Car Travel to School

A review of related literature also reveals the numerous benefits of non-car travel to schools. Such advantages include a range of benefits from increased social interaction to reduced air pollution for the city.

Travel to school is an important part of children's social experience since they increase a child's sense of belonging. A survey by the Department of Transport, Local Government and the Regions in Scotland showed that meeting and talking to friends were by far the most important positive factor in walking to school. They also found that not meeting classmates was the fourth most important reason for not liking car travel to school (DTLR, 2000). Children who walk to school also demonstrated an awareness and understanding of road dangers earlier than children with less experience with traffic (Lewis et al., 1998). An enhanced perception of traffic dangers and the importance of personal security (Davis and Jones, 1996) often proved to be even more important than simply getting daily exercise in the walk to school. Travel on foot also gives

children a chance to act on societal or school health promotion messages they have felt they were unable to act on in every day life, given that walking is a convenient source of daily exercise (Mackett, 2004).

Another reason for avoiding the car and walking highlighted is that that exposure to the street traffic noise during vehicle commutes can reduce the mental efficiency of children (Simenova 1980). Car travel to school also can decrease the availability of bus services (Cross and Thornthwaite, 1998). To reduce the bus fares in Scotland, Halden and McGuigan (1999) showed that even though increased public transportation improved access to school for some, growing congestion and pollution around schools became growing problem for school staff, parents and children in the country.

Negative attitudes to car travel and more positive attitudes to walking and cycling were demonstrated in a survey of children aged 7 to 11, in Britain (DTLR, 2000). This showed that 38% of the children who were driven to school would rather walk or cycle. Mackett (2004) noticed a wide range of negative factors associated with car travel such as congestion, pollution, lack of exercise and lack of social contact. The positive social factors associated with walking recorded in his research, on the other hand, included increased socializing with friends, having escorts, increased exercise, fresh air, and the ability to do shopping en route. He also called for the need consider these factors in order to balance sole concentration of the positive factors associated with car travel (quicker/ more convenient, en route to work, protection from weather, or safety, etc).

In such countries there also appears to be wide public understanding of the key transport policy issues and the challenge of making walking, cycling and public transport more attractive than they are now in relation to car travel. To show the safety inherent in walking to schools, some studies focused on the danger of commuting to school by car. Bradshaw and Jones (2000), for example, pointed out the danger of crossing routes. He specifically paid attention to how even when commuting by bus or car, such trips still required children to cross roads on foot. Parents were also concerned about their children's safety when walking to and from bus stops and on-board the buses (as cited in Atkins, 2000).

Some researchers also discussed the obstacles in travelling to school on foot to show ways they could be eliminated. Even if walking is the best means of a commute to school, having a safe walking was also necessary. Of facilities encourage walking and cycling safe routes, secure cycle parking and lockers also can have an impact. Though a lack of facilities at such schools can become an obstacle to walking and cycling to school, simply providing new facilities will not necessarily encourage more walking and cycling (Halden et al., 2001). Odense (1989) also, indicates how a shared sense of responsibility was a key element in turning around

Denmark's problem of child accident casualties and giving it one of the best records in Europe.

Weather may also restrict student travels on foot. Focus group results have suggested that poor weather also influences travel decisions (EPPI, 2001). Concern about being wet and cold and the impacts that this may have on performance in the classroom were shown to result in an avoidance of walking, cycling and buses. To ally such concerns a primary aim in delimiting attendance areas for the research is making the shortest possible walking distances between home and school the norm. This will increase the willingness of students walking to schools even in times of wet and cold weather.

Other obstacle identified was by parents who were still aware that the risk of a road accident was greater than personal safety factors. The largest concern among parents of this study was about stranger danger issues (Bradshaw and Jones, 2000). Although Scottish parents in this survey showed concerned about both factors, the study showed that obstacles to walking and cycling could only be tackled by overcoming concerns about strangers in the streets.

The US is a good example of a country in which there is heightened concern about unsafe environments where children walk. According to the Federal National Household Travel Survey, more than 85% of American children do not walk to school regularly. A school in a fast-growing suburb north of Columbus is a good example. On a typical day, just 60 to 70 students of its total 670 population walk to school. The rest ride the bus or are driven by parents. A look at this trend over time in the US reveals that is it is becoming much more concentrated over time with fewer and fewer students opting to go on foot even in cases when the schools are not far from homes.

An overriding reason why vehicles are so popular in the US in recent decades reveals that it is largely connected to parental insecurity about an environment that is potentially unsafe. This fear encompasses everything from heavy traffic, to lack of side walks, and even possible abductions. One factor that understandably features prominently in parent's minds anywhere in the world is safety considerations. In the US intense parental concern for child's safety arises from fear of their children getting struck by fast moving cars. As statistics compiled on accident rates points out such fears reflect the very real dangers that lurk on busy roads. Being killed by a car while on foot, after all, is the second leading cause of unintentional death in children younger than 14, second only to being killed while being a passenger in a car, according to the National Safe Kids Campaign. Another danger that pervades parent's minds relates to lack of construction needed for pedestrian safety. The comments of a mother who insists her son journey 1.3 miles from home to school by bus is typical; "There aren't sidewalks, so I won't be allowing him to do that." The final major fear listed by parents who increasingly prefer walks for their children in the US is similar to parental worries of crime prone streets in Rasht; fear of abduction.

The fear of "stranger danger" is so pervasive often the greatest single justifications for

keeping children off the streets in the US. Although, abductions of children is rare with just 2,000-3,000 a year abducted in a nation of 71 million children, according to federal crime statistics, parental apprehension is constant. The comment of a parent who will not let her nine year old son walk to school is a good illustration of the severity of parental concern. When asked why she replied simply, "It only takes one time." Thus, in addition to worries about their children being involved in traffic accidents parents also fear their children may become another crime statistic. This high level of parental fear about safety in developed countries also permeates considerations about walks to school in the study area often making vehicles the viable option despite the hazards they entail in Iran. To fully understand current feelings about walking to PFJH schools of Rasht City, further detail on the nature of current walking commutes in the study area will be discussed in later sections.

2.6 Techniques and Methods for Delimiting School Boundaries

Researchers have a number of techniques to create or redefine school attendance areas and school districts. The aim of this research was utilization of a technique that was most effective in keeping to the principles reviewed above. Mainly, that the best approach is not only one that can give equitable access to neighbourhood schools regardless of socio-economic backgrounds, but also one that takes into account the benefits of reducing the length of inconvenient commutes to best meet the educational needs of every child. In keeping with the principle of a safe and convenient walk, any delimiting method will also yield attendance areas that will eliminate as much as possible vehicle commutes allowing travel on foot the shortest distance possible. As mentioned above, this research will utilized the Multiplicatively Weighted Voronoi Diagram (MWVD) method in place of the current random parental choice based system to best allocate students in accordance with above considerations. Before providing more information on this method, this section will give a brief review of the various techniques applied in studies on school attendance areas in the US, a country often in the forefront of developing approaches, and also some other countries. The author will then provide a brief literature on the MWVD to give more detailed information on the approach.

According to Lemberg and Church (2000) for the past 30 years, researchers working on school district planning have formulated models concentrating mainly on the objective of minimizing both the cost and travel distance function. These models did not gain widespread popularity among school district planners who instead utilized “pin mapping.’’ Originally, planners stuck pins in a map of a school district with each pin representing the home location of a student. The planners would then wrap string around the pins to create attendance area boundaries and subsequently count the pins. If the number of students fit the school capacities,

and the boundaries looked good, the planners would then present the plan to the public. As computer mapping developed, ‘’electronic pin mapping’’ systems were created for faster school district planning.

In the late 1960s and early 1970s, delimiting schools became a major issue especially within urban school districts. This era also saw the development of faster and more affordable mainframe computers allowing even moderate sized school districts timeshared access. This period also saw the development of the first readily available linear programming solvers. The first application of optimization to school districting was introduced by Garrison. He suggested the possibility of using the ‘’transportation problem’’ to analyze the spatial structure of a school district (Garrison, 1959). Yeates (1963) was the first to apply the transportation problems as a policy analysis tool in analyzing the efficiency of school busing in a Wisconsin school district. Because of his model Yeates was able to demonstrate an 18% difference between the transport distances in the district under study and the optimal configuration.

Building on the original problem formulations, research later moved from a transportation structure to an expanded linear programming (LP) formulation with added desegregation constraints. The size and scope of the schools for large school districts was still beyond the capability of LP solvers of the period. Researches continued on improved transportation formulations that could solve larger problems within existing time and cost constraints. As desegregation became a driving issue for school district planners and administrators within the US, Belford and Ratliff (1972) applied a network flow model to a school districting problem with ethnic minority assignment constraints. This work expanded on the earlier LP- based efforts of Clarke and Surkis (1968). Again, it was concern over the size and complexity of the school districting problem that prompted the implementation of a network flow formulation. Other formulations of school districting as network flow or classic transportation problems include those of Maxfield (1972), McDaniel (1975), Jennergren and Obel (1980), and Woodall et al. (1980).

More importantly, there were major drawbacks that arose from the classical network formulation of the school districting problem. In school districting planners do not usually wish to assign a specific number of students to a school. More desirable is some range under the site capacity of total enrolment and some range between upper and lower bounds of the minority group assignment of the school site. It thus required fixed capacity and consideration of ethnic balancing levels. Schoepfle and Church (1989 and 1991) addressed this problem by creating a hybrid heuristic that iteratively solves network models whose inputs and outputs (optimal school sizes and ethnic balance) complement one another. They also presented a generalized network formulation with side constraints to address this problem.

An additional drawback of the network flow formulation is that it treats students as commodities. While efficiency is a major objective in fleet delivery of cargo from warehouses to depots, it is should not be the most important aspect in reallocating children. Schoepfle and Church (1989) introduced the Generic School Districting Problem (GDIP), which refers to school boundary problems and allocating students to schools while minimizing a cost or distance function, subject to school capacity and racial balancing.

Much research into the theory of location-allocation was also conducted during the 1960s and early 70s in relation to the growth of computer science in general. According to Ghosh and Rushton, (1987), Tewari examined the decision making process for locating high school facilities and their attendance areas in India using location-allocation models. Møller (1997) discussed a set of needed digital data of sufficient scale and accuracy for a GIS based location-allocation model in connection with the process of assigning children from portions of a street network to the nearest school for a selected area of Copenhagen. The capacity of each school, the demand for school seats in the surrounding areas and other considerations - e.g. a maximum acceptable travel time for any student – were also taken into account. The general goal of the research focused on maximizing accessibility while at the same time insuring that no one had to travel an excessive distances to attend school.

Researches also applied mathematical programming into school attendance areas as when Koenigsberg (1968) developed a generalized mathematical model of pupil assignment within school districts. The model could be then used to examine various policies of student integration. He proposed bussing schemes, school location policies, educational parks, attendance boundaries, etc., could also be tested for cost/ravel time effectiveness or other measures of efficiency. Church and Schoepfle (1993) believed that one of the most controversial problems faced by school administrators involves the drawing of school boundaries. They introduced a series of mathematical programming formulations that enabled administrators the ability to rapidly generate alternative assignment schemes that maximized school choice.

Hybrid systems were also developed merging mathematical programming models into GIS and/or Spatial Decision Support System (SDSS) applications. Since the mid-1980s, Onpass (San Jose, CA, USA), Edulog (Missoula, MT, USA), and Ecotran (Cleveland, OH, USA), amongst others, have been marketing school district boundary analysis systems for PC’s with mapping and reporting capabilities (Lemberg and Smith, 1989). Similar systems have been introduced by Ferland and GueÂ nette (1990). Attendance areas established for the Blue Valley School District, for instance, the sixth largest school district in Kansas, used GIS-based SDSS. The Planning and Facilities Committee at Blue Valley a Board of Education subcommittee is charged with the task of reviewing and recommending school boundaries. Under the established

student enrolment decision support system (SEDSS) committee members were able to see graphically how the new boundary configurations would look and examined what they meant to the school district from a school enrolment perspective. This method enabled the Committee to explore and debate several boundary alternatives. The use of SEDSS also facilitated discussions related to school boundary conflict-resolution among Committee members (Slagle, 1995). Armstrong et al. (1993) used a GIS-based SDSS for school redistricting that enabled school administrators to analyze school redistricting problems and develop solutions for them. Rushton et al. (1995) described a new GIS-based method for making student enrolment projections by grade and ethnic group for small geographical areas. Makino and Watanabe (2002) investigated application of GIS in school mapping in developing countries. They showed that in using GIS, not only was the distribution of schools with detail characteristics main available but that it also allowed for seeing relationships between school and population density. In addition, transportation networks could be clearly illustrated for schools in places like Bangkok. A GIS-based project of student allocation and student pre-registration was also successfully implemented in Belo Horizonet, the third largest Brazilian city in 1993 (Fonseca and Zuppo, 1994).

2.6.1 Voronoi and Multiplicatively Weighted Voronoi Diagrams (MWVD)

A classic way of regionalizing or allocating space around a predetermined set of points or generators is Voronoi tessellation. This method is based on finding the nearest generator for every point within the space. The resultant regionalization is known as a Voronoi diagram (VD). In a comprehensive presentation on the subject including an extensive review of the literature, Okabe et al., (2000) presented the ordinary VD as well many of its generalizations. In ordinary Voronoi diagrams all generator points are identical and each generator has the same weight. In a regionalized area by a VD borders are straight and the regions are contiguous.

According to Mu Lan (2004) Voronoi has been discovered and rediscovered many times and is often referred to in different ways, including Voronoi diagram, Voronoi foam, Thiessen polygon, Dirichlet tessellation, atom domains, domains of actions, Wigner- Seitz regions, areas-of-influence polygons, areas potentially available, plant polygons, capillary domain, heavens, and so on (Okabe et al., 2000). Among these, Voronoi diagram and Thiessen polygon are the most well-known terms. Typical examples of Thiessen polygon applications include; location-allocation models such as chain stores service areas, proximity analyse such as the UK's postcode boundary generation with Voronoi polygons (Boyle and Dunn 1991), and surface

interpolation such as rainfall data in Kansas and Nebraska (Haining et al., 1984).

With the exploration of many applications in Thiessen polygon (Ahuja 1982, Ahuja and Tu¨ceryan 1989, Edwards 1993, Gold and Zhou 1990, Gold 1992, 1994a, 1994b 1996, Gold et al. 1995, Gold et al. 1997), concerns have also emerged. The shape of the polygon, for example, is completely dependent on the location of the sample data points. Other concern is that the value of each polygon is estimated from only one sample, and the fact that the Thiessen polygon method does not assume that points closer together are more similar than points further apart. Ordinary Voronoi diagrams, also, assume that all points have the same weight.

In practical applications this assumption may not be appropriate. Rather, it is better to assume that generator points have different weights reflecting their variable properties; for example, the population size of a settlement, the number of functions in a shopping centre, the amount of emissions from a polluter, or the size of an atom in a crystal structure, and so forth. If weights are taken into account, then weighted Voronoi diagrams are generated. Depending on the variation methods they can be either multiplicatively, additively, or compoundly weighted diagrams (Okabe et al., 2000).

2.6.1.1 Definition

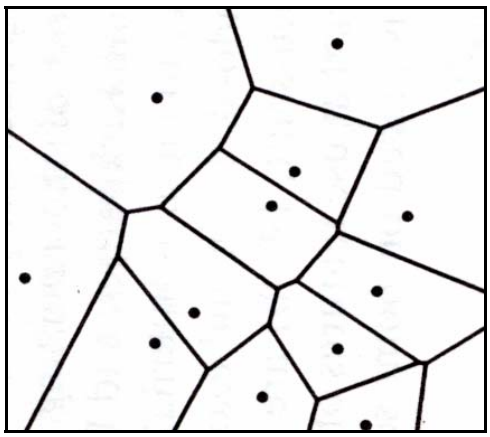
Let S be a finite set of points in the Euclidean plane. Let p and q denote two points in the plane. Let the weights of the two points be $w(p)$ and $w(q)$. Let x be any point in the plane. The Euclidean distance between x and p is $d_e(x,p)$, and the weighted distance between x and p is $d_{mw}(x,p)$. The key to distinguishing between different types of weighted Voronoi is the definition of d_{mw}. Let *region (p)* denote the dominant region of point p; that is, *p's* influence region in S. In Figure 2-1, the weight of each point is labelled. The planar ordinary Voronoi diagram on the left of the figure can be defined as:

$$region(p) = \{\, x \mid d_e(x,p) \leq d_e(x,q),\ q \text{ in } S \,\}$$

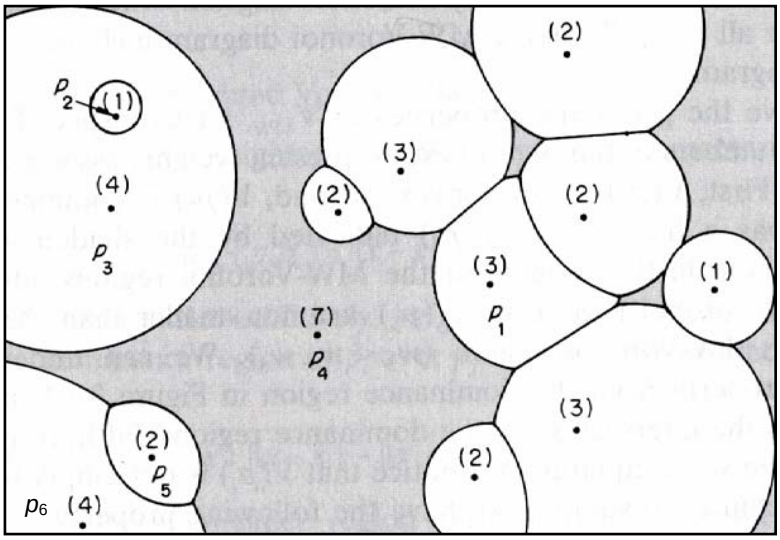
The multiplicatively weighted Voronoi diagram (MW-Voronoi) on the right can be defined as:

$$region(p) = \{\, x \mid d_{mw}(x,p) \leq d_{mw}(x,q),\ q \text{ in } S \,\},$$
$$where \quad d_{mw}(x,p) = d_e(x,q) / w \qquad \text{(MU Lan, 2004)}$$

A Voronoi diagram is, thus, a method for dividing an area into regions or polygons so that all locations enclosed within a single polygon are closest to a designated point. A weighted



Voronoi Diagram



MW-Voronoi Diagram

Figure 2-1 Voronoi and multiplicatively weighted Voronoi diagrams.
(The numbers in parentheses represent weights associated with the generators)

Source: Okabe et al., 2000

Voronoi polygon can be utilized when points differ in size to draw polygons around them accordingly. Thus larger points will have larger polygons drawn while smaller points have smaller ones based on the distances between the points.

As seen in Figure 2-1, MW-Voronoi regions have some geometric properties that Okabe et al. (2000) summarized in following properties:

Property MW1: An MW-Voronoi region is a non-empty set; it need not be convex, or connected; and it may have a hole(s). An MW-Voronoi region (region p_i) is convex if and only if the weights of adjacent MW-Voronoi regions are not smaller than w_i. Obviously, the slope of the convex becomes flatter as the weight w_i increases. From Figure 2-1 we notice that the generators (points) whose weight is the largest eventually dominants the places far from the locations of the generators; consequently, the MW-Voronoi region of the largest weight is infinite. When two or more generators have the same largest weight, however, the rightmost and leftmost Voronoi regions are infinite. Generalizing these properties obtains the following property.

Property MW2: If the generator with the maximum weight is unique, we have only one unbounded MW-Voronoi region. An example is shown by the shaded MW-Voronoi region in Figure 2-1.

A bisector (boundary) is either a circle or a straight line. In Figure 2-1 the Voronoi edge shared by regions (p_4) and (p_5) is disconnected. These findings provide the following property with respect to edges.

Property MW3: Two MW-Voronoi regions may share disconnected edges. An edge is a circular arc if and only if the weights of the MW-Voronoi regions sharing the edges are different; an edge is a straight line if and only if the weights of the MW-Voronoi regions sharing the edge are same.

2.6.1.2 Application

According to Mu Lan (2004) applications of the weighted Voronoi diagrams in GIScience can be divided into four periods:

1. Early prototypes (1800s to 1940s);

Shieh (1985) tracks the earliest study of Rau (1841). According to Okabe et al. (2000), the early research starts with mathematics and geometry, and is later applied to economic markets (Fetter 1924, Launhardt 1882, Rau 1841), and engineering (Johnson and Mehl 1939).

2. Application in market and urban analysis (1950s to 1970s);

The literature on the MW-Voronoi begins to appear during this period. The MW-Voronoi

was used as a geometric and mathematical modelling tool to solve problems in market and urban analysis. Table 2-1 accommodates cited literature from all resources. Works in this period cover topics ranging from fundamental theoretical models to practical applications in urban systems and socioeconomic structures. Gambini designed a virtual space, an ‘‘information seeking process,’’ for consumers under conditions of uncertainties (Gambini et al., 1967). That paper tests different scenarios of the supply points’ activity. In the straight-line scenario, when two points have unequal attraction it is actually a MW-Voronoi model even though Gambini does not explicitly say so in his paper. Huff and his colleagues studied the MWVD (Huff and Jenks, 1968) and applied it to Ireland’s urban system (Huff and Lutz, 1979) and the U.S. national systems of planning regions (Huff, 1973). Boots’s work in 1970 provides a foundation for his paper in 1980. In a clustered work and publications from 1973 to 1975, he discussed the MWVD from an economic geographer’s point of view and applied the model to urban settlement and socioeconomic structures (Boots 1975a, 1975b).

3. Parallel development in computer geometry and GIS (1980s to 1990s);

Starting in the 1980s, the extensive development in computational geometry and GIS added new components to research on MW-Voronoi. Intensive computation became less of a constraint and along with other computational geometry algorithms, the MW-Voronoi entered the world of GIS. Four roles of the Thiessen polygons in geography were identified: models of spatial processes, nonparametric techniques in point pattern analysis, organizing structures for displaying spatial data, and information theory approaches to point out patterns where they are used in calculating individual probabilities (Boots, 1980). The relationship between the generalized Voronoi diagram and alpha-shape and Delaunay triangulation were also shown (Edelsbrunner et al., 1983). Aurenhammer and Edelsbrunner’s work in 1984 is a milestone for all of the algorithms and methods developed for the MW-Voronoi after 1984. The implementation of weighted Thiessen polygons using a GIS tool (Vincent and Daly, 1990) was first found in this period. Vincent and Daly used the network analysis idea to ‘‘trick’’ the Arc/ Info program to simulating an MW-Voronoi growth. Even though the actual implementation can no longer be found, their work pioneered bringing the MW-Voronoi into GIS. Many other discussions contributed to this field by providing alternative algorithms, improving on existing algorithms, and applying it to more research fields (Radke 1999, Schaudt and Drysdale 1991, Tanemura and Hasegawa 1980, Wang and Tsin 1990).

4. From algorithm to implementation (1990s and beyond);

GIScience researchers want something beyond theoretical discussions and algorithm optimization. They would like to have some methods and implementation tools that allow them to actually use the model in research and teaching, the so-called off-the shelf- tools. Gambini

Table 2-1 The MW-Voronoi research, 1950s-1970s.

Author(s)	**Date**	**Topic**	**Study area**
Hyson and Hyson	1950	Economic law of market areas	
Gambini et al.	1967	Market place properties	
Illeris	1967	Functional regions of urban centers	Denmark
Huff and Jenks	1968	Urban systems	
Hubbard	1970	Functional regions	Jamaica
Beckman	1971	Market potential	
Hogg	1971	Archaeology site territory define	England
Boots	1973	Subdivision of space	Great Britain
Huff	1973	Urban Spheres of Influence	
Boots	1975a	Patterns of urban settlement	
Boots	1975b	Structure of Socioeconomic Cellular Network	Great Britain
Wood	1974	Functional regions	Kenya
Cox and Agnew	1974	Theoretical counties	Ireland
Fraser	1977	Forest Sampling	
Getis and Boots	1978	Spatial Processes	
Jones	1979	Economic law of market areas	
Huff and Lutz	1979	Urban Hierarchy	Ireland

Source: Mu, 2004

developed his computer program in FORTRAN IV (Gambini, 1966) to calculate equilibrium lines between points. Vincent also had his Network Analysis solution (Vincent and Daly, 1990). Recent software developments have made efforts to overcome this problem, including GAMBINI (Tiefelsdorf and Boots, 1997) and VORONOI (Gahegan and Lee, 2000), and Mu Lan (2004).

After a review of the cited literature it is possible to apply the same approach to the specific discussion at hand. In order to eliminate the random student distribution of parental-choice based school selection it is necessary to establish school enrolment areas to spatially organize student allocation to schools. This study proposes that this is possible by making the size of each school within the school attendance area the central consideration. It can also allow students equal access to the closest possible local school and in turn result in commuting to school on foot for students over smaller areas.

Following a review of the Voronoi and weighted Voronoi diagrams, the author decided to utilize the MWVD method for a number of reasons. First, as a widely utilized bounding technique, it has been used in numerous field studies by researchers. Second, a MWVD based delineated area is a non empty set with all jointed areas. Thus, all regions are divided into a set of enclosed polygons. This property of MWVDs make it the most appropriate method for the purpose of the research; the delineation of residential areas of the city into regions around PFJH schools. Another beneficial outcome is that by use of this method any non-assigned area will also be kept within the city. The weighted Voronoi approach was also useful for the purpose of weighting school areas based on their size.

In the construction attendance of areas the research aimed to allocate students within the closest commutes to designated schools, while taking into account differing student populations. Though in the Voronoi method the areas are simply polygons around points (generators) with same sizes, in MWVD method, the polygon around each point is related to their sizes. This is clearly appropriate for the research. All things being equal, larger schools after all tend to have larger areas. The boundary between two neighbouring schools thus will be weighted according to the relative size of the two schools. Finally, since others have not utilized the MWVD for delimitation boundaries among schools, particularly in developing countries, it presented a chance to be one of the first studies to use a fresh approach.

The construction of weighted Voronoi diagrams is computationally more difficult than the Voronoi diagrams. The areas cannot be easily constructed within any standard GIS packages. Instead, specialist packages such as GAMBINI are available to complete the task. GAMBINI can construct weighted Voronoi diagrams that are proportional to a defined attribute, in this case the number of students. It is able to determine a sphere of influence around the generator points. In

addition to being difficult to maintain, the polygons can not be properly built. Difficulties with the software arise more, when trying to create polygons for use in standard GIS packages (Pearce, 2000). Other packages are available that compute weighted Voronoi polygons and are likely to overcome some of these technical difficulties (Boots & South, 1997). In order to construct school attendance areas for Rasht the author decided to apply a specialist packaged called WVD18 (Mu Lan, 2004). WVD18 offered one of the newest specialist packages that provided precise computation MWVDs. Though it is not a GIS package, the created areas can easily be exported in shape file formats and then be added to GIS packages such as Arc/Info. WVD18 has been also recommended for this research by professors A. Okabe at University of Tokyo, Japan and B. Boots at Wilfrid Laurier University, Canada (personal contact).

In delimiting boundaries to reduce inconvenience for PFJH students, numerous principles were investigated for the best possible approach to curbing problems that arise from the current selection system. Following the literature review it's possible to deduce some basic principles necessary for constructing attendance areas that are the most beneficial for students and their families. The first principle considered is that eliminating parental choice in school selection is a necessity in reducing the length and inconvenience of commutes. The second is that students from any socio-economic level must have equal access to schools within their local areas. The third principal is that there is not any optimum size of school districts. The fourth principle stems the intuitive assumption that smaller attendance areas are necessarily the best ones for the goal of reducing the time and distance of commutes and should therefore be an overriding consideration in delimiting. Finally, in taking into account not only the benefits of walking outlined earlier but also the dangers inherent in commuting by a vehicle in Iran, the sixth principle is that its best for as many as possible to travel to schools on foot rather than a vehicle. With these overriding principles as a guide, the research will detail the conditions in which unnecessary commutes and high inconvenience arise in the study area. It will also serve to illuminate why the application of MWVD based attendance areas is such a pressing need.

Chapter Three

Parental-based School Selection in Rasht and Commute Problems It Generates

3.1 Introduction

Without school attendance areas to clarify the student's residential-based enrolment area for each school Iranian parents, including parents living in Rasht have become the central decision makers in school selection. This system of parental choice results in numerous problems for students particularly for their daily journey to schools. In this section the research will show the impact of parental choice in school selection and the necessity of bounding the schools by areas of student attendance. After a brief review of the education system in Iran, it will detail the process of school selection by which parents choose PFJH schools in Rasht. Given the numerous problems that resulted from the current system of selection, it will reveal the necessity of constructing attendance areas to allocate students to the nearest schools.

3.2 A Brief Review of the Education System in Iran

An understanding of the basic structure of the Iranian education system is central to a fuller understanding of the PFJH schools that are the subject of this research. The Ministry divides the general educational structure into the following cycle structure:

Pre-school Education Cycle

Pre-primary education is not yet considered as formal and compulsory in Iran. However, since 1990 more attention has been paid to this aspect of education by the government. Pre-school lasts one year and is geared toward children aged five to prepare them for entry into primary schools. There is no exam at the end of this cycle and children can automatically proceed to the next cycle. Currently, more than 15% of children attend pre-primary education centres. Preliminary measures are being taken to officially integrate this level of instruction into the country's education system.

Primary Education Cycle

The five-year primary cycle covers grades 1-5 for children 6 to 11 years old. This phase is both free and compulsory. Students at this level are required to take exams at the end of each year for promotion to the next grade. At the end of the fifth grade, students must also take a nation-wide exam.

Lower Secondary (Junior High) Cycle

This three year cycle covers grades six to eight for children 11-13 years old. Like the preceding cycle, it provides students with general education. In this phase, the abilities as well as the interests of students are identified so they are prepared to decide which branch (academic or technical-vocational) they intend to pursue in the next education cycle (Embassy of Iran in Canada, 2003). The curriculum is general in nature and uniform throughout the country. Admission is given to those students who pass an examination upon completion of elementary school.

Students are assessed through both coursework and annual examinations which determine eligibility for promotion to the next grade. Upon completion of the guidance cycle, a regional examination is given by provincial education authorities to determine if the student can be promoted to the next level of education. Students who successfully pass the examination are awarded a Certificate of General Education. Eligibility for admission to academic or vocational/technical upper secondary education is determined by the grades received in relevant subjects by examinations.

Upper Secondary Education (Senior High) Cycle

This four-year stage covers grades 9 to 12, ages 14 to 17. Secondary education is divided into two main branches namely, academic/general and technical/vocational. The choice of either branch is up to students themselves. The academic branch, also known as the "theoretical branch," is divided into four main categories, namely, literature-culture, socio-economic, physics-mathematics, and finally the experimental sciences. The technical/vocational branch is designed to train technicians for the labour market. This branch covers three main categories which include technical, business/vocational, and agriculture. There are also specific subjects and performance requirements for admission into secondary programs. National examinations are conducted at the end of each grade during the secondary cycle (Embassy of Iran in Canada, 2003).

Senior high education covers three years and a one-year pre-university program. The courses offered in the first year are general and after successful completion of the first year, based on aptitude, interest and the grades obtained in guidance school, students can continue their studies. The one-year pre-university program prepares students to enter university and

higher education institutions. To enter this course, students should pass the appropriate exam. After passing the one-year period, they are granted the Pre-University Certificate and can sit for the National Entrance Exam of universities and higher education institutions (called Konkur). Qualified students entering the technical-vocational branch can continue studies leading to the Post-Diploma degree (technician) or sit for the Pre-University Examination. Those who wish to acquire skills before completing secondary education can enter the skill knowledge branch and obtain first or second class Skill Certificate, or sit for the Pre-University Examination (UNESCO, 2001). A new plan was approved in 1990 by the Ministry of Education aimed at upgrading the quality of the secondary cycle by making use of the latest educational developments.

3.3 Parental-based School Selection in Rasht

Before focusing on the limitations of the methods of school selection by parents, a brief discussion of parental choice within the context the policy guidance set by education boards is first useful. In the case of Rasht, it requires touching on the inadequacy of current efforts by the Education Office to provide meaningful guidance to parents on how their children should best be enrolled in schools.

Although the Rasht Education Office has taken the necessary first step toward demarcating school enrolment zones, progress remains slow and far short of the formal and enforced delimitated attendance areas necessary. Over the last twenty years, for example, the only progress towards delimitation has been an unofficial, verbal notification to schools that students should be enrolled within the local area as much as possible. Since no maps are provided the meaning of “local areas” remains ambiguous and subject to individual interpretation. As a consequence of such vagueness, neither schools nor parents have taken the school board notification seriously. Not only do schools continue to enrol students regardless of their residence or the length of their commute, parents continually seek out better educational environments at schools outside of their local areas. To fill void left by the Education Office parents have become the central decision makers in which PFJH schools children enroll in.

Without defined school attendance areas parents take the lead responsibility for choosing a school for their children. In case of the five studied schools, though some (34.2%) did not answer the question on who most guides school choice, a clear pattern emerged from the majority that did. The survey shows that an overwhelming majority of students have been rnrolled at the schools because of their parent decisions and not the school board determined the choice of which PFJH they will attend. With little variance in the percentages, 63.6% of those questioned indicated that the choice of their current PFJH schools was directed through parental guidance. The questionnaires also revealed that only 2.2% of the students questioned attend their

schools based on any sort of counsel from the Education Office (Table 3-1).

Parental input and choice in the school their children will attend usually denotes positive connotations. The notion of parental choice in school selection typically invokes images of freedom and impowerment. Given lack of a delimited attendance areas and stricter guidance from school boards, parents do after all have increased rights to choose the schools they feel best meet the needs of their children. This also allows direct involvement in the direction of their child's future academic life. Though freedom is one aspect of parental choice, it is also misguided to cast it in a purely positive light. Though at times impowering, selecting school can also often a dauting and complicated task. School choice in the case of the PFJH schools of Rasht is no exception.

Parental choice schools in the study area is both complicated and fraught with challenges. The difficulty of the task of parental selection is first evident given the array of choice within the city. Parents have to choose among the 45 PFJH schools in different time slots, each with a variety of teaching staff and environments. Since schools are not standarized in terms of the safety, accessibility to public transportation, proximity to student's residence or level of teacher and staff care they provide, schools choice is far from a simple one. Unfortunately, there is still not any published information on which to evaluate facilities or school performance. To fill this void, parents have to undertake their own informal investigations among possible choices by asking parents of students who have already been studying in schools. In order to choose the best possible PFJH school for their female children they often start their search when their children are in primary school. This process largely consists of informal inqueries of friends and relatives to find out which schools come the most highly recommend. After careful consideration and weighing of different criteria parents do manage to make their choice. The next challenge they must deal with is enrollment.

For parents, especially for those whose aim is well known schools, enrollment can be an extremely frustrating and exhausting process. One aspect of enrollment in more prominent schools that can be particularly disheartening for many is the element of nepotism. The research showed that most parents realize that the only avenue for making their enrollment easier or even possible is being "connected" to someone who works at the chosen school. Such connections with "friends in high places" plays a major role in finding a quick and open place at reputable schools in Rasht. Questionnaires for this research reflected unfair and unequal access to popular schools in the form of complaints about favoritism from numeorus parents at the studied schools. For those who do not have privileged access to important decision makers within the school such as school staff or the prinicpal enrollment is all the more time consuming. Theses parents have to wait with everyone else in long lines for the chance to enroll their children. In some PFJH

Table 3-1 Number and percentage of students who have been enrolled at the studied schools because of their parent decisions or Rasht Education Office guidance.

Studied schools	Parents	Office	No answer
Aban	152	3	95
%	60.8	1.2	38.0
Anvar	34	1	30
%	52.3	1.5	46.2
Azadi	140	5	49
%	72.1	2.5	25.2
Felestin	131	9	81
%	59.3	4.0	36.7
Rahzahra	128	2	59
%	67.7	1.0	31.3
Total	585	20	314
%	63.6	2.2	34.2

Source: Questionnaire data collected in September 2004

schools, the wait at school offices lines can go all day. Since schools do not have the manpower to accommodate all enrolment requests within office hours parents are often forced parents to return for second and third rounds of prolonged waiting. For those who cannot find an open seat at these schools enrolling their children at schools that was not their desired one is usually the only option.

In the case of more reputable public schools of the city, the research found that the parents also have to contend with student selection policies that promote exclusion rather than open access. Given locations within better areas of the city and high quality education environments, such schools are in privileged positions to make enrollment stricter. The well-known PFJH schools of Rasht are a prime example of restrictive student selection policies that create obstacles to enrollment that should not be a feature of any public school. Particularly given the governments position that even private schools should remain “non-profit” institutions. At the Fajr PFJH School, priority is given to students whose parents are teachers or to parents who work at a branch of the Education Office. They also limit enrollment by choosing students with better educational backgrounds. Students with lower provincial test scores also have less of a chance for attending.

Behind formal enrollment policies, efforts to stimulate added funds for ailing budgets are evident from arbitrary fees and giving priority enrollment to students that are able to pay them. Since most parents cannot pay the requested money, schools like Fajr School almost become closed off; reserved primarily for higher paying students and children of teachers. Shahed is another example of schools that give priority to students through favoritism or restrictive policies. In addition to only admitting the highest scoring students on standardized tests, the school gives priority to children or first relatives of those who died in the Iran-Iraq war. Such practices also describe the enrollment policies of the reputable PFJH schools of this study, Aban and Anvar. Despite their status as “public” institutions students are continually excluded on the bases of lower test scores. In the end, many parents cannot enroll their children at the chosen school and have to look for other options.

In next section, the research will detail the criteria parents utilize in choosing PFJH schools in Rasht and how the selection affects the allocation of students to schools within the city. It also indicates that without defined school boundaries, parental choice of school selection results in major commuting inconveninces for children.

3.4 Criteria Used by Parents for a School Selection

Without delimited attendance areas from the Rasht Education Office, school selection is a complicated process requiring evaluation of a number of factors by parents. In the case of the

five studied schools parents were asked what criteria they considered in a school selection. The question offered different criteria to the parents such as proximity of student's residence to school, proximity of parent's workplace to school, the presence of siblings for their children, school accessibility to public transportation, journey safety, school facilities, school reputation, and also allowed them to give other criteria they considered in school selections. They were also allowed to choose more than one criterion if needed. The responses showed that parental choice is based on five major criteria; *proximity of student's residence to school, school reputation, school accessibility to public transportation, school safety, and school facilities*, respectively. Before showing how each criterion has been weighed by the parents in choosing a school, a review of how each is defined is needed.

3.4.1 Proximity of Student's Residence to School

Proximity of student's residence to school can be an extremely important consideration in school choice for those parents at PFJH schools seeking to protect their children from the dangers inherent in commutes on foot for girls. Like other countries in the developing world, the young female students of Iran are particularly vulnerable to verbal and physical sexual harassment that frequently occurs under the cloak of dark, winding side-streets in the city. As such dangers also form the backdrop of side-streets which are routes to the PFJH schools of Rasht, parents naturally want to reduce any travel in such social environments as much as possible. This often translates into a parental preference for the shortest time and distances for commutes on foot. Choosing a school closer to home, for example, allows parents more sensitive about the environment of the daily commute, usually the mothers, to accompany their kids to school on foot every day to ensure the safety of their children. A natural outcome is a high preference for schools that are nearer to student's homes. Mothers naturally prefer to enrol their children at schools closest to their homes so their daughters do not have to be in Rasht's streets longer than necessary, especially in the winter time when there is even less daylight.

Financial considerations are another factor that leads to parental choice of schools that have the best proximity to student's residence. Many families in the study area do not have cars and simply because they cannot afford them. Renting a vehicle for their children's daily travel also represents a significant financial burden on families that is too heavy given the cumulative cost of daily fares involved. Consequently, most end up having to give up on their most desired school out of range of commutes on foot, even in the case of more reputable schools, sending their children to closer ones instead. When costlier vehicle travel to schools is not feasible for such families, choosing a school with good proximity to home is even more of a necessity since it allows for parental escorts to safeguard the environments of children who have to travel on

hazard-ridden side streets.

One question that might arise in any discussion of proximity as a prominent consideration of parental choice is; if travels by car or rental vehicles are so financially unfeasible, what about affordable travel by other means such as a bike? Though travel by bike might reduce the hazards associated with walking in unsafe streets and allow students to travel further than foot commutes, cycling by females in public have been formally banned since the 1979 Islamic revolution.

Though proximity of residence to school typically refers to notions of "nearness" and "closeness," this defining characteristic is far too restrictive to encompass the unique attributes of a city enclosed by farmlands. A more expansive understanding of the proximity consideration requires inquiry into how it would be defined within the context of the regional features specific an agricultural province. A comprehensive definition of proximity therefore requires taking into account not only what proximity would mean for students living in the central part of the city where schools are clustered closer together, but also how it is defined for those living in outer areas of town on the outskirts. Instead of relegating discussion of proximity to the short commutes of schools relatively close to student's homes, the most finely tuned definition then should encompass just how the proximity considerations differ for residential areas near farmland on the outskirts of town.

The diverse spatial distribution of PFJH schools throughout Rasht makes the actual proximity distance to schools vary anywhere from zero to more than 4km depending on whether parents live in the central part or more remote sections near the city borders. When defining proximity in terms of outer city schools, proximity refers to the "closest" distance to a school from homes in remote suburbs of city. Put another way, it means the *shortest* possible distance from a student's home to an outer city school. For students living in southern part of Rasht, for example, even though Etminan School is the school with the best proximity, it is still a considerable distance from homes. Many of these students, even when travelling to the closest school still have to get their by vehicle. This is especially true for those students whose houses are actually located near farmlands.

3.4.2 Accessibility of School to Public Transportation

When parents decide on a school that lays outside the local area of student's residences parents have to take into account the specific the mode of transportation required for their children. Hence as another essential criterion in school selection, school accessibility relates to the ease of access of a PFJH school to public transportation. For parents seeking to maximize limited financial resources by use of public buses and taxis for access to PFJH schools further from their homes, school accessibility to public transportation can become the driving factor in

school choice. Parents who must consider how accessible the school is to a cheap public transport are those without cars or the funds to rent pricy rental vehicles (e.g. private telephone taxis or mini-buses). For them utilizing the city's public transportation presents the more affordable option. Like most countries, public transportation in Iran includes the ubiquitous "city cab" that can be hailed throughout the city and the public bus system.

In Rasht, as well as other cities, given the fact that such modes are cheaper than others there also restrictions in terms of services offered. For the public buses and city taxis the limitation is that they do not travel on side-streets or secondary routes, relegating service to transport along main routes instead. When public buses and taxis are the most feasible commuting option, then the factor that must enter into the consideration for parents choosing schools further away is whether or not the public transportation can actually get to the chosen school. Public taxies, particularly the ones operated by drivers in the informal sector, rarely transport passengers on secondary routes and then only when offered up to ten times the regular fare. Paying such exorbitant prices for direct access to a school located on secondary routes is, of course, impossible for students on a daily basis. Getting to the school hidden behind secondary roots is also an obstacle for the city buses as well. The fact that buses all bus stops are only located along the main routes of the city makes them impractical for getting to such schools.

For parents forced to utilize public transport for their children's commute, parents are more likely to choose schools located on main routes close to a bus or public taxi stop. Choosing the accessible school placed on main roads, after all, allows students the convenience of being dropped off or picked up in a taxi or bus in front of schools without the expense of renting a private vehicle. It can also save children from walking in the cold or on rainy days.

Thus, in the case of Rasht, accessibility can be defined in terms of how close a PFJH school is located to main roads. PFJH schools such as Rahzahra, Narjes, Taleghani and Felestin located on a main route offer better accessibility for commutes by public transportation (see Figure 1-6, Chapter One). Schools such as Aban, Anvar, Etminan and Aemmeh, on the other hand, located along secondary routes do not provide more direct routes from home to destination required when travelling by taxi or buses. Schools located off main routes and would make walking for several minutes necessary after being dropped off by taxis, makes them even less accessible. Such schools are naturally less sought after for families relegated to cheaper public transport since students would be exposed to harassment dangers and also might also require traversing on roads that are less clean and safe. The undeveloped side routes of Rasht are often plagued by potholes and inadequate pavement that muddies streets on rainy and snowy days making walking more difficult and longer for young female students.

3.4.3 Journey Safety

A criteria linked to school accessibility to public transportation is journey safety. It concerns the safety of the environment for female students who must travel school on foot. Since city development differs by area in Iran levels of dangers also vary. In newer and more developed areas, for instance, journey safety can be defined in terms of the socioeconomic environment or road conditions higher for students commuting on foot. The Ghods School is one such case. The older parts of Rasht city less developed, conversely have journey safety is lower.

Another factor which effects safety considerations for walking students is the presence of side streets and secondary routes within the city. For the students who have to pass these streets to get to school, secondary routes signify increased dangers outlined briefly in the proximity section. Typically narrow and surrounded by buildings, one danger of side streets is that they are without any sidewalks. Since car traffic can often pass within inches of pedestrians in Iran, female students walking to PFJH schools are at grave risk of injury from either car or motorbike accidents. Moves by residents to different parts of town have left low income migrants eager to take advantage of cheaper rents concentrated in these areas. Many are unemployed. This has far-reaching effects on the socioeconomic environment. As these streets are quiet and dark in most parts, they have become the hot spots for sexual harassment by “street men” that congregate there. Parental concern for the students, particularly young girls, who have to pass these streets, is thus also high. They naturally fear that one day their children might fall pray to would-be harassers.

In addition to the dangers of environments around less developed roads, students who reside on the outskirts of town have to pass open rice fields on their daily commute to schools. Although such areas are relatively free from harassment worries, other environmental dangers that loom are the muddy and slippery nature of these remote rural areas in rainy weather making students prone to injury. In addition, rabid stray dogs often congregate around these places. Calling for help if injured or hurt in such deserted areas adds to the danger students face. Given that most students living in farmlands on the outskirts of town attend the PFJH school of Amupur and Aemeh, the hazards outlined above are a constant concern for parents.

Low-income areas are also more likely to carry the added danger of higher crime, making them even less safe for female students. The Etminan PFJH School is a good example of how crime can lower the safety of an area and effect school choice. Its location in an area of chronic underdevelopment has resulted in a high concentration low income, low education level residents, in one of the most populated areas of the city. High rates of unemployment among the residents around Etminan, particularly for its youngest, make it a place with high crime rates. These factors have had a profound effect on how parents view the school, particularly for those whose

children must commute on foot, increasing fears and tensions. The resulting negative reputation of the school, for instance, has turned numerous parents off to enrolling children there.

3.4.4 School Facilities

Although significant factor in any parental choice, school facility is a criteria that rates lower on the priority spectrum of parental choice of the PFJH schools in Rasht. Before any discussion of why this is so, it is first necessary to review how school facilities can typically play a major role in the educational performance of students in general. Following this review, the research will then detail the poor availability of quality school facilities in Rasht and how this makes parents largely indifferent to facility considerations in choosing schools for their children. To evaluate the overall quality of facilities, the author conducted interviews with staff at the Education Office of Rasht. First-hand observations by the author of facilities at the five sample schools were also an invaluable part of understanding the conditions of school facilities throughout the city. Together, they paint an image of PFJH schools suffering from a chronic lack of quality building construction and equipment, blurring any distinctions between schools for parental choice.

A number of studies such as those by Phillips (1997), Dunn et al. (1985), Luckiesh and Moss (1940), and Bowers and Burkett (1987) have focused on the importance of school buildings in providing good quality education. They point out the enormous impact of decaying school buildings detailing how they threaten the health, safety, and learning opportunities of students. A growing body of research has also linked student achievement and behaviour to the structural environment and building conditions of the school. Decaying environmental conditions such as peeling paint, crumbling plaster, defective toilets, poor lighting, inadequate ventilation, inoperative heating and cooling systems can all affect the not only the health and the morale of students, but also their capacity to excel academically (Knirck 1970, Blackwell 1963, Hathaway 1994, Sinofsky and Knirck 1981, and Papadotas 1973). These studies also conclude that quality facilities are an important precondition for student learning and supporting academic goals of school programs. A study of the District of Columbia school system, for example, found that after controlling for other variables such as a student's socioeconomic status, students' standardized achievement scores were lower in schools with poor building conditions. Students in school buildings with poor conditions had achievement scores that were 6% below schools students with facilities in fair condition and 11% below schools in excellent condition (Edwards, 1992). The prevalent low state of facilities in Rasht PFJH gives parents little hope that the facility factor can play a positive role in their children’s education.

Lack of adequate space in buildings not designed with education in mind is a persistent

problem that complicates the task of finding quality schools for parents in Rasht. With the exception of a few, most buildings now utilized for schools were once residential houses that owners donated to the Education Office or buildings designed for other purposes. Consequently, numerous rooms in such buildings are often too small to accommodate standard class sizes forcing students to sit cramped together even in reputable schools such as Aban (Photos 3-1 and 3-2). In some schools, buildings are so small that administrators and staff have to share inadequate room space making even the basic "teacher's room" non-existent. The narrowness of school corridors and classroom aisles also makes for cramped spaces and noise prone classrooms as class noise echoes from room to neighbouring room. Yet this is not the only areas affected. The prevalent lack of space can also have far-reaching effects on freedom of movement and exercise. Many schools suffer from extremely limited space for playgrounds restricting the areas in which students can interact in during recess (Photo 3-3). Overall, this lack of space can be extremely damaging for the goal of quality educational environments at junior high schools, giving parents even less options for investing in their child's future.

Other widespread design flaws of PFJH schools represent major obstructions to the search for safe and productive schools for parents. The construction of stairs is one example. Since the measurements of stairs are often not standardized, some steps have different sizes. In addition to these hazards, steps in many schools are rickety and have the potential of breaking in some parts. Some buildings are so broken down and in need of repair that has rendered them unfit for use. In some buildings, the rooms on the second floor have been locked up permanently since damaged roofs pose dangers to student use

In addition to construction designs that reduce safety, another major inadequacy in Rasht school facilities across the board is the neglect of upkeep or colour in school buildings. Most classrooms in Rasht are dark and dimly lit at best. Since lights are seldom replaced, most schools have to contend with broken lights and low supplies of properly functioning ones. The dilemma of dark classrooms extends to the newly constructed school buildings in the study area as well. Upkeep to maintain their pristine condition was routinely dropped once construction was complete. Maintenance shortcomings worsen in the case older buildings. There, classrooms are blackened not just by lack of adequate lighting but also by dusty and dirt-ridden walls in dire need of painting (Photo 3-4).

Dark and dirty classrooms and poorly maintained buildings can have a lasting detrimental effect on a student's ability to learn. A number of researchers have reviewed the importance of different environmental factors such as lighting in classrooms. Lighting can play a critical role in student performance (Phillips, 1997) especially since student vision and studying is impaired when there is inadequate light. In addition, studies have also been conducted on the optimal

Photo 3-1 Students sit cramped together in a small classroom in the reputable PFJH school of Anvar.

Photo taken by the author in September 2004

Photo 3-2 Students sit cramped together in a small classroom in the reputable PFJH school of Aban.

Photo taken by the author in September 2004

Photo 3-3 A small courtyard that serves as the playground for the 307 students at the reputable PFJH school of Aban.

Photo taken by the author in September 2004

Photo 3-4 Old, dark and unclean classroom in the Felestin PFJH School.

Photo taken by the author in September 2004

lighting level for classrooms (see Mayron et al. 1974, Dunn et al. 1985). The consensus of the Jago and Tanner (1999) studies is that appropriate lighting plays a significant role in students' achievement improving test scores, as well as reducing off-task behaviour. A student's educational performance is also influenced by colour and aesthetic appeal. Available research supports the correlation between classroom colours and a favourable influence on students. One example is Cash's report (1993). It concludes that student achievement improved when walls were painted pastel colours instead of the standard bland white.

There are other examples of dilapidated facilities that can hamper student performance and make for uncomfortable classrooms in PFJH schools. Damaged ceilings in numerous schools are one illustration of poor maintenance affecting students. Since roofs at many schools are in need of repair, the ceilings often leak on rainy days leaving classes wet and dripping with rain water. In other schools, classrooms are equally exposed by broken or missing doors (Photo 3-5). The stalls in bathrooms are other places where broken doors can be found, including damage to windows and sewage pipes. Broken windows are another persistent sight for students in the classroom obscured only by wooden boards put in place to block views of street traffic outside.

The most apt description of junior high school rooms, then, is not of "classrooms" but rather "boxes," enclosed on all sides by dingy walls and outdated furniture. In addition to lacking basic maintenance, first hand observations conducted by the author also revealed that classrooms at the sampled schools are equally barren and poorly equipped (Photo 3-6).

Positive, stimulating environments classrooms at the very least require clean desks, chairs, a clock and perhaps some decorative educational posters. In the study area such items are either in a run-down state or completely missing altogether. It is so widespread that even the most reputable PFJH classrooms in Rasht are places with old furniture, absent of essential supplies. In most classes wooden desk tops have cracks and notches that often puncture holes in paper when students write on them. The metal portion of the wooden desks are usually rusted over and covered in dirt and grime. So much so that students often come away from school with hands black with residual dirt from contact with the desks. Size is another consistent problem since students have to sit cramped together in groups of three to four at desks designed for two. Seats that are also mostly old and broken down offer no relief from discomfort. In every case, the walls of classrooms are completely absent of posters, pictures, or any other educational display so that rooms are devoid of flair or expression. Classes are so barren that neither calendars nor clocks are available for reference. The only clean updated displays visible are newly framed pictures of past and present leaders of the Islamic government.

Aside from expressionless classrooms, another reason why few parents would choose a PFJH school for its facilities is that in addition to blank classrooms, schools libraries and

Photo 3-5 Broken door left in the hallway in the reputable PFJH school of Anvar.

Photo taken by the author in September 2004

Photo 3-6 Bare “box” classroom without displays or equipment in the Felestin PFJH School.

Photo taken by the author in September 2004

recreational facilities are also substandard. Currently only a few schools even have libraries. When available libraries are usually restricted to the smallest rooms in the building offering a severely limited number and variety of books as a result. The playgrounds are another area of the school that is almost completely bare. The only equipment available for games or P.E. is a few volley balls or basketballs with little space to conduct games. Other limitations in facilities have a direct bearing on student health.

The purpose and positive impact of ventilation systems is well documented. Poor indoor air quality (IAQ) can make teachers and students sick, further reducing in class performance (EPA 2000, Kennedy 2001, Leach 1997). Temperature and humidity affect IAQ in many ways, perhaps most significantly because their levels can promote the presence of bacteria and mold, the precursor for many illnesses. In classrooms and school buildings, at a minimum, systems such as air-conditioning should serve to remove or otherwise dilute the contaminants that can build up inside. Schools also strongly need ventilation systems because children breathe a greater volume of air in proportion to their body weight than adults do (Kennedy 2001,McGovern 1998, Moore 1998). Left unprotected, humidity and temperature extremes from heat can be extremely damaging to student well-being. Classroom ventilation is thus a domain neglected in PFJH schools that accounts for rampant health worries among students and their families.

For schools located in high humid areas being equipped with ventilation systems like air conditioners is particularly an urgent concern. As temperature and humidity increase, students are likely to report greater discomfort. Their achievement and task performance also deteriorate as attention spans drop (King and Marans, 1979). No where are the hazards of such high humidity more pronounced than in Rasht schools. As reviewed in the study area section Rasht is situated in one of the most humid areas of Iran with levels approaching more than 90%. Discomfort can also become amplified by a dress coat which requires female student to wear the “Magnaeh” head cover and long coat as part of the school uniforms at all times, regardless of seasonal temperatures. Without relief from air conditioners, the heavy mandatory uniform can make humidity and heat unbearable for female students. At present none of the PFJH schools of Rasht has ventilation or a working air conditioning system.

To describe the full extent to which facilities are conspicuously missing in schools in the study are it is useful to cover yet another area of disregard that effects parental views toward the schools they attend; quality food services. The limited food service that is available for snacks remains underdeveloped in the studied schools and far short of what would be needed to contribute to the nutritional needs of students. This “food service” typically consists of food cooked and served out of the janitor’s residence. Foods that can be purchased include the typical junk foods like cookies, chips. Common complaints noted in questionnaire responses of students

at the studied schools include lack of attention to cleanliness in food preparation, food spoilage and even occurrences of food poisoning.

Parents naturally pay much less attention to the school facilities in making choices when so little is offered. The investigation shows that none of the schools in the study area provided standard school construction or equipment for the children. The overall low state of facilities reviewed above in nearly every Rasht PFJH school has a profound impact on parental expectations, downgrading facility considerations as an important factor of school selection for their children.

3.4.5 School Reputation

A leading factor in parental choice that also plays a major role in which school Rasht children attend is its reputation. School reputation commonly refers to how highly schools are regarded in the eyes of both parents and students of the city. A favourable reputation, which is often simply spread by word of mouth from parents and former students, can take years to cultivate. Negative experiences at schools can formulate into an unfavourable reputation over the same period by similar means. This section will give a brief analysis of the root causes for positive reputations at schools and touch on its implications for parents that send students to PFJH schools in Rasht. One question worth exploring given the facts presented in the facilities section is; do school facilities augment the formulation of the overall reputation of a school? The answer becomes much clearer after recalling the chronic facility underdevelopment reviewed in detailed above.

In the case of the PFJH schools of Rasht, reputation is solely based on the quality of education offered to students. Though a positive or negative reputation might partly hinge on the level of facilities elsewhere, the higher income areas of developed countries for example, widespread degradation in facilities in Iran takes this factor out of consideration altogether. Instead reputation is cultivated by the human factor of teacher and school staff performance. The most reputable schools are thus the ones with the highest calibre teachers. The Aban and Anvar schools are a case in point. As the most widely sought after PFJH in all of Rasht, these prestigious schools have reputations built primarily on the proven teaching methods of seasoned teachers. Successful teachers, after all, breed outstanding students with few exceptions. Since students attending reputable schools like these have access to the best teachers it should result in the perfect “match” with no complaints being made. While this sounds ideal, it is often not the case.

Despite appearing to be unproblematic, parental preference for schools with the best

teachers can also conflict with the best interest of children. As noted earlier, a school reputation in Rasht schools hinges on the relative popularity of its teachers with students and parents. Though more reputable schools might offer students the best teachers and at times slightly better facilities, other problems can arise. One difficulty noted in the surveys among attendees of popular schools is that they are too far from homes making for inordinately long and inconvenient commutes. “Anvar is a PFJH well-known school, however, it is far for me, and also I am not with my friends here,” a student noted on the survey. Like long distances, other disadvantages can serve to negate the benefits of good teachers as well. Another difficulty reported on surveys conveyed what happened when even the most reputable schools fail to deliver on the promise of improved conditions like better facilities. Students of Aban, for example, indicated not only that the school playground and science lab were much too small for practical use, but also that the restrooms were unsanitary. Respondents also mentioned overcrowded classes and a complete lack of basic exercise equipment such as basketball or volleyballs.

In summary, parents consider a number of criteria for school choice, of which school reputations is also a factor. As briefly touched on throughout the criteria section parents do not pay attention to criteria with equal weight. To discover how each criterion specifically rated in parental choice of the PFJH schools of Rasht the research also measured how often each was used in the choice of the five studied schools. The next section is a summary of those findings.

3.4.6 Portion of each Criterion Used for Choosing the Studied PFJH Schools

As discussed, this research focused on criteria used by parents at the five studied PFJH schools of Aban, Anvar, Azadi, Felestin and Rahzahra. Although the focus thus far has been on broad descriptions of proximity of student’s residence to school, accessibility of school to public transportation, school facilities, journey safety, and school reputation, another topic worth exploring is the specific mix of these factors at certain schools. This can give clearer image of the state of schools in the study area and contribute to understanding just how each criterion can impact parental choice in school selection. Aban and Anvar are a case in point. As the two most sought after schools in the study area they also have the most favourable reputation with parents in the study area. Despite the advantage of having the best teachers, an aspect that might make attending these schools impractical for parents without cars is the low accessibility to cheap public transport. As the least reputable school in terms of teacher care, Azadi also suffers from the fact that it has low accessibility for students that must travel by public means. Another

disadvantage for parents seeking to enrol female children in this school is its location in underdeveloped and crime-infested areas, making it the least safe school for students. Azadi does have one saving grace that has elevated it to the most attended PFJH school in the study area: good proximity to student homes. On the opposite end of the spectrum, the schools with the safest journeys for students are Rahzhra and Felestin. Students at these schools can also take advantage of good accessibility. It is worth noting again that the shared characteristic of all schools in the study area was the lack of adequate facilities to meet the educational needs of its pupils. With little variance between them all schools suffered from a shortage of modern, updated facilities, Azadi having the worst.

The research discovered that while all factors went into the decision making process for PFJH school selection at the studied schools each had varying degrees of importance for parents. The research concluded that school reputation and the proximity of student's residences to schools were the most common criteria overall in school selection among respondents in surveys, representing 38.7% and 32.8%, respectively. Two schools in particular (Anvar 89.2% and Aban 71.6 %) had the highest rates of being chosen based on reputation reflecting the popularity of their teachers and staff in relation to the other three. In addition to preference for schools with quality teachers and the best proximity to homes, a large share of parents also naturally wanted safe environments within which their children could travel to schools. Thus, school safety was the next significant factor in school choice since it was on average the third most important factor for parent choice of the studied PFJH schools in Rasht with 18.3% of the total (Table 3-2).

Within the parental-based school system selection in the study area schools were overwhelming chosen based on whether or not they were had quality teachers, good proximity to homes, and offered safe environments. Without the constraints or guidance of attendance areas, parents freely enrolled children in schools over a wide area seeking schools that fit these criteria. Unfortunately, the research concluded that this was the impetus for major difficulties for their children. What follows in the next section is an investigation into the spatial distribution of students throughout the study area and the major inconveniences that result.

3.5 The Spatial Outcomes of Parental Choice in the Case of Students Attending the Studied PFJH Schools

Given the difficulties in choosing the first choice school for their children, the ultimate outcome of the parental choice-based system is that many students are in fact unhappy with final school choice made by their parents. Figure 3-1 shows the percentage of students dissatisfied with their school choice among the five studied PFJH schools. The research concluded that a

Table 3-2 Number and percentage of parents who chose studied schools for each reason.

Reasons	Studied schools					Total students and average percentages
	Aban	Anvar	Azadi	Felestin	Rahzahra	
Returned questionnaires	**250**	**65**	**194**	**221**	**189**	**919**
Proximity of student's residence to school	49	18	55	87	93	302
%	19.6	27.6	28.3	39.3	49.2	32.8
Accessibility of school to public transportation	12	4	17	24	32	89
%	4.8	6.1	8.7	10.8	16.9	9.6
Journey safety	48	13	21	52	35	169
%	19.2	20.0	10.8	23.5	18.5	18.3
School facilities	30	5	7	9	15	66
%	12.0	7.6	3.6	4.0	7.9	7.1
School reputation	179	58	20	70	29	356
%	71.6	89.2	10.3	31.6	15.3	38.7
No answer	4	1	82	23	29	139
%	1.6	1.5	42.2	10.4	15.3	15.1

Note: Some parents implied more than one reason.

Source: Questionnaire data collected in September 2004

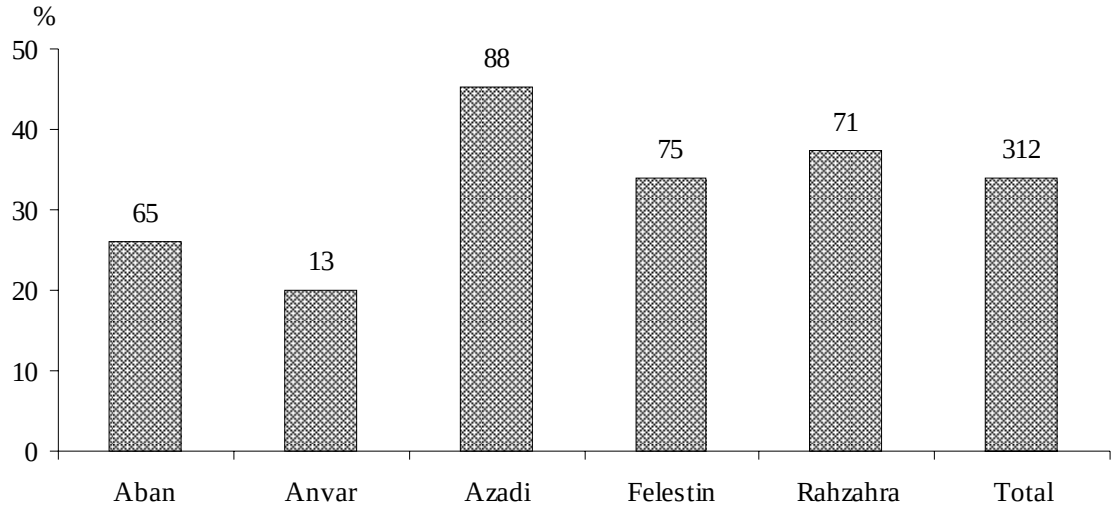


Figure 3-1 Number and percentage of students who are not happy with their school choice in the studied PFJH schools.

Source: Questionnaire data collected in September 2004

significant percentage of students or 34 %, of those attending the five-studied PFJH schools of Rasht, wish to have been enrolled in another one in the city. It also found a strong correlation between satisfaction and the level of the schools. Students currently enrolled at lower quality schools, for example are less satisfied with their choice and vice versa for attendees at ones that are more popular. Students enrolled at the more reputable schools of Anvar and Aban, for example, are generally happier with their choice to be there. Students attending the less popular schools of Azadi, Felestin and Rahzahra, however have a much higher percentage of students who have aspirations for studying in other schools. Parental choice, thus, results in students preference for a large number of schools located on the other side of town. As seen in Figure 3-2, respondents indicated preference for 16 other PFJH schools, specifically; Mohseni, Tagva, Aban, Resalat, Anvar, Azarbani, Azadi, Asgari, Felestin, Ghods, Etminan, Tohid, Amupur, Reshad, Rahzahra and Esmat. The wide distribution of preferred schools in Rasht covers close to a quarter of the city.

As mentioned above however, lack of open access enrollment policies in these schools meant that many students attending their present schools simply had little chance of ever enrolling. Long distances were another reason why students were ultimately unable to enroll in the schools of choice listed above. Many eventually have to settle for a school that was not their exact choice. Naturally, when the hope of attending the desired school is dashed, student motivation towards attending the "second tier" one is lower.

Another disadvantage of parental based selection in schools is that even when parents do manage to find a school that was the first choice it still not necessarily the *best* choice resulting in moves from chosen schools in search of a different one. The survey of the five studied PFJH schools of Rasht revealed that 67 of the 919 students (7.2%) questioned were originally from different schools before moving to the present one (Figure 3-3). Although a change in residence accounted for some of these moves, the other reasons for these moves reflect the shortcomings of parental choice in schools. For 16.4 % of the 67 students, the major factor in moving to a different school from the one originally chosen by parents was that they were located too far from their homes. Though these students were enrolled in well-known PFJH schools, they required travelling lengthy distances for daily commutes. Another 22.3 % changed to their current PFJH schools because after attending their first choice they found that it did not meet basic educational requirements such as competent teachers or administrators. Finally, 5.9 % of the total includes students who moved to their current PFJH schools were lucrative private ones. A result of their parents being unable to pay the hefty expenses private schools required.

Although the interpretation and ranking of each criterion occur in the private social worlds of individual parents, the combined effect has a significant impact on the spatial

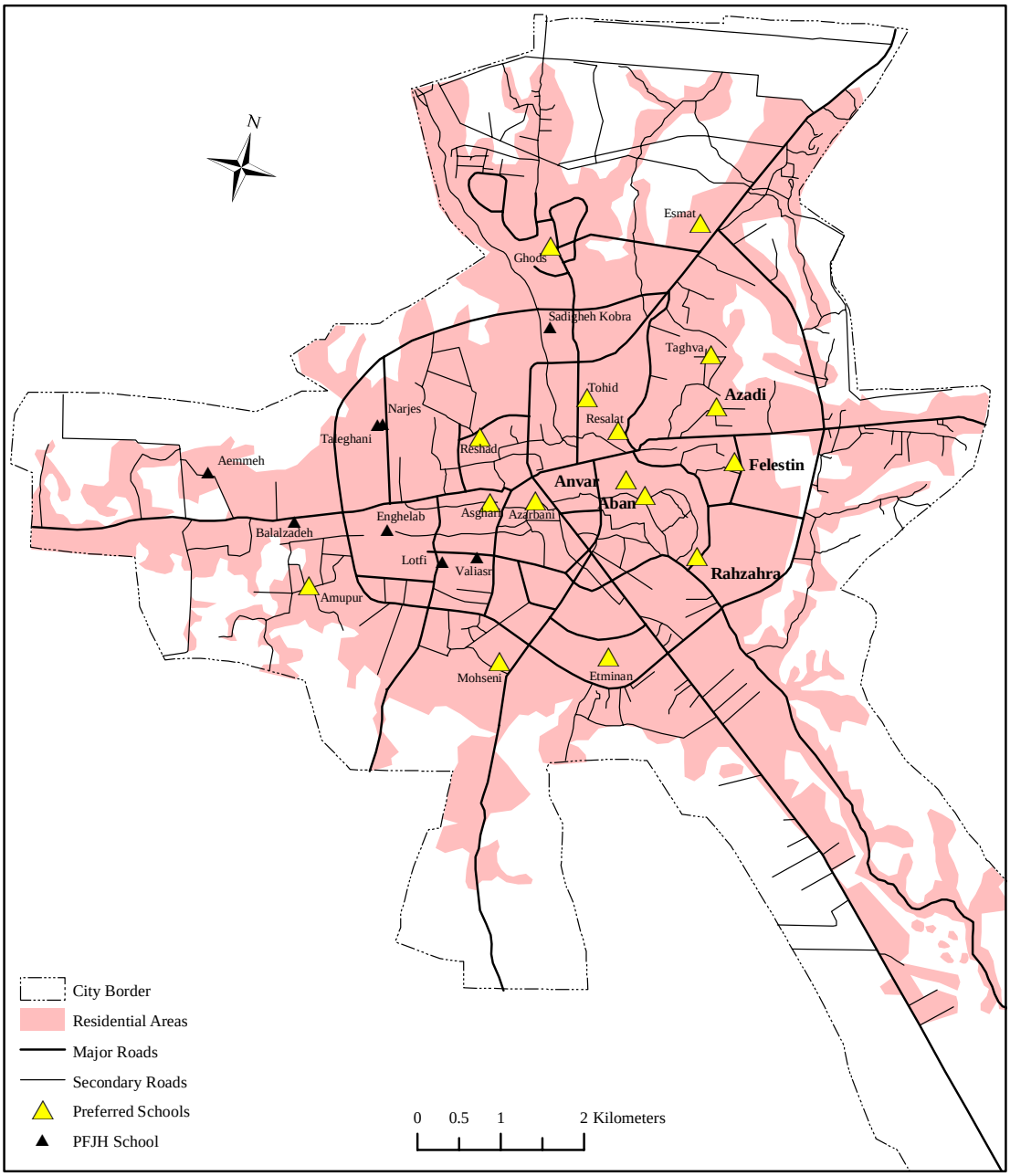


Figure 3-2 Map showing preferred schools indicated by the 34% unhappy students currently enrolled at studied PFJH schools highlighting city residential areas.

Source: Questionnaire data collected in September 2004

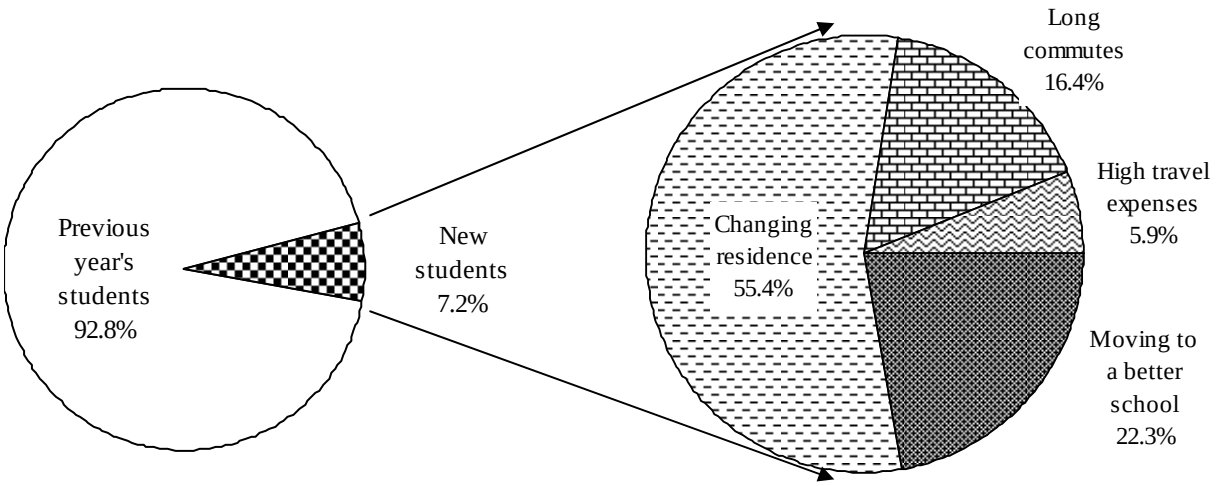


Figure 3-3 Percentage of students who came from a different PFJH school last year (new students) and the reasons.

Source: Questionnaire data collected in September 2004

distribution of students at schools. In the case of the PFJH schools in Rasht, parental choices result in flight from local schools in search of the best ones throughout different parts of the city. This is true since the broad availability of choices for parents invariably leads to options of choosing junior high schools beyond neighbourhood boundaries. The widely dispersed enrolment area that results from individual parental choices can make for highly inconvenient and hazard ridden commutes. To fully understand how this is so the next section investigates the spatial distribution and commuting patterns within the current parental based selection in more detail. It concludes that in searching for the best schools, many students are enrolled so far from their local areas it results in a heavy dependence on uncomfortable, unsafe transport that can even endanger lives.

3.5.1 Expanded Residential Distribution of Students within Rasht

To illustrate the residential allocation of students attending the studied PFJH schools, the construction of a detailed location map was necessary. Construction of a map was a time consuming process since it was not already provided by either the Education Office or individual schools. Figure 3-4 indicates the students' location around the studied schools based on the residential addresses extracted from the research questionnaires. The outcome of analyzing the residential allocation of students in relation to the five PFJH schools yielded surprising results.

Without the guidance of bounded areas, parental choice results in an expansive distribution of students to schools in the study area. The students attending the five studied PFJH schools of Aban, Anvar, Azadi, Felestin, and Rahzahra are allocated residentially over a wide area that, as mentioned above covers close to a quarter of the city. Attendees of the studied schools also include students who reside near the PFJH schools of Resalat, Taghva, Tohid, Etminan.

One consequence of the complex parental-based school selection system is that students living in the same residential area have been enrolled in numerous different schools despite close proximity to one. Figure 3-5 shows examples of how students from the same area residential areas travel to different schools throughout the city. As seen on the map, students living in designated residential area *A* covering approximately one square kilometre, attend not only Felestin but also the more distant schools of Azadi and Anvar. Students residing in residential area *B* follow a similar pattern. In spite of proximity to the school of Rahzhahra, residents in this area also attended more distant schools, in this case Felestin and Aban.

Parents living in the same areas choose different schools based on what means of transportation children use. Those who have the benefit of a family car or the funds for rental vehicles can seek schools over longer distances. Parents with fewer financial resources have

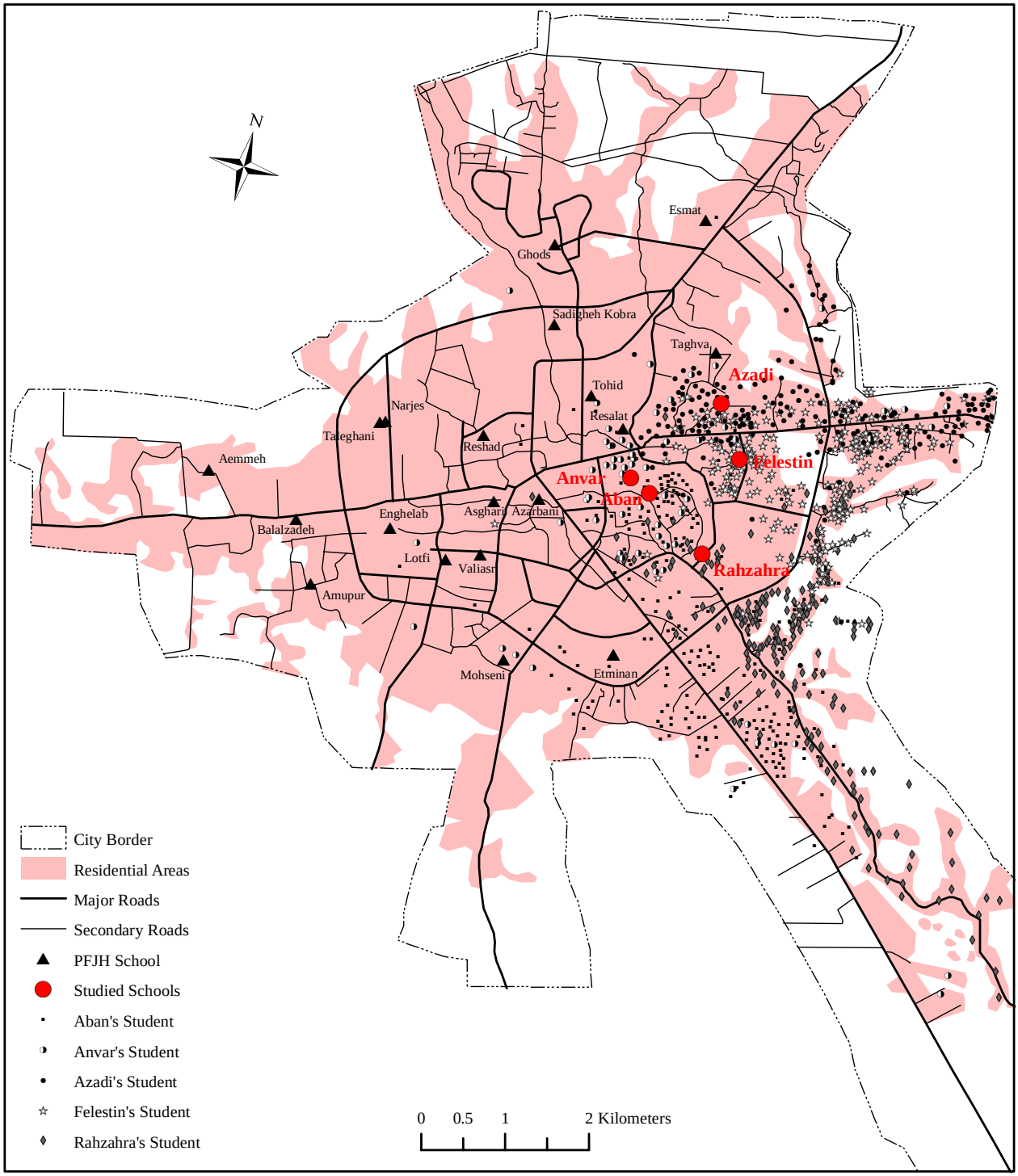


Figure 3-4 Students attending studied PFJH schools by name with city residential areas highlighted.

Source: Questionnaire data collected in September 2004

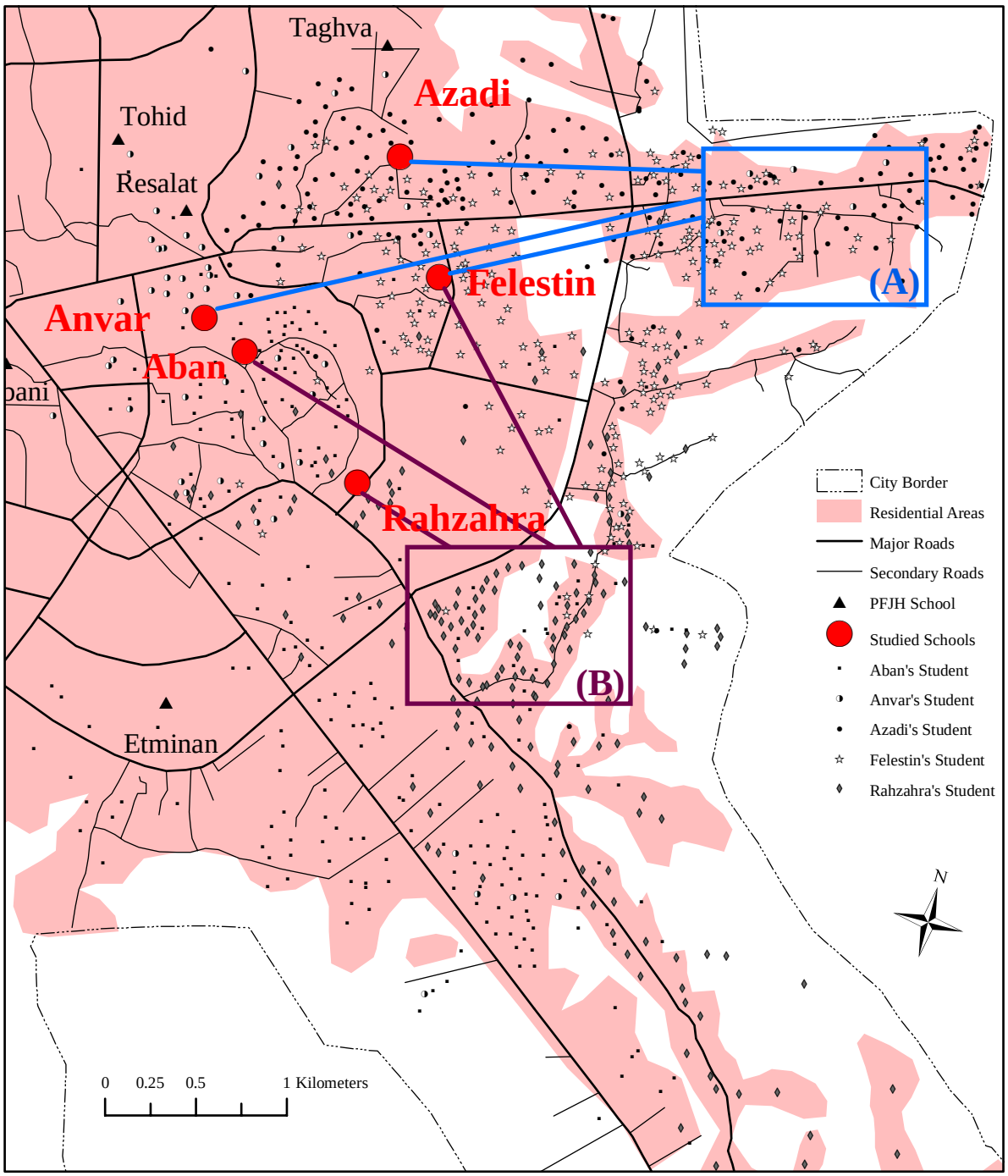


Figure 3-5 Two samples residential areas (A and B) that illustrate students attending different PFJH schools from the same residential areas.

Source: Questionnaire data collected in September 2004

fewer choices. Though they share similar preferences for the most sought after schools, parents that cannot afford vehicle travel have to confine their choices to the local ones nearby.

3.5.1.1 Commuting to School on foot and by Vehicle

Seen from the perspective of commutes, the current parental choice system of school selection has succeeded in distributing children over wider areas outside local residential areas resulting in longer commute distances on dangerous Iranian roads. Responses on questionnaires revealed that numerous students attending more distant reputable schools despite the presence of closer ones nearby. Parental choice of schools in the absence of delimited attendance areas has also led to the outcome of students taking longer commutes than necessary. This was especially true for students whose parents chose schools based on favourable reputations. Parents who could have been enrolled in the PFJH school of Etminan but chose Aban School instead is a good illustration of the one sighted pursuit of reputable schools. In providing a justification for attending the more distant Aban despite being close to Etminan one parent said frankly, “I’ve always liked to enroll my daughter in a reputable school like Aban and, fortunately, I did it.” Anvar is another example of a popular school chosen by many that reside near closer alternatives. Attendees of Anvar include students that live very close to the Resalat School. Once again, despite the availability of a local school, a further one was chosen in its place.

Investigation into the specific length of commutes also found that a significant percentage of students must travel substantial distances just to get to schools everyday. Currently, the commute for 43.6% of the students enrolled at the studied schools is more than a two kilometres. The percentage of students that commute this distance is particularly higher in the case of the more popular schools with 30.8% in Anvar and a whopping 67.2% of Aban students travelling that far (Figure 3-6). It is also worth pointing out that a journey of two kilometres or more are particularly lengthy for female students due to travel in environments that are in many cases hazard-ridden. To make the distance of the daily journeys manageable for their children, many parents have no choice other than to provide some form of vehicle transport for their children.

Commutes by vehicle were the most favoured means of travel, particularly among students who travelled furthest from their homes to the studied schools. A review of travel patterns of female students to PFJH schools shows that an overwhelming majority have to rely on some form public or private transportation for commutes. Some 59.5 % of the students surveyed currently travel to the studied PFJH schools by some sort of motorized vehicle. (Figure 3-7). Students attending Rahzahra and Aban had the highest number of students who commuted

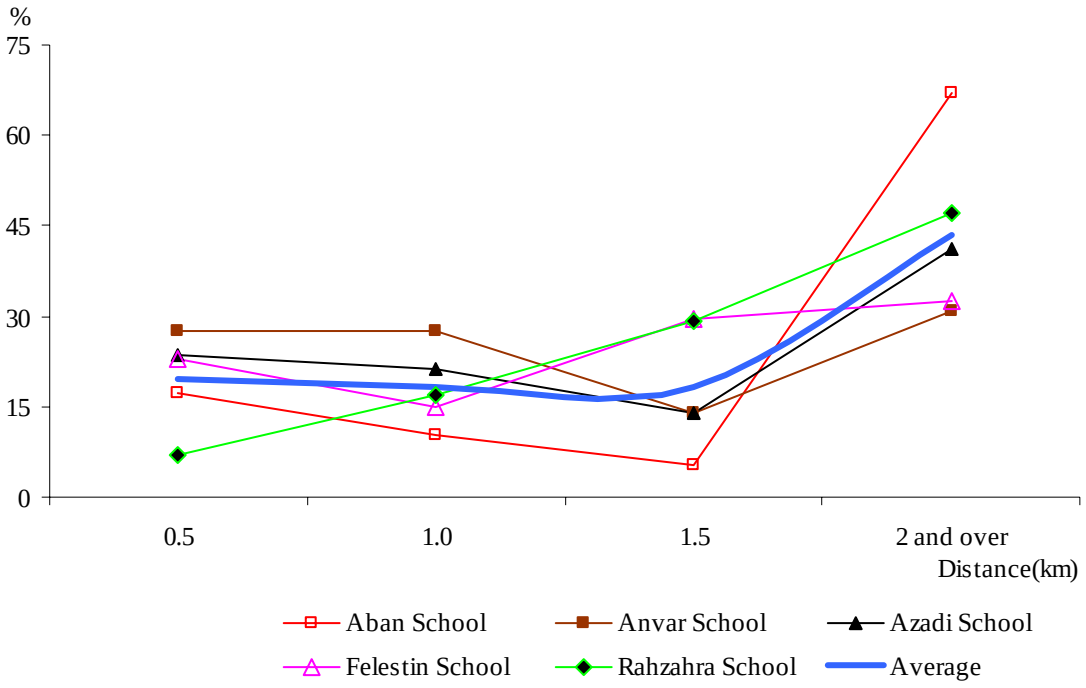


Figure 3-6 Percentage of students attending studied PFJH schools from different distances.

Source: Questionnaire data collected in September 2004

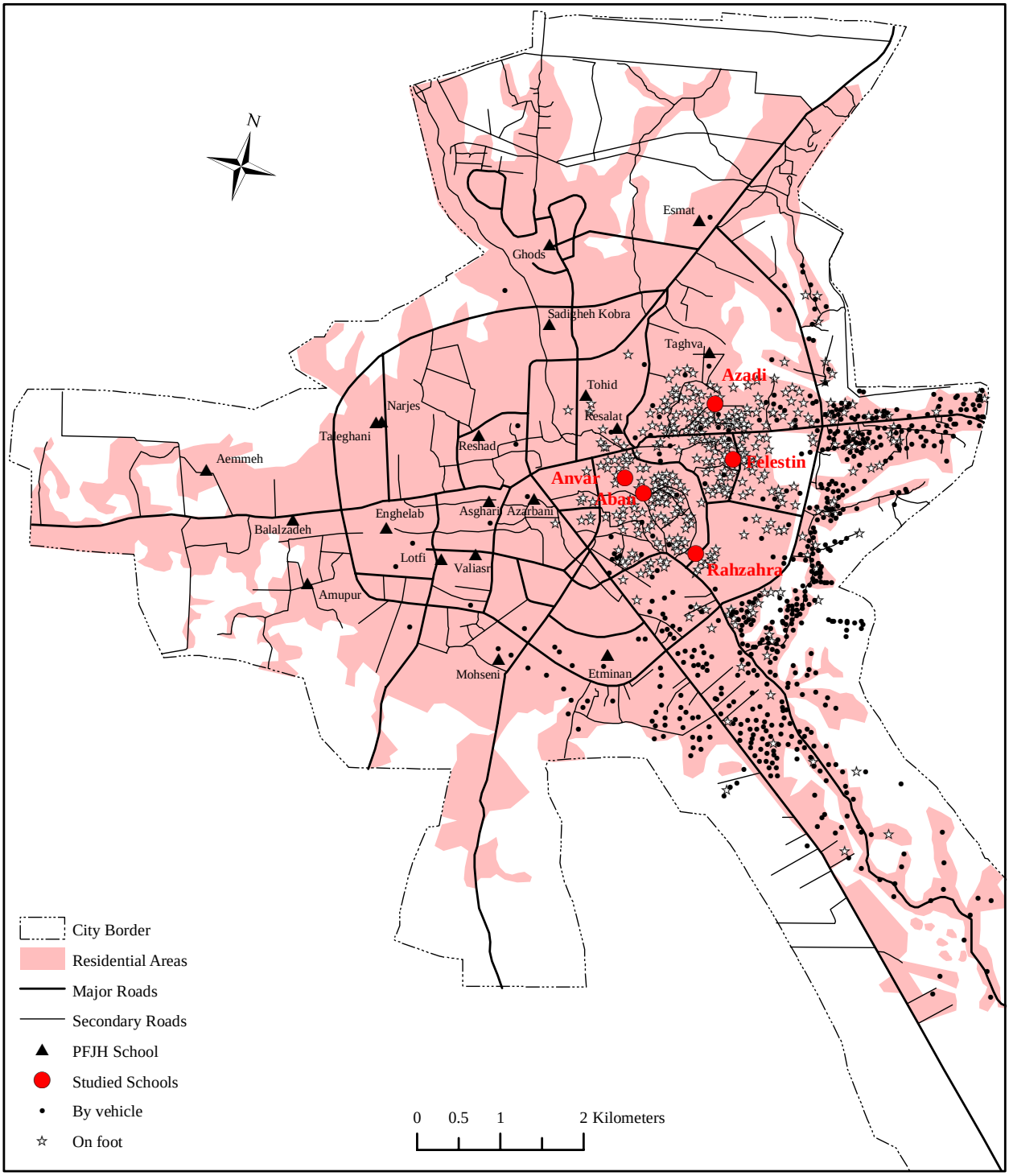


Figure 3-7 Students attending studied PFJH schools on foot or by vehicle with city residential areas highlighted.

Source: Questionnaire data collected in September 2004

by vehicle with the distance travelled from remote areas often exceeding six kilometres.

Although safe mass transit or bicycles are options for commutes in other countries, this is not the case for children travelling to PFJH schools in Rasht. As mentioned above, travel by bike is officially banned for females. For families seeking a safe, affordable commute this leaves either privately owned vehicles, taxis, buses or a train system, if available. Like most of Iran, residents of Rasht are still awaiting access to trains. Though a Metro train system has been constructed, widespread access to efficient railway system is still in its infant stages in Iran. Currently the newly constructed Metro only offers convenient mass transit to commuters in the capital city of Tehran.

Without other available choices, those commuting to PFJH schools have to rely on buses and a variety of taxi services. The category of the more lucrative private services includes telephone taxies, shared rental taxies, and shared-rental minibuses. The family car is also available to some. Clarifying each travel option will be helpful in further illuminating how female students get to schools and the hazards involved in Rasht.

As the most widely utilized public form for city goers, taxis are available in two forms; formal and informal. Formal taxies are those employed by the Organization of Taxies and have received certification to work within the city limits. With the number of unemployed increasing sharply, taxies of the informal sector have also become a permanent part of the public transport landscape in the last three decades. They include any drivers that convert their cars in taxis for employment to augment bare subsistence salaries. Though taxis in the informal sector are technically illegal the government has had little success with curbing its popularity given the continued high rates of unemployment. The popularity is so widespread that the informal sector taxies actual outnumber their formal sector counterparts. In the search for income informal drivers also routinely overcharge customers more than formal taxies. Unfortunately the lack of oversight or identification by formal employment agencies offers little hope in curbing such abuses.

To further clarify the nature of rides in taxis of the informal sector, more needs to be said about the nature of the cars they utilize. Exactly what kinds of cars are used in this case? The most popular city taxi in Iran is without question the clunky four-cylinder Paykan. Though they lack air conditioning and crank windows, their cheap price has made Paykans the most sought after vehicles. Thus, for the poorer taxi drivers in the informal sector seeking to minimize costs, the ubiquitous Paykan is the natural car of choice. Currently, an estimated 70 percent of the passenger cars that clog Iran’s roadways out of economic necessity are the four-door Paykans. Though the initial production run began in 1967, tens of thousands of old Paykans remain on the road. They make up the more than 1.5 million dilapidated cars that operate with out upkeep or

standard safety features like operational seatbelts. Theses vintage Paykans routinely pick up students waiting at taxi stops on a daily basis. Such rickety cars are indistinguishable from newer predecessors by a greater preponderance of dents and blemishes. They are also more colourful due to repeated paint jobs and retooling to keep them operative (Payvand, 2003).

As expected, such outdated vehicles are also extremely uncomfortable rides. Even though passenger can barely sit comfortably in them; two are often crammed in the front a natural outcome of seeking as much income as possible by drivers. For students travelling by such means the only way to get these taxis for exclusive use and comfort is to specify they wish to travel without further passengers pick ups. Although this allows for direct travel to the destination, it is simply not on affordable option for most since the transportation fees is at least five times more.

Public buses are by far the cheapest of the commutes for students that must travel to school. Like any typical bus service passengers are required to purchase bus tickets before boarding. Public bus services in the cities of Iran are also characterized by segregation with males riding in the front and females relegated to the back. Though cheap and efficient, inter-city buses are in general less comfortable rides for passengers. They are also less modern. It is not uncommon, for instance, for buses, to be without air-conditioners in hot humid temperatures. Another set back of bus services is that there are too few in operation and thus crowded. Many people are often forced to stand in the aisle at peak times. The noisy and crowded environment of buses is also the perfect places for pick-pockets to slip in and out undetected. Another point worth mentioning concerns the limitations of the service offered. Buses services in Rasht City are limited since they can only travel via main roads. Students who reside along smaller secondary roads typically have to walk to the closest main road to catch buses, adding to the overall commuting time.

Though travel to school by the family car offers a safer commute free of rental charges, only a few students have parents who can afford this luxury. As reviewed earlier in the research cars remain very expensive and out of the price range for most families. According to the data published by the Statistical Centre of Iran, only one car is available per 26 Iranian families. This means only a lucky few have access to a car for driving their children to schools, including the parents whose children attend the studied PFJH schools in Rasht.

Even when families own a car major limitations for vehicle use persist. The reason for this lies with the element of patriarchy in Iranian families. Driving is still widely viewed as the father’s job. As a consequence the car is typically for exclusive use by the man of the house, with some women never ever learning to drive. Even though mothers might have more free time as housewives women rarely if ever drive their children to schools. When an inflexible job

schedules precludes the father from driving the mother cannot step in to take his place.

As another form of private motorized commuting available to parents with a higher incomes, telephone taxies, are another option for making their children's daily travel more comfortable. These taxies belong to private taxi companies that are registered at the Rasht City Hall, making them more secure than informal sector ones. As the name suggests their service is available upon request by phone to anyone, including students. They are also far more convenient than the city taxi variety for the service they offer. This is true since they can pick students up directly from their homes without additional passengers. Parents can either rent telephone taxies for their children's journey to school with daily payments or set up yearly contracts. Convenient service is not without costs. Renting these taxies can get very expensive becoming a heavy financial burden on family income.

To keep school commutes not only convenient but also cheaper, some parents share a rental taxis. Four to five students can rent these taxies up to a year for their daily commutes to schools. The taxis are selected in two different ways. First, interested students can look for the other four passengers after school commences. Though the result is a ride with friends it can also be time consuming. This search might takes up to a month for some since it requires connecting either with classmates or from others different classes in need of a ride. Second, interested parents can ask the school administrators to introduce them to others seeking to split use of rental taxis. If this search proves unfruitful then parents have to search for safe drivers by themselves. Once the required number is reached, groups of parents can make a shared-payment-based contract with a driver to drive students to and from school every day of the school year (Photos 3-7 and 3-8). Contracted drivers are responsible for the entire round trip journey to school for all student passengers. It is worth mentioning that schools do not bear any responsibility for the safety of the vehicle student travel in. As such, parents have to be extremely vigilant in choosing safe cars and responsible drivers for their children. To safeguard the safety of such commutes, families often only hire drivers that are relatives or highly recommended by friends. As in the case of telephone taxies, these taxies are also pricey for many parents and out of reach for most.

For those who cannot afford the telephone and rental taxi option shared rental mini-buses offer yet another less expensive and relatively safe choice (Photo 3-9). Theses mini-buses can be rented by 35 or more for the daily commute to schools. This, in fact, exceeds the designated capacity for mini-buses. Although originally designed for twenty, drivers routinely pack more to lower the price per head and make mini-buses a more attractive option for parents. Like the shared rental taxies, mini-buses also drive the students to and from school. Despite this similarity, mini-buses rarely if ever offer the convenience of picking up or dropping off students at their place of residence. Instead, mini-buses have predetermined pickup and drop off points for each

Photo 3-7 A shared-rental taxi waiting to pick up another student passenger of Aban PFJH School.

Photo taken by the author in September 2004.

Photo 3-8 Students waiting in front of the Rahzahra PFJH School for their (late) rental taxis while a dilapidated green rental taxi waits for its student passengers.

Photo taken by the author in September 2004

Photo 3-9　Two rental mini-buses waiting in front of a school to pick up students.

Photo taken by the author in September 2004

residential area. Though these bus stops can make for an inordinately lengthy walk for some it still offers the economic advantage of being cheaper than other rental means. Parents who chose mini-buses must send their children to apply for the chance to rent upon enrolment in schools. Typically, schools have one or two mini-bus drivers that they regularly do business with. Another point of interest is that unlike school district bus services in developed countries, Iranian schools are not in any way legally responsible for the conduct of drivers on the road.

Having discussed in detail the services offered by each means of transport, one question is the percentage of students at the sample schools that use them. Public transportation is an excellent starting point. The investigation showed that only a few students travel to their schools using public transportation such as city taxis and public buses. Table 3-3 shows the portion of each travel option utilized by students attending the five PFJH schools of Rasht. Only 146 of the 919 questioned students used public transportation for their daily travel to schools. The number utilizing city taxies outnumbers those on buses. Given that they were fewer and offered slower service, only 49 of the junior high students questioned indicated commutes to and from schools by public buses. Most parents opted for the increased convenience of private transportation like telephone taxis and mini-buses for their children.

In the private transport domain another feature discovered from the investigation is a preference on the part of parents for the cheapest services. Of the 401 students using private transportation to the studied PFJH schools, for instance, only 38 take telephone taxis. Even less, receive rides from their parents. Thus, only 11 of the students surveyed responded that they travelled to school in the family car.

Since shared rental mini-buses are much cheaper than shared rental taxies, most of the commutes utilize the mini-bus option. Of 919 questioned students, only 67 students make the commute by the pricey shared rental taxies. As expected, the largest number of students commuting by way of a private vehicle travelled by on the most affordable options available; shared rental mini-bus. A whopping 285 students took advantage of the mini-buses, reinforcing its status as the cheapest and most attractive means of private transport.

Though parents tried their best to make the travel shorter by motorizing commutes, one question remaining regards the impact. Are public and private means of transport compatible with meeting basic standards of convenience and safety for students? In following section, the research answers this question.

3.5.1.2 Inconvenient Commutes to Schools

As discussed above, a large percentage of students currently commute to the schools in the study area via motorized transport in a myriad of public and private vehicles. Based on

Table 3-3 Number and percentage of students who travel to studied schools by transportation type.

Means of transportation	Studied schools					Total
	Aban	Anvar	Azadi	Felestin	Rahzahra	
Returned questionnaires	**250**	**65**	**194**	**221**	**189**	**919**
On foot	74	37	107	100	54	372
%	29.6	57.0	55.1	45.2	28.5	40.5
By vehicle						
Total	176	28	87	121	135	547
%	70.4	43.0	44.9	54.8	71.5	59.5
Public transportation:						
City taxi	2	3	27	28	27	87
%	0.8	4.7	14.0	12.7	14.2	9.5
Public bus	4	5	9	19	12	49
%	1.6	7.6	4.6	8.5	6.5	5.3
City taxi & public bus	0	3	2	2	3	10
%	0.0	4.6	1.0	1.0	1.6	1.1
Private transportation:						
Parent's car	6	1	13	12	6	38
%	2.4	1.5	6.7	5.5	3.2	4.1
Telephone taxies*	1	0	0	7	3	11
%	0.4	0.0	0.0	3.2	1.6	1.2
Shared rental taxies**	9	9	7	19	23	67
%	3.6	13.9	3.6	8.5	12.2	7.3
Shared rental mini-buses***	154	7	29	34	61	285
%	61.6	10.7	15.0	15.4	32.2	31.0

*Taxi available by phone that comes directly to students homes. This taxi is only used by one student for the daily commute.

**Taxies that rented for up to a year by students (usually four or more) for their daily commutes to school.

***Mini-buses rented by 35 or more students for their daily commutes to school. This number exceeds the mini-bus capacity of twenty people.

Source: Questionnaire data collected in September 2004

responses on questionnaires each mode of transport was chosen for different reasons according to the specific student and parental preferences for the services offered. Though commuting by rented vehicles might conjure up images of comfort and convenience this is not the case for students' daily journey on the taxis and buses of Iran. Despite the best efforts of parents to match their children with what they feel is the safest rented vehicle possible, there are extreme inconveniences and hazards associated with each one. Such difficulties combine to make travel by vehicle not only exhausting but potentially life threatening. Thus in addition to outlining the specific justifications students have noted for why they chose their current mode of bus or taxi transport, this section will also outline the major commuting problems that students must endure in daily journeys to the PFJH schools of Rasht (Table 3-4).

Students listed a number of different reasons for choosing the public buses and taxis that make up Rasht's transportation system. This selection is often arrived at after carefully weighing the costs and benefits of travelling on each one. The choice of city taxis and public buses are a good example. Travelling by such means of public transportation is a considerably lower burden on family income when compared to journeys on private vehicles. Parents listed their current preference for city taxis, for example, since travelling by taxis carries the added benefit of much quicker commutes, meaning less time on the road for their children. The high probability of falling victim to crime by drivers of city taxis in the informal sector often makes the benefits of fast travel pale in comparison to increased security of other means. Instead, parents seeking increased security choose more open, albeit crowded, rides on the city's public buses. Parents seeking even less chance of public dangers often turn to the private means of transport for their children as an even safer alternative for their child's commute to school.

As alluded to in previous sections, when discussing the buses and taxis of Rasht's transportation network the term "private" refers to those vehicles made available for use by companies or individuals. Since there is enough variance in the costs among the various vehicles that make up the city's private vehicle network, parents try to select the one which bests fits with their financial resources. As mentioned in previous sections, the costs of commutes are highest for private vehicles like telephone and shared rental taxis (the two most costly) and are cheapest for shared-rental mini buses and the parents' cars.

The advantages afforded by ownership of a car in the family can also outweigh the benefits of cheaper services. The benefits listed in shuttling their own children to and from school are a good illustration, as reflected on responses on questionnaires. The parents indicated that despite the monetary costs of owning a car, driving children in their own cars provides the luxury of not only ensuring they get to school on time but also the safest and most comfortable transport. Another benefit listed is that aside from the initial purchase cost of the car, no

Table 3-4 The advantages and major problems associated with each means of transportation listed by questionnaire respondents.

Transportation	Advantages	Problems
City taxi (formal and informal)	♦ Punctuality ♦ Travelling is faster	♦Expensive. ♦Decreased security because of drivers that are often unsafe and disregard traffic rules especially in the case of informal taxis. Parents are thus always worried for their children safety. ♦Low availability of taxis at peak use times (school start or ending times, or on rainy days). ♦Increased commute times because of travel in heavier street traffic. ♦Decreased time and energy for homework at home and other activities because of long distance commutes.
Public bus	♦ Increased security ♦ Cheaper than other means	♦Lateness at school because of traffic or long distance. ♦Lack of a defined time-table for public buses being at a bus stops at a certain time. Students have to leave home earlier to catch the earlier bus. ♦Lack of bus ticket booths at bus stops (the Iranian bus system requires that people purchase bus-tickets at bus stops, though availability of tickets is often severely limited). ♦Overcrowded buses that result in students standing for the entire trip. ♦Decreased time and energy for homework at home and other activities because of long distance commutes.
Parent's car	♦ Punctuality ♦Comfortable ♦ No expense	No problem.
Telephone taxi	♦ Punctuality ♦ Comfortable	♦Expensive.
Shared rental taxis	♦ Punctuality ♦ Increased security	♦Due to the lack of upkeep of older model cars in use in Iran, students often have to endure heavy car fumes, clanking sounds, and even occasional breakdowns in traffic. ♦Students crammed into taxis which are meant for a smaller number of passengers (e.g. two students in the passenger seat). ♦Up to an hour of increased commuting time for the first passenger since they have to wait for the other passengers to be picked up. ♦More expensive. ♦Decreased time and energy for homework at home and other activities because of long distance commutes.
Shared rental mini-buses	♦ Convenience specifically in cold weather ♦ Increased security ♦ Riding with friends on the same bus	♦Increased commuting time for the first passenger since they have to wait for the other passengers to be picked up. ♦Long walking distances in the early morning hours to the bus pick up area for some so that parents have to accompany them. ♦More expensive than city taxies. ♦Bus drivers are often late by as much as 15 minutes resulting in late arrivals at schools. ♦Due to the lack of upkeep of older model buses in use in Iran, students often have to endure heavy car fumes, clanking sounds, and even occasional breakdowns in traffic. The ride is also made even more uncomfortable by damaged or ripped seats, damaged roofs that leak on rainy days, or windows that cannot be rolled down in hot, humid weather. ♦Bus drivers are often late by as much as 15 minutes resulting in late arrivals at schools for students. ♦Overcrowded buses that result in students standing for the entire trip. In some cases mini-buses with a capacity of 20 pack in 70 students a trip! ♦Decreased time and energy for homework at home and other activities because of long distance commutes.
On foot	♦ More convenience for short distance commuters ♦ Good exercise for students everyday ♦ No cost on family income	♦Extreme weather in the winter such as heavy rain. ♦Loss of energy at school. ♦Lateness at school. ♦High risk of getting hit by cars. Widespread lack of adherence to the right of way for pedestrians and other traffic rules in Iran, resulting in cars that often pass within inches of paediatricians crossing the street. This danger is heightened by the lack of working traffic lights at most intersections. ♦Frequent verbal harassment by street boys especially along the streets and alleys. The lack of a safe environment results in increased inconvenience for some parents who must accompany their children both to and from school everyday. ♦Cracked sidewalks in need of repair making them difficult to walk across, forcing some to walk along the sides of roads in heavy traffic. ♦Decreased time and energy for homework at home and other activities because of long distance commutes.

Source: Questionnaire data collected in September 2004

additional daily rental fares have to ever be incurred. All that is needed instead is for parents to adjust their schedules to picking up or dropping of children at the appropriate time.

As stated earlier, one of the stated goals of the research is to eliminate unsafe and hazardous travel in current vehicles. Since commutes in vehicles will be inevitable for some; those living on the outskirts of town, for example, a subject worth investigating is the type vehicle that can be provided as the suitable substitute. Analysis of student justifications for the choice of mini-buses is particularly relevant. Currently shared-rental mini-buses are by far the most utilized for journeys to the PFJH schools of Rasht. In terms of numbers more students chose mini-buses for commutes to the five sampled schools than any of the other rental vehicles. Research into the means of conveyance to the sample schools found that just over half (51.2%) of all those surveyed commute to school on mini-buses. Understanding the reason behind the overwhelming popularity of mini-buses, after all, can provide valuable input into what form the safer alternative to current travel should take.

The fact that the majority of students travelling to the sample schools prefer the fun and security of interaction with their peers on bus rides underscores the viability of a similar alternative widely utilized in developed countries; free school buses. When asked why they selected mini-buses over other vehicles for travel from home to schools, students gave a variety of responses. The most notable response given repeatedly is that mini-buses allow children the comfort and fun of rides with their friends. Another answer was that rides with fellow students meant increased feelings of security during rides. Unlike other rented vehicles, mini-buses also offer the service of drop off points in front of the school, eliminating the need for students to walk any further. This is another feature similar to free school buses services offered abroad.

For those seeking a way to shuttle their children to and from schools without the funds for a car, telephone taxis are another viable option. In listing the benefits of such means of conveyance the most common reasons listed was “punctuality.” Such responses make sense since these vehicles offer the benefit of punctual pick ups right at student’s doors with very few delays. It is also important to note that telephone taxis utilize newer model cars which come with features such as air conditioning and power windows. Hence, on top of timely service, students also listed “comfort” as a justification for their choice of telephone taxis over others.

Given the high expense that can accrue from utilizing this more costly taxi, parents often look for cheaper transport for their children. The choice of the shared rental variety of taxis is a good example of vehicles chosen for this economic imperative. Like their telephone taxi counter part, shared rental taxis are also sought after in the study areas for the punctuality factor. This is true since taxis pick up fixed numbers students who have already contracted the vehicle for the year. Such students naturally have a higher chance of getting to school on time than those

travelling in city taxis. Students therefore listed getting to school on time as one of the leading reasons for the family decision to utilize them. Feelings of increased security are an expected outcome given the fact that in most cases the drivers was chosen out of trust and familiarity with at least one member of the contracting party's family. The contract arrangement of shared rental taxis is beneficial to students for another reason; peace of mind.

However appealing telephone taxis may be the fact remains that the cost is still too high for many parents prompting searches for other options. Shared rental mini-buses provide a less costly choice. In discussing student justifications for commutes in general, one question that remains is what positive comments students had about non-motorized commutes. Specifically, what advantages did students list for walking to school?

The major advantage of commuting indicated by students who lived relatively close to schools was that walking represented the most convenient choice for getting to school over other means. Students that walked shorter commutes enjoyed the journeys more given the fact that they are relatively safe. Hence, students listed as an advantage the ability to get daily exercise outside in the fresh air. The value of the exercise activity is heightened by social interaction with friends since students often walk in groups. Another benefit indicated by students is the fact that walking does not involve any costs for the family. This is particularly advantageous for those low income families that simply cannot afford the daily monetary burden of transportation fees.

After a review of the reasons behind the choice of each transportation type, another essential question remaining is, did the selected means of transport create the comfortable, convenient commutes that parents want and expect for their children? Put another way; are current commutes safe enough and conducive to secure, productive students at school? Investigation into the major problems that students face for each commuting option shown that this is simply not the case. Although parent listed what were the reasons for choosing their commuting choices after being asked to do so in questionnaires, the preponderance of complaints also indicated that the disadvantages far outweighed and negated any perceived benefits. A look at each will make clear that serious hazards and discomforts involved in current commutes and the problems that warrant addressing.

The serious hazard inherent in any type of vehicle for children commuting schools in public or private transport in any developing country is the high risk of injury and death from traffic accidents. Iran currently has one of the highest accident rates in the world with an average of 200,000 accidents reported annually. On average, about 15,000 people are killed and 87,000 injured in traffic-related accidents in the country annually. In statistical terms, one person is killed every 40 minutes and one injured every seven minutes. In 2003, the Interior Ministry's Road Transportation Affairs reported that road accidents across the nation caused a staggering

189,245 deaths and injuries. In the developing world the tragically high figure related to road side recklessness is an almost unparalleled phenomenon, particularly within the region. Even countries such as Turkey and Pakistan have considerably lower traffic fatalities compared to Iran (Payvand, 2003).

The two causes pointed for most of the accidents are dilapidated vehicles and reckless driving. As in other parts of the world, careless driving and old cars often combine into lethal combinations that endanger anyone travelling by vehicle. Iran still lacks the basic enforcement mechanisms to safeguard traffic regulations such as working traffic lights or serious police enforcement. Despite the establishment of traffic rules, a widespread lack of precaution prevails drivers of taxis, buses or personal cars routinely to ignore basic traffic precautions such as yielding to pedestrians. In addition to this atmosphere of careless, drivers also have to settle for run-down cars out of economic necessity.

The number of out-dated vehicles prone to mechanical failures in traffic that can lead to accidents also helps to explain the high occurrence of death and injury in Iran. As touched on above more than a million dilapidated cars, which have been running for more than 20 years, continue to ply on Iranian roads. Many of the vehicles over 15 years of age are still operating, requiring the adoption of a serious plan for their replacement (Payvand, 2003).

These hazards provoke high parental concern for children's safety on daily basis. For those students lucky enough to escape falling prey to high risk of traffic related injuries there were other difficulties which make commutes equally burdensome. Aside from carrying the threat of bodily harm, research into the five studied schools indicates that current commutes in taxis or buses to PFJH schools are also exhausting and highly inconvenient for students. To offer more detail on the reality of commuting within the city, the researcher also asked respondents to detail the numerous disadvantages outlined by students of the five studied schools for each of the commuting means.

The problems detailed by respondents on city taxis are typical of the dangers and inconvenience associated with travel by vehicle. When asked about the disadvantages of travelling by city taxis to the PFJH students pointed out the incompatibility of taxi travel with being punctual for school. The major reasons for this noted on questionnaires is that difficulties to find taxis at the peak morning rush hour times to get to school on time. Commute times are further slowed by morning traffic jams during the collective rush to schools and work.

Travel in dilapidated Paykan's to PFJH schools can extract a heavy toll affecting student productivity. Students that had to use such means for journeys to the five sampled schools also noted that they disliked such taxis since after such rides they had little energy left for homework and other activities at the end of the day. In addition to inconvenience rides, a natural outcome of

rides in such taxis also means less peace of mind for both parents and students. As noted above, there is widespread of lack of adherence to basic safety considerations when driving. Drivers of the city taxis are no exception. Drivers are chronically unsafe and disregard safe rules of the road. Informal taxis are less safe given the likely hood of frustrated drivers turning to crime. Iranian newspapers regularly report informal taxi-drivers being condemned for kidnapping or rape. In 2002, for example, it was reported that five young taxi-drivers had been sentenced to death in the Iranian capital for raping a young woman. Parents wary of such dangers frequently recommend that their children avoid informal taxis when possible, particularly on more quiet roads. Hence another overriding disadvantage noted by respondents was the fact that parents always worry for their safety when they utilize taxis for the commute.

As money is also dominant concern for families with limited funds, the drawbacks of any form of taxis is the high expense involved. This was particularly true in the case of city and telephone taxis. The research found that for all taxis, student consistently noted that travels by such means are “expensive,” reflecting the heavy financial burden of the daily fees that have to be paid. The high expense involved is even clearer when commuting by telephone taxis given the high rates that drivers charge for the service of picking students up directly from their homes. A consistent complaint of shared-rental taxis was also that they were costly. This is noteworthy of the how much taxis extract since students felt such taxis were expensive even though they allow the option of splitting the costs with others. Clearly, students and their families would opt for cheaper alternative for travel to schools if made available.

As mentioned earlier most vehicles that students ride in for commutes to schools are not new but often dilapidated ones. This is particularly relevant when looking at the specific drawbacks of shared rental taxis listed by students. Given the lack of upkeep of older model cars in Iran, a constant complaint of students on questionnaires is to endure heavy car fumes, clanking sounds, and even breakdowns in traffic. Moreover, students are crammed into taxis which are meant for a lower number of passengers, making the ride even more uncomfortable. Students using such taxis reported the major disadvantage of up to an hour of increased commuting time since shared taxis pick up numerous passengers before going on to their final destinations. As in the case of journeys in other taxis, students also listed decreased energy, the natural outcome of heavy inconveniences. Yet, taxis are not the only vehicles that were the subject of censure in the research. Students and families also indicated numerous disadvantages in travel on buses.

The disadvantages listed by students in utilizing the city bus present a clear illustration of the extreme inconveniences students must endure just to get to schools. One consistent problem pointed out by students is the lack of defined time-tables with buses consistently arriving behind scheduled pick up times. Another is the lack of availability of bus tickets, which passengers are

required to purchase at bus stops to pay the fare. Students also indicated other major the disadvantages associated with trips in city buses as well.

"Overcrowding" was a consistent theme of comments on why travel in city buses was draining for students. This resulted from the fact that, like other public and private transport in Rasht, most buses are filled beyond capacity requirements with passengers packed in every corner. Such severe overcrowding makes it difficult to find seats for the ride to schools so that it is not uncommon for many to have to stand for the entire journey. Although city buses are among the cheapest ways to travel within Rasht, it does not mean that the more lucrative and sought after vehicle options are problem free. Students also indicated numerous problems with the more popular mini-buses.

Questionnaire replies for the disadvantages associated with shared rental mini buses also reflected the fact that they were highly inconvenient for students and at times even hazardous for their health. The substandard condition of the buses was a consistent theme of student comments on problems with mini-buses. Students mentioned, for example, that due to the older make of the buses they often have to suffer from heavy car fumes that seep through broken windows for the duration of the journey. The ride is made even more uncomfortable by ripped seats, damaged roofs that leak on rainy days and windows that cannot rolled down in hot, humid weather. Clanking sounds and occasional breakdowns in traffic often add to the feeling of discomfort and insecurity. Another complaint common for rented vehicles is consistent late arrivals at school (averaging 15 minutes or more). The final disadvantage related on questionnaires was the same complaint of students that ride city buses; overcrowding. The lack of oversight and scrutiny of mini-bus contracts with the families of students means that drivers can pack as many students as possible for increased profits. As a consequence there is also severe overcrowding on mini-buses with some packing in 50 over capacity. In addition, to detailing the discomforts associated with vehicles, students also noted the harsh realities of walking commutes to the PFJH schools of Rasht.

Like journeys in vehicles, respondents noted that commutes on foot were also the source of high inconvenience and dangerous conditions. As noted earlier any pedestrian in Iran has a high likelihood of being involved in a traffic accident. Given this fact, fears associated with this very real danger in Iran were also a common theme of disadvantages listed on the questionnaires. Hence, a large volume of students listed the high risk of being hit by a car as a prevalent concern when walking to school. It is further justified by the fact that numerous areas lack sidewalks and few traffic lights are in working order in the city. The reality of unsafe environments in Rasht was further confirmed in the research by students indicating their fear of verbal harassment by "street men" in dark alleys or along certain streets in underdeveloped areas (Photos 3-10, 3-11,

3-12, and 3-13).

Another problem noted relates to inconvenience encountered by exposure to the elements in Northern Iran. In addition to physical dangers, students also said that a major disadvantage of walking was the fact that they had little protection from the heavy downpours that are commonplace in the “city of rain.”

The numerous hazards students listed in walking and in vehicles commutes to the studied schools make it abundantly clear that such journeys need to be reduced by as much as possible. Achieving that goal is the subject of the next chapter.

Photo 3-10 Students walking home from school in roads without sidewalks.

Photo taken by the author in September 2004

Photo 3-11 Students walking home from school. No sidewalks. Cars pass very close to pedestrians.

Photo taken by the author in September 2004

Photo 3-12 Students crossing the street. No crosswalks to cross safely.

Photo taken by the author in September 2004

Photo 3-13 Students walking home in an area where verbal harassment happens.

Photo taken by the author in September 2004

Chapter Four

Minimizing Commuting Problems by Constructing School Attendance Areas

4.1 Introduction

Given the life-threatening hazards and serious inconveniences involved in commutes for young female students outlined above, Rasht City is in dire need of a system in which decision making guides parents to more local schools and the closest possible commutes to their homes. Research into commuting distances travelled revealed that parental-based selection of schools has resulted in journeys that are longer than necessary for most students travelling to the studied PFJH schools. The longer than necessary commutes are especially impractical and dangerous for students due to the major problems linked not only to travelling longer on foot, but also in outdated public and private vehicles that travel in crowded, accident prone environments. In order to make the travel shorter and more convenient in Rasht, parental decision making power must essentially be eliminated. In its place, the assignment of students through uniform school attendance areas is needed. In construction an achievable school attendance areas, however, the parental preferences in children commutes to schools were taken into account. This section will outline how this is possible through the demarcation of attendance areas to each of the studied PFJH school. It will introduce the proposed school attendance areas for the city and will prove how the school attendance areas allocate students to closest possible schools on foot. It will also show that assignment of students to schools through the proposed attendance areas can reduce commutes by vehicles as much as possible and make the travel more convenient for the students.

4.2 Delineated Attendance Areas for All Rasht City PFJH Schools

Rasht can be divided into areas that allow travel to the closest possible PFJH school, reducing inconvenient commuting distances for its students. To construct enrolment areas that create an organized flow of students to the closest possible schools, the research bounded areas

around each of the studied PFJH schools utilizing the Multiplicatively Weighted Voronoi Diagrams (MWVDs) approach. As mentioned in Chapter Two, its status as one of the most widely utilized bounding techniques makes it useful in creating attendance areas around PFJH schools based on the school size. By constructing MWVD polygons to represent delineated schools attendance areas, all locations enclosed within a single area will be closest to designated PFJH schools, ensuring the closest commutes and optimum capacities. To give a fuller picture of the nature and effectiveness of attendance areas in achieving the goal of reduced commutes the next section will give a brief overview of its general characteristics.

4.2.1 General Characteristics of the Constructed Attendance Areas

To create attendance areas that accommodate the students and take into account the two-shift structure of Iranian schools, certain features had to be integrated. The first is that the attendance areas were defined for both morning and afternoon shifts for each school building to reduce commutes for the two student populations. The second feature of enrolment areas is that they are all based on the current student population of each school. Another feature is that schools which accommodate larger numbers of students will have larger enrolment areas given that they draw more people to its school from wider areas. The third feature of attendance areas constructed required to reduce the troublesome commutes of female students is that with the exception of residential areas on the outskirts of town, the majority are small in size to allow for shortest journeys possible. To ensure that attendance areas apply to all parents attending PFJH schools equally without exception the fourth necessary feature of attendance areas is that they be contiguous, with no gaps or spaces between. The final feature towards this end is that all areas are enclosed and jointed (Figures 4-1 and 4-2). Below, is a description of the boundaries in more detail.

4.2.1.1 Residential-based Attendance Areas

As reflected by the policy of the two most popular schools of Aban and Anvar, the primary interest of some schools is enrolment of students with the most connections or the highest family incomes possible. The atmosphere of favouritism and individual interpretation of parental criteria has resulted in large numbers of parents sending their children on hazardous rides to schools despite the existence of a closer one nearby. This research intended to create attendance areas that allow shorter travel within the local area in order to both guide parental choice and reflect the need to make commutes safer and more convenient for the children.

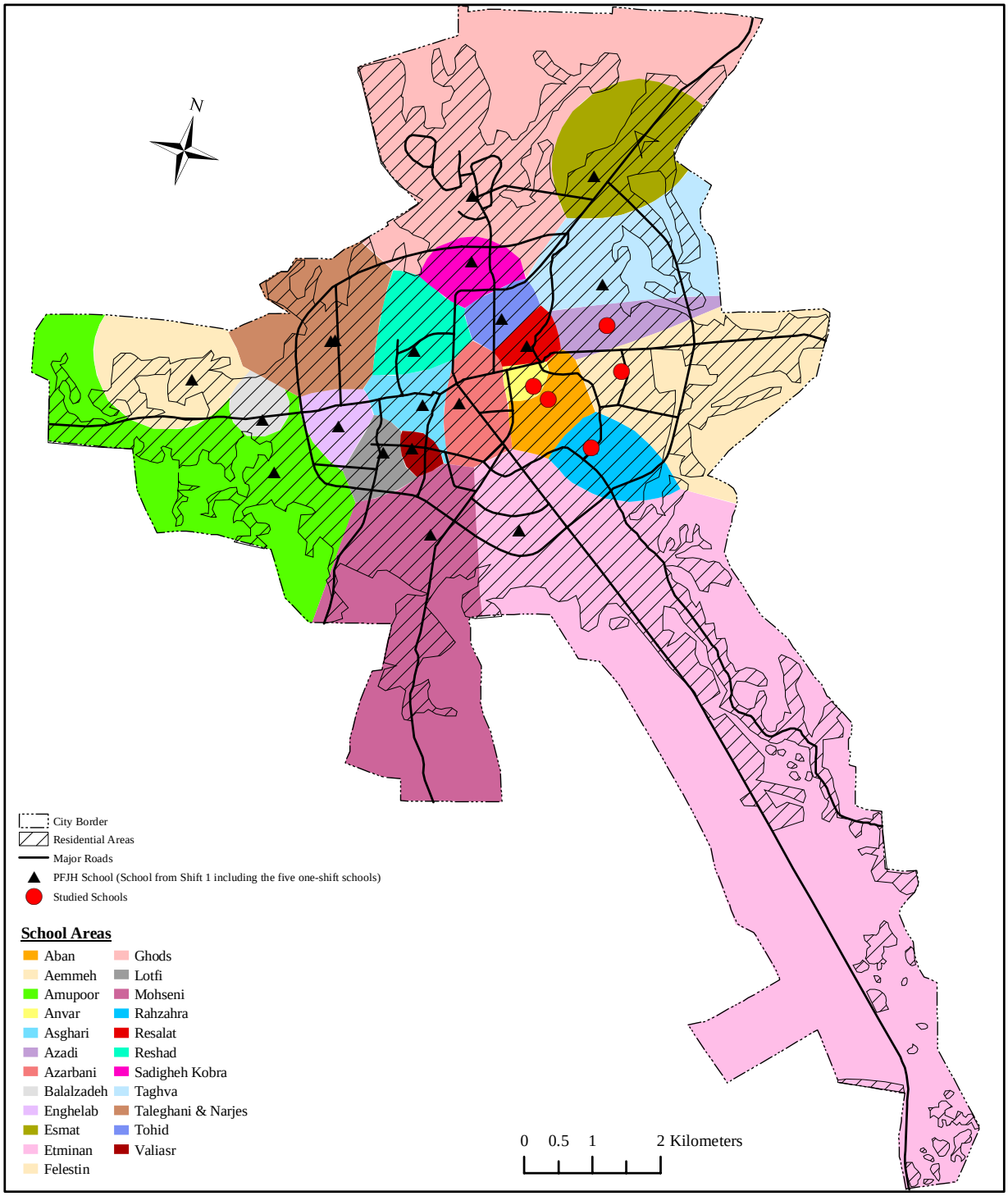


Figure 4-1 MWVD-based attendance areas for Shift 1 Rasht PFJH schools showing studied school locations and city residential areas.

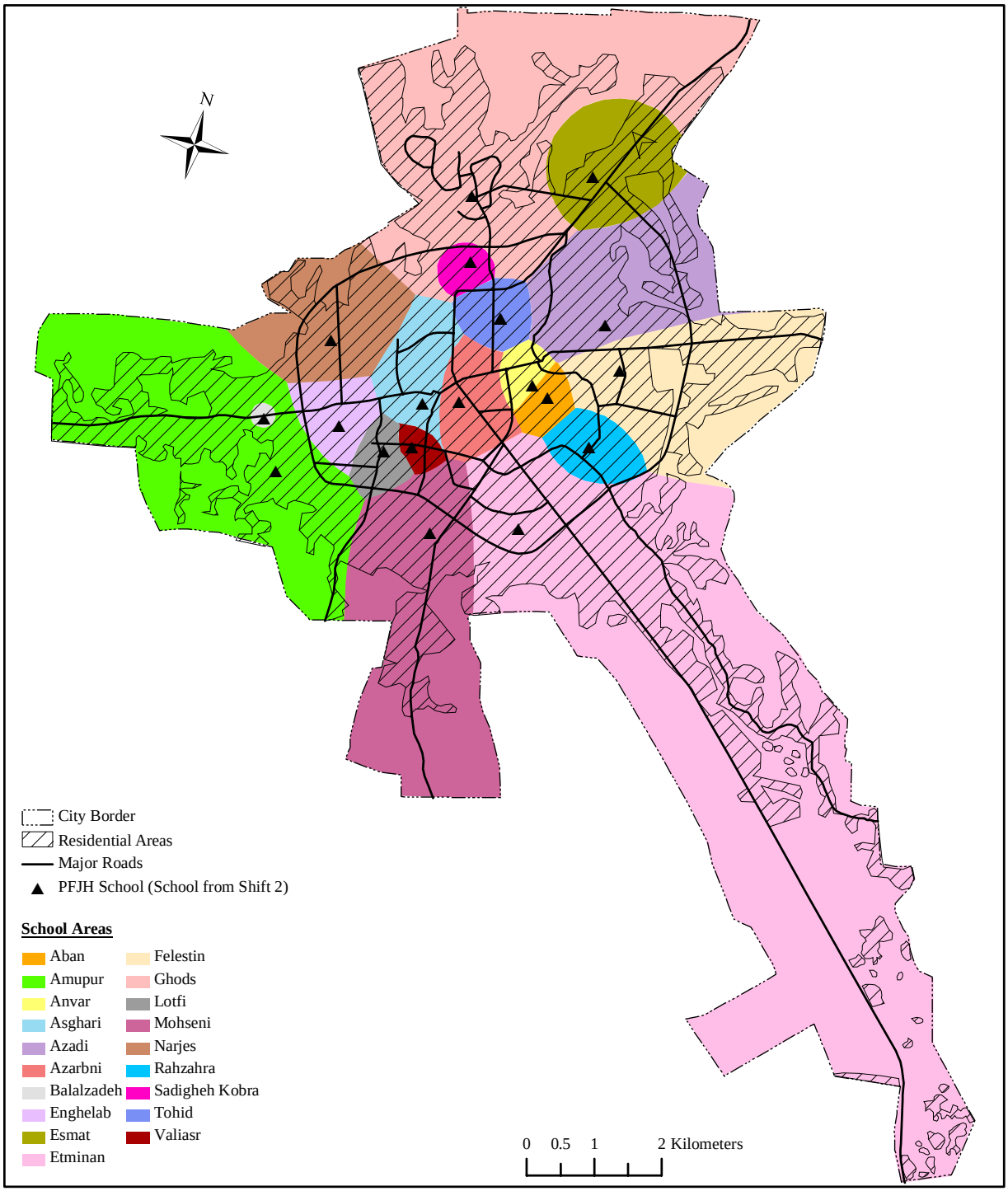


Figure 4-2 MWVD-based attendance areas for Shift 2 Rasht PFJH schools showing city residential areas.

To eliminate widely divergent outcomes in school access based on subjective policies of favouritism at schools or individual parental resources like family cars, the research aim was to create school attendances areas that provide equal access for all students. Thus instead of random parental choices, the defining factor for assignment to PFJH schools within attendance areas will be student's residence. Within the MWVD-based constructed, all families regardless of income or social class status will have equal access to their local schools based on where they live. The defining characteristic of attendance areas is also that parents only be allowed to enrol their children at one central school, instead further ones. So that attendance areas meet the needs of every child attending the female junior high schools that are the topic of this research, other factors were also to be taken into account in of construction enrolment areas to service the specific characteristics of the education system. What follows is a brief discussion of the second central feature of MWVD-based enrolment areas; school-shift based attendance areas.

4.2.1.2 School-shift based Attendance Areas

This section outlines the necessity of separate maps to depict of attendance areas for each shift of PFJH schools in Rasht. In order to take into account the change in school sizes and number for each time slot, school attendance areas were constructed for both of the morning shifts of the PFJH schools. As mentioned in the section detailing the characteristics of the Iranian education system, most PFJH schools share the same educational buildings to maximize scant educational resources. As the size of the school population and the number school educators varies for morning and afternoon shifts, so do the students that schools accommodate for each shift.

Another feature of the two shift structure given that some schools close in the morning or afternoon is that it changes the number of schools available in each shift. The number of educational buildings in Iran is different for each shift. The PFJH schools of Rasht are no exception. There are 26 educational buildings for the public female junior high students of Rasht. Two special educational buildings (Fajr and Shahed) have been excluded from this research since they lack the open access of public schools with each reserved for either children of parents slain in the Iran-Iraq war or school staff family members. Of the remaining 24 educational buildings, five offer classes for only for the morning shift. The rest are open for use in two school shifts. Hence, although there area 24 schools in morning shift, only 19 schools are open for use in the afternoon (see Tables 1-1 and 1-2). After a discussion on the different number of schools in each shift, the next issue is the nature of MWVD-based attendance areas constructed for each school shift.

Given that the number of schools, school size and distance between them differ for each

school, the constructed areas differ for each shift in size and shape. The difference in the Azadi morning and afternoon schools are a good illustration of how shift can impact the attendances area size. A look at Figures 4.1 and 4.2 for example shows how the attendance area for the Azadi 1 School is larger than the Azadi 2 School. In the absence of close schools to bind its borders, the enrolment area for the Azadi 2 School becomes much more expansive and comes to share its boundaries with more distant PFJH schools like Esmat 2, Anvar 2, Tohid 2 and Ghods 2. Hence, though Azadi 1 shares boundaries with the close neighbouring morning shift schools of Taghva and Resalat, these schools disappear in the afternoon naturally widening the polygon for Azadi 2.

Another reason for the increased size of the attendance areas relates to the school size consideration. There are fewer schools available for students in Azadi's residential area in Shift 2 (afternoon shift). As such it must accommodate a larger capacity of pupils, with 20 more students attending in the afternoon. In keeping with its ability to host higher numbers, the larger attendance area of Azadi 2 allows it to enrol students a wider area than the smaller sized Azadi 1. The lack of more than one shift offered by Ammeh and Resalat effect the attendance area sizes of other Shift 1 and 2 PFJH schools as well. The enrolment areas for the Amupur and Tohid schools, for example, are also larger given the unavailability of Ammeh and Resalat in the afternoon.

One common designated school for each shift can also aid in eliminating as much as possible the excessive commutes students currently take. Though attendance areas allow closest possible commute parents still have the option of choosing of which shift they would like to attend. The construction of attendance areas that takes into consideration the two-shift structure of Iranian schools can help both parents and educators to identify which designated schools are open for enrolment. In addition to the integration of residence locations, eliminating of any element of parental choice in delimiting boundaries for the schools in question also requires specific attention to the nature of constructed boundaries that will form attendance areas. The next section will discuss this important feature of attendance areas in more detail.

4.2.1.3 Contiguous Borders: No Unallocated Parts of the City

As stated throughout this research, reducing the length of the current hazardous commutes by as much as possible can be achieved by replacing the arbitrary parental choice based system with the viable alternative utilized in developed countries; expansive attendance areas. In constructing attendance areas for the entire city of Rasht the relevant concern that comes to mind is; will the boundaries have some gaps between them or will they be continuous without spaces? Eliminating the difficulties (i.e. dangerous commutes) inherent in the parental-

based selection requires the construction of attendance areas that leave no part of the city uncovered.

Attendance areas without gaps can also ensure the equal access so central to all can benefiting from constructed attendance areas across the board. An important aspect of eliminating the current complex parental choice and the exhausting commutes that result then is ensuring that parents in any location know which schools have been designated as the local ones their children must attend. If the boundaries do not assign every residential area a local school, parents not covered may once again opt for the choice of the furthest schools outside local areas, putting children at risk with highly inconvenient vehicles or lengthy foot commutes. This translates into the necessity of avoiding delimitation methods that potentially leave gaps or empty sets on either school shift map.

As seen on both school shift maps, the constructed polygons also leave no gaps between them. Utilizing the method of MWVDs thus results in attendance areas that cover every portion of Rasht City without any unallocated parts left to chance. Hence, all locations within the city are allocated to a local PFJH school and parents living in any location within the city can be guided to the nearest schools for their children's enrolment. In addition to continuous borders specific attention was also given to the current size of schools and the number of students it can educate.

4.2.1.4 School-size based Attendance Areas

As larger schools are able to enrol and educate more numbers of students, larger attendance areas are in order to draw an increased number of students to them. Conversely, it is equally sound for schools with smaller populations to have smaller attendance areas to avoid being overwhelmed with more students than its educational resources and teaching numbers can handle. In order to construct enrolment areas that fit with the current flow of students to schools, this research also focused on the impact of school size in terms of school population. Since each school has resources to accommodate differing student populations it is crucial that when enrolment areas are drawn, each PFJH has the space and facilities available for students from assigned residential areas. In this way, enrolment areas linked to "school sizes" can allow for optimum use by the female junior high students of Rasht.

When dividing the schools of the city between the residential areas to create localized attendance areas, another critical consideration is in how the distance will be divided between two schools. Hence, the crucial question that arises in constructing boundaries around a school to make it the central one for the area is; how the distance will be divided between schools for boundaries that are smaller or larger?

In the case where the schools can accommodate the same number of students dividing the

distance between two schools involves a straight-forward approach; simply divide the distance equally. Partition areas around two schools with the same size cuts areas into two equidistant halves. Creating borders between two schools that have different capacities for students, however requires a different approach.

As mentioned before differing student populations require the flexibility of differing attendance areas to match the diversity of schools in the city. Instead of borders based on the equidistant partition of space among schools, divisions of space based on the more complex nuanced approach of Weighted Voronoi can incorporate the variety of school sizes in Rasht. Based on this approach, partition of borders among schools that is twice the size of the other means that the border is moved twice to three times the distance outward, reducing the distance allocated the smaller school by a up to a third. With school size as the weighted factor dividing the distance between two schools can more accurately mirror the reality of diverse student populations.

The utility of MW-Voronoi in delineating different sized attendance areas is even clearer once applied to specific PFJH schools. Dividing the distances between the Etminan 1 and Rahzahra 1 schools to form attendance area borders is a good illustration. As Etminan is the larger school with 174 more students than Rahzahra the MWVD calculus is that Etminan also is allocated a larger portion of the partition (see Figure 4-1).

In line with this weighted distance approach, the division of space between schools with similar sizes is by equal partition. Thus, the border dividing two schools with roughly equal student populations warrants cutting the distance between them in half. The border dividing the Azarbani 2 and Asghari 2 schools are a case in point. Since the two schools have nearly the same number of students (Azarbani 2 with 357 and Asghari 2 with 403), the distance between the partition that divides them within the MWVD-based attendance areas is also roughly equal.

To reflect the variation in school capacities in Rasht, attendance areas were constructed based on the varied approach of weighted distance. This structure will not only guides parents to schools closer to homes but will also ensure these local educational institutions have the resources and capacity to meet the educational needs of each child. To achieve this, the school sizes were then considered as the weights for demarcation of the boundaries among PFJH schools of Rasht for each shift. The next section will focus on the size of the polygons that form the boundaries of attendance areas. Clarifying the differing sizes of the constructed boundaries can further illuminate how the attendance areas contribute to the goal of reducing hazardous commutes.

4.2.1.5 Small Attendance Areas for the Majority of Schools

As stated in Chapter Two, the function of the MWVD is for dividing an area into polygons or regions so that all locations enclosed within a single polygon are closest to a designated point. This represents an ideal approach for the goal of reducing highly inconvenient and hazard-laden travel to schools that plague students at PFJH schools. With PFJH schools as the designated points, MWVD can be utilized to divide the city into polygons that will serve as the attendance areas in which journeys for every student within the area will be the shortest possible commute. The major advantaged observable after the construction of MWVD based attendance areas for the research had to do with the size of most of the polygons yielded.

Given the tendency of MWVD to produce smaller polygons for points bunched together, the current distribution of a high number of PFJH schools also clustered around the city centre is a perfect match for the creation of optimum attendance areas. When points of roughly similar weights are clustered around the centre, one feature of the MWVD is that such polygons become reduced in size in relation to other polygons on the periphery. A natural outcome of higher densities of people in the central area of Rasht is that there are a greater number of schools within fairly close proximity. Thus, the geographic location of schools fits nicely with the features of MWVD when points are clustered together since it serves the purpose of creating as many small sized attendance areas as possible for reduced commutes.

As mentioned, there are 43 PFJH schools (minus the two excluded schools) in Rasht for both morning and afternoon shifts. Of this total, 25 PFJH schools, or more than half, are the "inward-city" variety clustered around the city's central point, with the rest located at different points on the outskirts of town. Given the fact that these schools are similar in terms of the weighted factor of school size (most with student populations within the 200 to 300 range), the enclosed polygons constructed to form the basis of projected attendance areas are also smaller in size than their "outward-city" counterparts. Hence more than half of the attendance areas yielded by the MWVD-based approach will be smaller, allowing the majority of students assigned to PFJH schools to take shorter and less arduous commutes.

The significant positive impact of small attendance areas constructed on journeys to school is even clearer once we observe the sheer number of students affected and the specific reduction in travel distances to the five studied schools. As mentioned, fully 25 of the PFJH schools are located "inward" and have reduced-sized attendance areas characteristic of their location near the city centre. In terms of student numbers this means that 6,718 students over two shifts will have reduced commutes.

With small-sized MWVD attendance areas commutes on feet are also drastically diminished. As Table 4-1 shows a maximum of a 1.7 kilometres projected walking distance to all inward-city PFJH schools in Rasht, with commutes as low 0.2 kilometres for some. The number

Table 4-1 Maximum commuting distance within MWVD-based attendance areas for both shifts of PFJH schools*.

School location	Shift 1			Shift 2		
	School name	**Number of students in 2003-2004 school year**	**Maximum distance**	**School name**	**Number of students in 2003-2004 school year**	**Maximum distance**
Inward-city schools	Anvar **1**	236	0.6	Balalzadeh **2**	125	0.2
	Enghelab **1**	286	0.7	Aban **2**	210	0.4
	Valiasr **1**	207	0.8	Anvar **2**	206	0.6
	Resalat	211	0.8	Sadigheh Kobra **2**	169	0.5
	Sadigheh Kobra **1**	243	0.8	Valiasr **2**	238	0.5
	Tohid **1**	201	0.9	Tohid **2**	189	0.7
	Balalzadeh **1**	203	0.9	Lotfi **2**	327	0.7
	Lotfi **1**	297	1.0	Rahzahra **2**	211	1.0
	Asghari1**1**	400	1.0	Azarbani **2**	357	1.0
	Azarbani **1**	363	1.1	Enghelab **2**	407	1.0
	Aban **1**	326	1.2	Asghari **2**	403	1.7
	Reshad	326	1.5			
	Rahzahra **1**	249	1.7			
	Azadi **1**	328	1.7			
Outward-city schools	Aemmeh	211	1.4	Esmat **2**	206	1.4
	Taleghani	247	1.9	Narjes **2**	386	1.6
	Narjes **1**	363	1.9	Azadi **2**	348	2.2
	Esmat **1**	219	2.3	Mohseni **2**	423	2.7
	Taghva	332	2.5	Felestin **2**	336	2.9
	Mohseni **1**	433	3.2	Amupur **2**	552	3.8
	Felestin **1**	336	3.5	Ghods **2**	442	4.3
	Ghods **1**	420	3.6	Etminan **2**	433	11.6
	Amupur **1**	451	4.5			
	Etminan **1**	423	14.3			

* Maximum distance has been calculated from school location to farthest residential location in a straight line.

Source: Map of MWVD-based proposed school attendance areas

of students that can travel this reduced distance is even greater if we add to those residing in "outward-city" schools who will also benefit from a shorten commute within attendance areas. Within the MWVD attendance areas 803 students travelling to the outward-city PFJH schools of Aemmeh, Esmat 2 and Narjes 2 will also have lessened projected commutes of 1.4, 1.4, and 1.6 kilometres, respectively. In other words, for a majority of students, travel within the delimited areas would mean being no more than a 1.7 kilometre walk from their homes. This can reduce exposure to the highly stressful and potentially perilous commutes meeting parental concerns on safety.

For some schools on the city periphery (termed "outward-city schools" for ease of reference), however, the MWVD approach results in relatively larger attendance areas with the outer edge of their boundaries incorporating the city border. Since eliminating the highly inconvenient public and private vehicle commutes was the major aim, travel planning is imperative for those continuing to make considerable journeys to the outward city schools on the edge of town. Instead of requiring these students to continue hazardous commutes with public means of transportation, the research suggests replacing them with the safer alternative that is often made available in developing countries; free school buses. Once funding is secured for such buses the next necessity in providing a safe and convenient commute is travel planning on the nuts and bolts logistics such as the safest pick up and drop of areas, the fastest travel routes, and the most convenient pick up times.

After a review of the general features of the constructed areas, it was also necessary to find out how much travel time and distances would be reduced if students are allocated to more local schools within them. To answer this question the research analyzed the five studied schools in more detail.

4.3 Spatial Assignment of Students throughout the Constructed School Attendance Areas in the Studied Schools

In order to evaluate the extent to which the drawn MWVD-based attendance areas will result in shortened commuting times and distances for female students at PFJH schools in Rasht, the next important phase in the discussion is an analysis of how current commutes under the parental-based school selection system compared with commutes within projected attendance areas based on the MWVD approach at the five studied schools. As highlighted in the section above, the MWVD based attendance areas are designed so that journeys from any student location to the designated school will be the shortest possible one. With this in mind, one measure of how highly inconvenient current commutes are for students due to the parental

choice system is to see how many students attending the five sampled school travel from outside the localized areas generated by MWVD based attendance areas.

The current spatial distribution of students to the five studied schools within and around the constructed attendance areas provides a clear illustration of how school populations are intermixed with students from outside local areas requiring longer commutes. The result is a large volume of students attending the sampled schools from different areas which are outside the designated local area ones designed to allow for the most convenient commutes (Figure 4-3). The number of students attending the most reputable of the five sampled schools is a case in point. As the map shows a sizable number commuting to Aban, an inward-city school, includes students whose homes are located in a neighbouring attendance area where the Etminan School would in fact have been the closest commute. The high occurrence of students travelling to schools further from their homes is even clearer when we take a closer look at the number of attendance areas from which students attend Aban and the other four sampled schools. Analysis of questionnaires responses revealed that students who attend the more reputable schools of Aban and Anvar, for example, travel anywhere from eight to up to eleven different neighbouring attendance areas. This phenomenon is equally pronounced for the remaining three PFJH schools of Azadi, Felestin, and Rahzahra. Despite less appeal relative to the two most popular ones, these schools also continue to draw students from a high number of adjacent or outside attendance areas. Following the construction of polygons to represent attendances areas, analysis concluded that students from between four to six different attendance areas travel away from the local designated schools to attend the aforementioned ones, adding to the phenomenon of high enrolment further than necessary.

The research shows that students attend the studied schools from a number of adjacent attendance areas. One question that follows is whether or not this has actually changed the residential composition of student populations at schools. Do a high percentage of female students from these outside areas intermix with the local resident students at the sampled schools? The answer is a resounding “yes,” particularly at the two most sought after inward-city schools of Anvar and Aban. Currently a whopping 84% of the students at Anvar, and another 82% at Aban are students from adjoining attendance areas. Investigation of the residential distribution of students attending other studied schools is equally significant. The research concluded that 65% of an overwhelming majority of students enrolled at the remaining sampled schools are in fact from other attendance areas (Figure 4-4). The school with the least percentage of students enrolled from outside area was Felestin, a natural outcome of the fact that this outward-city school has the largest defined attendance areas of the sampled schools making it a considerable journey for the majority of residents.

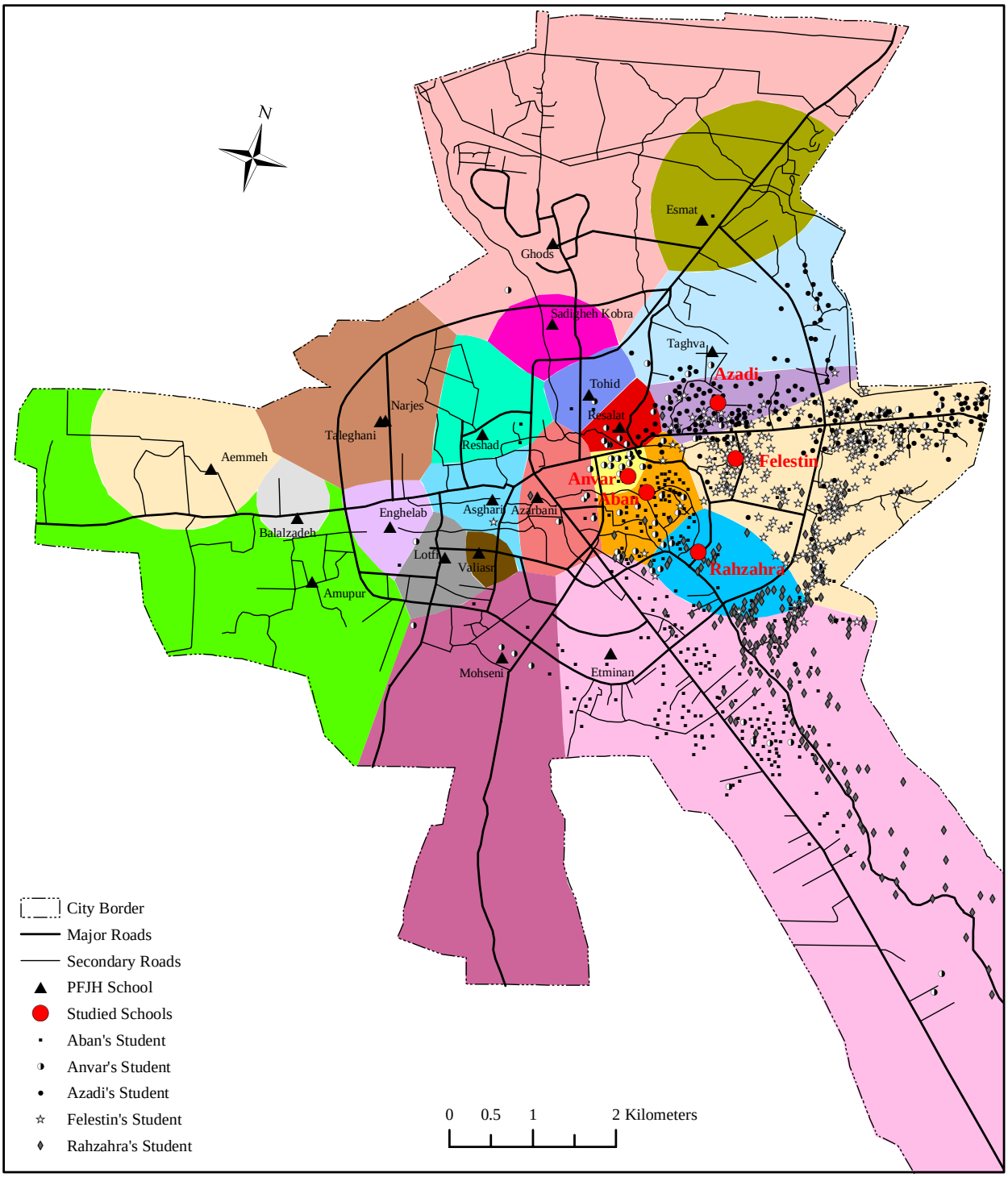


Figure 4-3 An overlay of MWVD-based school attendance areas over the current residential distribution of students attending the five studied PFJH schools in Rasht.

Source: Questionnaire data collected in September 2004

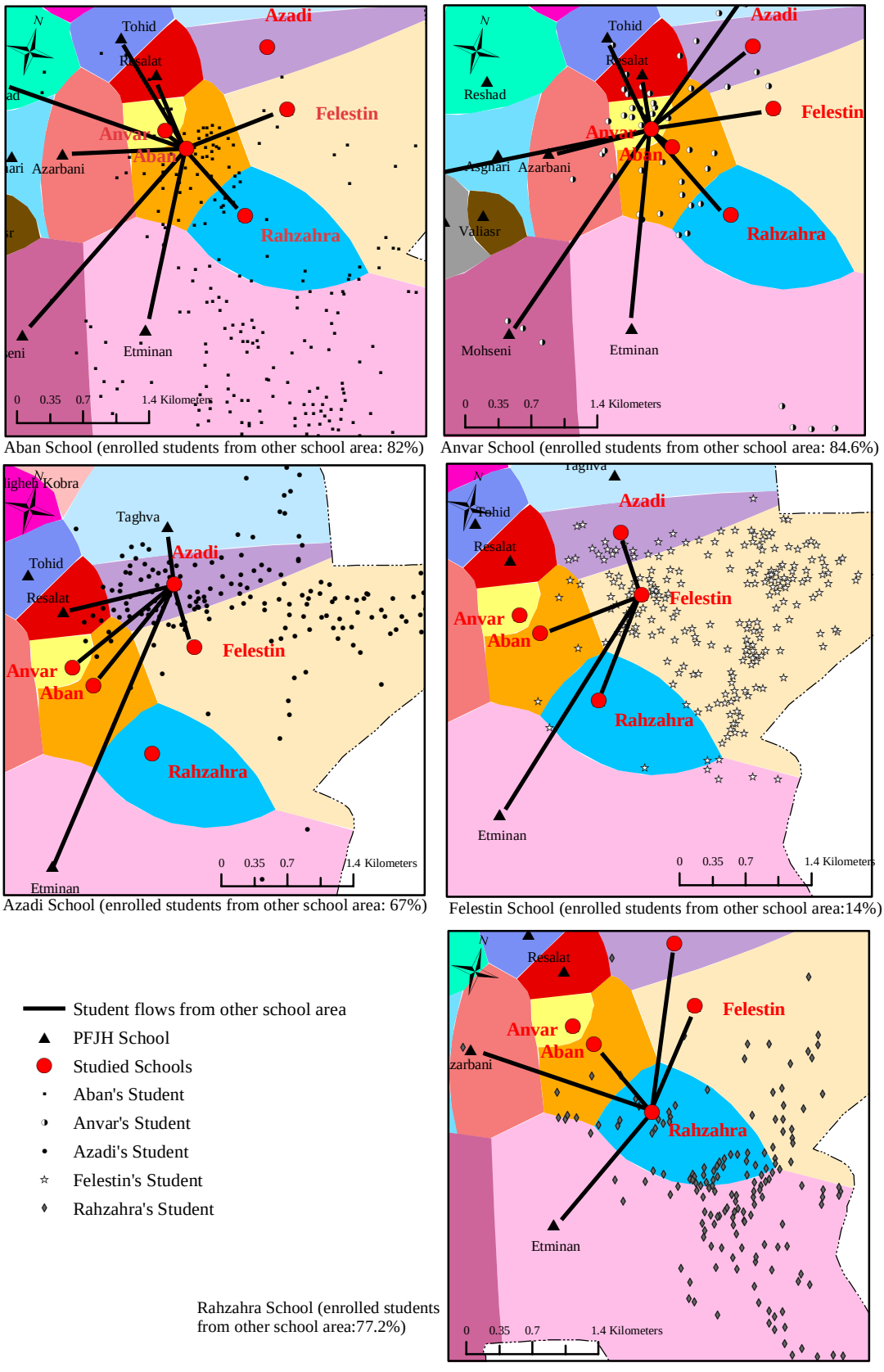


Figure 4-4 Spatial flows of students attending studied schools from other MWVD-based school areas.

Source: Questionnaire data collected in September 2004

By allocating all female students travelling to PFJH to designated schools within attendance areas the aim of this research was to allow students to travel the shortest distance possible for commutes on foot and if possible avoid the inconvenient and often hazardous public and private taxis and buses altogether. Guiding parental choices to the closest and safest schools, most convenient commutes to designated schools should reduce the current journey burden for the majority of students. The next section will demonstrate how this is so after the construction of MWVD-attendance areas by providing a breakdown of the drastic reductions in the time and distances of both vehicle and foot commutes that result.

4.4 Minimizing the Student Travel Time and Distance through the Constructed Attendance Areas

Since the MWVD-based attendance areas allow the shortest journeys to each school within its region, enrolment in a school within the constructed areas should result reductions of the "longer than necessary commutes" referred to in this research to denote the burdensome commutes that exceed what would otherwise be required if an attendance area system were in place. If parents enrol their children at the closest schools allocated to each residential area by the MWVD method the questions that remains is the specific amount of the reduction. In other words; to what extent will commutes shortened by constructed areas translate into a significant change in the current risk-laden parental choice based system? In order to answer this question, a discussion of the current commuting times and distances by the various forms of transportation mentioned in previous sections is needed. Then, following a breakdown of the projected commuting times and distances yielded by travel within MWVD-based areas, a comparative analysis of the current commutes will be given. The conclusion reached is that attendance areas can offer major reductions in the highly inconvenient journey times and distances to the sampled schools.

In order to develop a comprehensive picture of walking commutes to PFJH schools in Rasht under the parental based system of selecting schools, the research measured not only the average walking distance from student's homes but also the time it takes to travel such distances. The daily journey on foot from home can be as low as 1.4 km for students travelling to the Aban PFJH School and reach as high as 2 km for those walking to the schools of Azadi or Felestin.

Given such variances it was also useful to measure the average distance for commutes on foot to the five PFJH schools. Students currently go an average distance of 1.7 kilometres on foot from their homes. In addition to the length of walking commutes measured in kilometres, the research also focused on the time in minutes. Like the distance measurement of commutes on

foot, times also vary ranging anywhere from an average of 13.1 minutes for the Aban School to full 15.7 minutes for Azadi, the highest commuting time.

Typically one would expect walking times to increase in direct proportion to the distance travelled. In other words, the further the commute, the higher the commuting time (Table 4-2). Schools that are close to exact distances from student's homes would yield near equivalent commuting times. One unique aspect of commutes on foot in Rasht was that there was no causal relationship between the walking distances recorded and walking times. The research found no such correlations for the walking commutes to the five PFJH schools in Rasht.

The Aban and Rahzahra commuting times are a clear illustration of how the walking distance was unrelated to the time it took to walk to schools. Although Aban and Rahzahra are schools with roughly equivalent average travel distances, differing by only a tenth of a kilometre, commuting times were widely divergent. Aban students walk an average of 13.1 minutes, while Rahzhra's students walk the same distance in 15.7, representing a 2.6 minute difference in the journey time. In some cases, a shorter walking time still means a timelier commute. Though the students of the Rahzahra School walk an average distance that is shorter than Azadi's commute, it still takes them 2.3 minutes longer.

Since walking times are not related to the distances travelled, other factors must be at work to cause such variances. Research into walking commutes discovered that instead of the correlations with distances, commuting times in Rasht are strongly related to road conditions that students have to traverse for daily journeys.

The condition and environment of roads that students have to walk on daily can have a major impact on the travel time for foot commutes. This is especially true given the often congested roads of Rasht. Intersections and accompanying traffic lights are a good example of how specific road conditions can influence how long it takes to walk a given distance. More intersections, for instance, can also mean more waiting times at intersections, adding to the overall commute time. In addition to this factor, road development is another relevant feature in the case of Iran and other countries in the developing world. As mentioned in the section detailing commuting dangers, one of the serious construction deficiencies peculiar to Iranian roads is the persistent lack of sidewalks to shelter pedestrians from traffic dangers. Without the safety of sidewalks in underdeveloped areas many students have to proceed slowly and exercise more caution as they take their chances with increased exposure to fast moving traffic.

Daily female student walks to Rahzahra is a case of point. Given the fact that this school is the least developed area of the sampled school there are higher incidence of crime and the street harassment alluded to above. Travel in streets inches from the traffic adds to the danger slowing down commutes even more. The more popular school of Aban, by contrast has few such

Table 4-2 Average current travel times and distances and estimated maximum MWVD-based travel times and distances to the studied schools.

Travel time (min) / distance (km)		Studied schools					Average
		Aban	**Anvar**	**Azadi**	**Felestin**	**Rahzahra**	
Current average travel:							
On foot	Time	13.1	13.2	13.4	14.8	15.7	14.0
	Distance	1.4	1.7	2.0	1.9	1.5	1.7
By vehicle	Time	21.3	26.6	21.5	20.5	16.5	21.2
	Distance	4.7	2.7	2.7	2.8	3.7	3.3
Estimated maximum travel within the MWVD-based constructed attendance areas:							
On foot	Time*	11.2	4.6	11.4	27.2	17.7	14.4
	Distance	1.2	0.6	1.7	3.5	1.7	1.7

* Estimated maximum travel time on foot to school calculated by the equation of MTt=(MTd.Tt)/Td where MTd=Estimated maximum travel distance to schools Tt=Current average travel time on foot and Td=Current average travel distance on foot.

Source: Questionnaire data collected in September 2004 and MWVD-based proposed school attendance areas

hazards allowing students to travel the same distance in a shorter time. The underdevelopment of roads can slow down the walking commute for other reasons as well.

In the case of the crime prone areas that surround PFJH schools like Rahzahra, quiet, unsupervised roads have the potential for being congregation points for harassers and street boys mentioned in previous sections. The intertwining grid of dark alley ways and deserted side streets are a good illustration of how commutes can be affected. To circumvent the dark alley dangers, parents often choose the relative safety of comfort in numbers, asking their children to be accompanied by a classmate or friend in the neighbourhood. This has the effect further lengthening the time of commutes since waiting for unpunctual friends, or simply talking while walking can add minutes to the commute. One final justification for the lack of any correlation between distance and time in commutes can also be linked to road development; the persistence of muddy and pot-hole ridden suburban streets. Like other elements of the environment, such poor road conditions can form obstacles that make commutes longer than they would have otherwise been.

Although walking is the preferred means for a significant number of students the rest, representing the vast majority or 60%, travel to PFJH schools by other means. Parents of female students turn to vehicle commutes in far greater numbers as the more viable choice to journeys on foot. Since very few have the privilege of riding in the safety of their parent's cars, it's also been pointed out that these commutes are predominantly by public and private vehicles that entail major hazards and high inconvenience. To understand the choice of vehicles for commutes even when walking might have been possible it might be first be helpful to understand the growing dependence on cars in the case of Rasht.

Although the term "vehicle commute" might typically prompt images of more distant travel from the outskirts of town, most vehicle journeys to the five sample school are from locations that are relatively close. The average travel distance for motorized vehicles, an overwhelming majority of which are commutes on buses and taxis, is no more than a 3.3 kilometre journey. When compared to the length of commutes on foot, current journeys by car are only twice the average distance that most students walk to the studied schools (1.7 km). A look at individual PFJH schools reveals that average commutes dip even lower. The average travel distance when utilizing vehicle to Felestin is a 2.8 km trip for student. It is a slightly lower journey of 2.7 km for students of Azadi and Anvar. Taken as a whole, the average travel distance for these three schools is, of course, even less than two times the average walking distance. Although such distances exceed the current average walking commutes of 1.7 km, clearly these schools are not completely out of range of students homes on foot. Though it would entail some more effort, clearly walking would not be impossible in such cases. Why then, are students

living relatively close to current average walking distance not going on foot?

Data from questionnaires showed that like in developed countries parents in Rasht also turn to vehicles commutes whenever walks to school would be outside of the relative protection of the local neighbourhood. The trend recorded which supports this finding is the fact that commutes were mostly over short distances reflecting the immediate parental preference for vehicles once the distance from homes were over the 1.7 km range, as discussed above. Despite the fact that walks to school might still have been possible parental fears about the dangers inherent in longer walks precluded most from allowing their children to go such distances on foot, choosing commutes by rented vehicles to schools instead. This makes sense within the context of the numerous environmental dangers that children on foot have to contend with. Walking further distances, after all, would not only entail increased exposure to heavy rains in the winter but also a higher possibility of being hit by cars during heavy traffic or falling victim to sexual and verbal harassment prevalent in Rasht's streets. As a consequence, preferring not to take any chances with the safety of their children most parents living beyond the distance 1.7 km opt for rented vehicles for commutes instead. As outlined in the preceding sections, the choice of commutes by rented taxis and buses is equally inconvenient and perilous for female students.

It is also worth mentioning that like walking commutes, the time it takes to travel by a motorized commute is also unrelated to the distance of the journey. In analyzing the travel time on vehicles commutes, for instance, the research concluded that in travelling by vehicle to schools some travel the same distances in less time. A look at journeys to Azadi and Anvar is instructive. While students of both schools travel the exact same distance by car or buses to get to school, the travel time is around five minutes shorter (5.1 minutes) in the case of the commute to Azadi. Conversely, another phenomenon observed is that the travel time by vehicle is at times longer over shorter distances. Anvar and Aban are good examples. Though the journey to Anvar is much closer to home for most students with the ride to Aban being further away, the actual commute time to Anvar is on average 5.3 minutes longer. As in the case of walking commutes, given that the amount of time it takes to get to the PFJH schools by vehicles is not a function of distance this factor must be linked to outside factors as well.

As mentioned before, in motorized travel to the sample PFJH schools students ride in a variety of vehicles which include everything from the taxis of the formal and informal sectors to mini-buses. In the case of commutes to schools, variances in travel time therefore hinge on the kind of vehicle utilized by students.

Given that each mode of transportation operates differently with varying degrees of convenience for its customers, the outcome is that resulting travel times are also not uniform. A comparison of two private rental vehicle services offers ample evidence. As cited in the section

on modes of travel, mini-buses are often filled to capacity with up to 30 students requiring numerous stops during pick ups. The journey is slowed even further since the drivers of these rentals buses, secure in the notion that they have yearly contracts and guaranteed income for the year, are chronically less punctual. This might help to explain how students attending the Anvar School take a full 26.6 minutes to travel less than a 3 km ride. As this pricier mode of travel offers prompter pick ups at the door and the convenience of being the sole passenger for the duration of the ride travel, telephone taxis naturally offer much faster commute times than shared mini-buses.

The goal of this research was to eliminate vehicle commutes altogether where possible along with reducing walks in less than safe social environments. The next phase of the discussion is a comparison of current commuting within a parental-choice system with projected commutes within WMVD-based attendance areas to see if inconveniences were reduced.

A comparison of current and estimated commute times within the MWVD attendance area shows that the overall time and distance of commutes would decrease dramatically under a delimited attendance area system completely eliminating the need for vehicle travel of the four inward city schools chosen for study. Currently students attending the five studied schools of Aban, Anvar, Azadi and Rahzahra travel on foot or by vehicle. Table 4.2 shows the estimated travel time and distances for these schools would be dramatically reduced to much less than the current ones.

The reduction of the walking commute is further evidenced by the fact that within constructed attendance areas for the sample schools the absolute maximum distances that most students would have to travel on foot on average would not exceed what is now the *average* walking commute for students. The maximum travel time and distances within the MWVD-based constructed areas for each school are also shown in Table 4-2. When compared to current walking commutes they obviously represents a drastic reduction allowing journeys to PFJH schools that are not only well below what is required now but also closer to homes and thus safer. It is also worth pointing out that since a majority of students will be able to travel within a 1.7 kilometre average journey on foot within MWVD based attendance areas without buses or taxis, estimated times and distances for vehicle travel were also unnecessary and thus omitted from the figures.

Given the goal reducing the current reliance on vehicle commutes, the length of the projected maximum commute within the constructed areas is a promising step towards increased convenience for students. Recall that due to concern for their children parents turned to vehicle commutes out of necessity whenever walking commutes would exceed a walk of 1.7 kilometres beyond the relative protection of the local neighbourhood. With commutes limited to a

maximum of 1.7 kilometres within the constructed areas it's possible to allay the "stranger danger" fears about safety that drive the current choice of highly inconvenient and potentially life-threatening vehicle commutes.

A closer look at the reduction of the commute compare to the current one under the parental choice based system at particular schools in detail offers an even clearer illustration of how advantageous an attendance area system would be for students. The case of the Anvar School is particularly instructive for comparison purposes since the students there on average journey distances and times on foot equivalent to what would be the absolute maximum commuting length within an attendance area system. Currently, students at the popular Anvar School walk an average of 1.7 km from home to school in 13.2 minutes. Within the WMVD based attendance areas the longest commute to school on foot would be no more than a 0.6 km journey for 4.6 minutes, a more than ten minute reduction in the current time. For students attending Anvar, a change from the random parental choice focused system to a uniform delimitation one would be equally advantageous. Under constructed attendance areas, students attending Aban Schools would not require walks more than 1.2 km, a walking commute length that is also under the projected maximum.

Another useful indication of how the constructed areas can contribute to making commutes safer and more convenient is how few students would still be required to travel beyond 1.7 kilometres and the relative security of local neighbourhoods. The number of students that can travel the projected maximum commuting distance is highly significant. As discussed, an analysis of questionnaire responses on commutes revealed that current average walking commute for students is 1.7 kilometres. In understanding parental feelings about current walks to school and find the optimum distance student can travel on foot this distance is important since; first, it shows that currently students are able to manage the length of this journey on foot with few problems and second, it allows close enough proximity to home to alleviate parental concern the danger of the environment.

When the walking journey exceeds this distance, parents predictably prefer to utilize the quick travel afforded by vehicle travel to circumvent increased exposure to the risks of longer walks (i.e. getting hit by cars in heavy street traffic or high crime areas). Thus, when the number who currently travel more than 1.7 kilometres in highly inconvenient vehicles is reduced the expected benefits are twofold; not only will students be able to walk shorter distance but they can also bypass any use of highly inconvenient travel in vehicles.

A comparative analysis of current commutes and of commutes within the delimited attendance areas lends clear support to the conclusion that an overwhelming majority of students will be able to make more convenient commutes on foot shorter distances. The estimated

commuting distances within the attendance areas shows that students travelling to the vast majority of schools in the study area will in fact be able to travel under the current walking commute distance. As shown in Figure 4-5, with the exception of the Felestin School, the percent of students who would have travel more than 1.7 kilometres within the delimited boundaries to PFJH schools drops to zero. All travel within the polygon areas for the closely clustered inward-city schools, after all, would be no more than 1.7 km.

Where large percentages of students travel more than the current average commute of 1.7 km at such schools, none would have to do so within MWVD-based attendance areas. This sizable drop in travel was especially significant in the case of the schools like Aban where a large number (62.4%) of students currently have to travel the average walking distance or more to get to school. The fact that a large number of students will be able to take commutes less than 1.7 km within MWVD-based attendance areas is highly relevant to achieving the outcome of increased student safety.

As touched upon in the literature review section, the projected change from reliance on motorized travel to shortened walks within the constructed attendance areas will have considerable implications on the lives of female students that travel to PFJH schools. Travel the lowest possible distances, for example, can negate the need for reliance on rented vehicle travel that is not only often costly but also unsafe. Walks to neighbourhood schools will also mean less chance of being struck by cars that often pass within inches of pedestrians on the busy streets within the frenzied traffic environments of Iran. It also affords more peace of mind since parents particularly worried for their children's safety allowing them to more easily accompany children for the short walk to school and alleviate any "stranger danger" concerns.

Aside from specific safety considerations there are numerous other advantageous of walking as well. A short walk with friends for example, affords students the increased social interaction to and from school often missed by rides in taxis or public buses. Walking also can provide the daily physical exercise young people need to maintain robust physical health. Another benefit is an enhanced perception and awareness of traffic dangers and the importance of personal security when travelling. In addition, shorter walks mean less exposure to traffic noise and travel that is often too close to traffic. Shorter journeys on foot can also serve to safeguard children from hot humid or cold and rainy temperature extremes that accompany the seasonal changes of Rasht.

In addition to being advantageous for the PFJH students and their families, walking also entails far-reaching significance for the Iranian education system and society in general. Less time in exhausting and potentially dangerous rides also means more energy for school and ultimately more productive students. Less dependence on motorized transport ultimately can

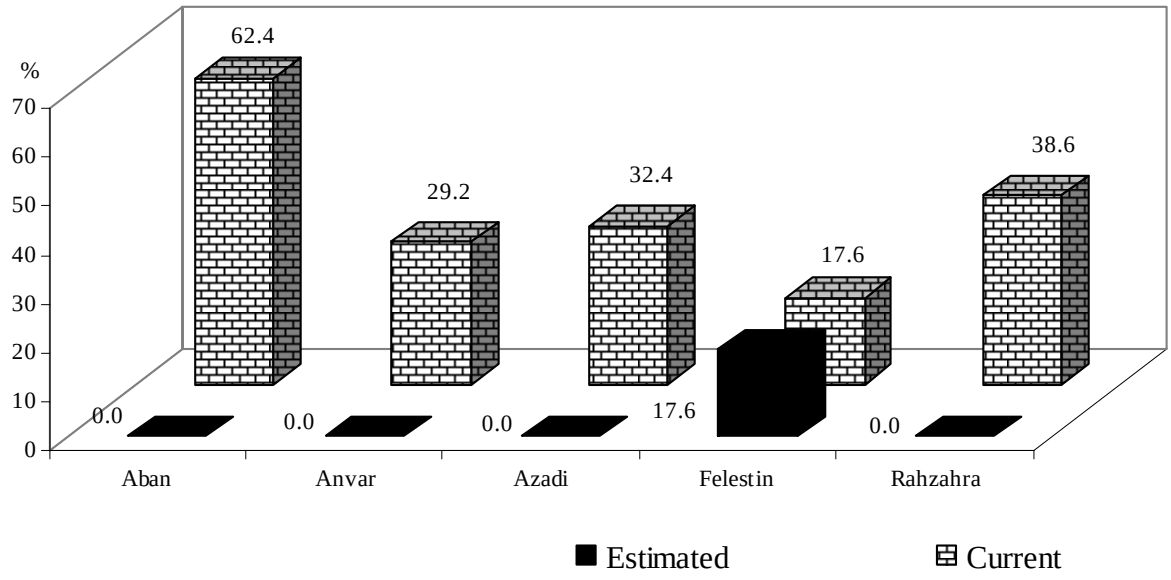


Figure 4-5 A comparison of the current percentages of studied students travelling more than 1.7km with estimated percentages travelling the same distance within the constructed attendance areas.

Source: Questionnaire data collected in September 2004
and MWVD-based proposed school attendance areas

result in fewer cars on the road. Thus, another potential merit is the reduced dirtying of the environment. Increased travel on foot can thus be a positive step towards reduced auto emissions and improvements in the air quality; a dire necessity given the level of environmental pollution in Iran.

Evidence of the feasibility of this goal has already emerged in developed countries like the US. The issue of walking and school location has already been the subject of study by the US Environmental Protection Agency. The direct positive correlations between increased walking commutes to local schools and lowered air pollution shown are revealing. A study by the agency of car traffic to two Florida high schools, for example, showed that the existence of neighborhood schools nearby would increase walking by 13% and result in reduced auto emissions of up to 15% (Moore, 2004). In addition to the environmental aspect, another benefit of less use of rented cars is decreased traffic congestion. The final long term merit that can emerge relates to the societal impact of commutes on foot. Awareness that walking is linked to a gradual change in a pressing environmental problem, for example, can also have a positive ripple effect on how students view the world around them. The knowledge that their actions have the potential of reducing pollution in the city, for example, can also led to a sense of personal empowerment and an increased connection with their communities.

As related above, some students in the study area residing in the more remote sections in town would still have to commute by vehicle within the attendance areas. Given that the goal of this research is dealing with any travel on inconvenient vehicles, recommendations for a safe, more serviceable alternative need to be provided to replace continued travel in the hazardous taxis and buses of Rasht. The solution to the problem of finding convenient low risk transport is best answered by looking to the popular standardized commuting option already in use in developed countries; free school bus services. Students in the study area have already shown a preference for groups travel in the company of classmates and friends offered on rental mini-buses, the most popular form of motorized commutes. School buses would therefore be the natural choice of commuting in Rasht. This mode of convenient, reliable travel would be perfect for the small but significant percentage of students in the study area (17.6%) that attend the outward-city school of Felestin where they still have to travel more than the 1.7 km average. Such services will not be excessively expensive or beyond the resources of the Rasht City Education Office in this case either since outward city schools compromise a smaller number and thus a minority of PFJH schools in the city.

Since excessively long walking commutes can be eliminated and vehicle travel drastically reduced for students in the study area, the next step in progression in the commute discussion is the projected effect on all female pupils attending PFJH schools in Rasht. If the

favourable results of the study area are applied to all PFJH schools within Rasht then for the majority of students that travel to inward-city schools, it not only completely negates the need for motorized commutes but also results in walks that are far shorter than the current ones.

If we generalize the result for all inward-city schools then the conclusions reached that no students will have to travel more than the aforementioned distance also apply, making the maximum commuting distance on foot 1.7 km. As mentioned, the distinguishing characteristic of the constructed attendance areas for the more tightly crowded schools that makes up inward-city ones are that they are smaller. Recall that, when the length of walking commutes was projected for the MWVD-based areas of the four inward-city schools of Aban, Anvar, Rahzahra, and Azadi the maximum walking commute for schools was no more than 1.7 km. Thus, all students travelling to inward-city schools can benefit from the major reduction in commuting times and distances projected for the study area under the MWVD-based areas, making shorter walks and non-vehicle commutes a reality for both shifts.

How many students will this affect? As touched on above, the answer to the question is in fact the overwhelming majority of female junior high students in Rasht. Counting the number of students that now make up the 25 inward-city schools of Rasht, 6,718 students can walk shorter distances without the need for vehicle travel.

The other beneficial aspect recorded by the research is that, like the case of their inward-city counterparts, travel for some outward-city schools will also be reduced. The estimated commute is similar for the projected maximum commute for inward-city schools of 1.7 km for the three outward-city schools of Aemmeh, Narjes 2, and Esmat 2. Within the constructed attendance areas students will be able to walk between 1.4 and 1.6 km for these schools. The extent to which this will be advantageous for students is even clearer once scene from the perspective of the actual number of students of these schools that can travel shorter distance. Fully 803 students, who now travel further distances can be able to journey to school the same short distance of less 1.7 km that is also the projected norm for inward-city schools under MWVD-based attendance areas, negating the need reliance on dangerous vehicles. Thus students of 15 schools of Aban 1, Aemmeh 1, Anvar 1, Asghari 1, Azadi 1, Azarbani 1, Balalzadeh 1, Enghelab 1, Lotfi 1, Rahzahra 1, Resalat 1, Reshad 1, Sadigheh Kobra 1, Tohid 1, and Valiasr 1 from Shift 1, and 13 schools of Aban 2, Anvar 2, Asghari 2, Azarbani 2, Balalzadeh 2, Enghelab 2, Esmat 2, Lotfi 2, Narjes 2, Rahzahra 2, Sadigheh Kobra 2, Tohid 2, and Valiasr 2 from Shift 2 do not need any school bus for their students (Figures 4-6 and 4-7).

If we generalize the result and recommendations of the research for studied schools the results for outward-city schools are equally positive since it will be possible for students to travel on more standardized reliable travel, with some can also benefit from reduced commutes as well.

As mentioned, the defining trait of attendance areas for outward-city schools is that they are larger due to the sparse availability of schools in the outskirts of town. Thus the majority of outward-city schools will need a free bus service like Felestin to ensure safe, convenient commutes to shuttle students' distances which exceed 1.7 km from homes. This will include the outward-city schools of Amupur 1, Etminan 1, Mohseni 1, Narjes 1, Taleghani 1, Ghods 1, Felestin 1, Esmat 1, and Taghva for Shift 1, and Amupur 2, Etminan 2, Mohseni 2, Ghods 2, Azadi 2, and Felestin 2 for Shift 2 (Figures 4-8 and 4-9).

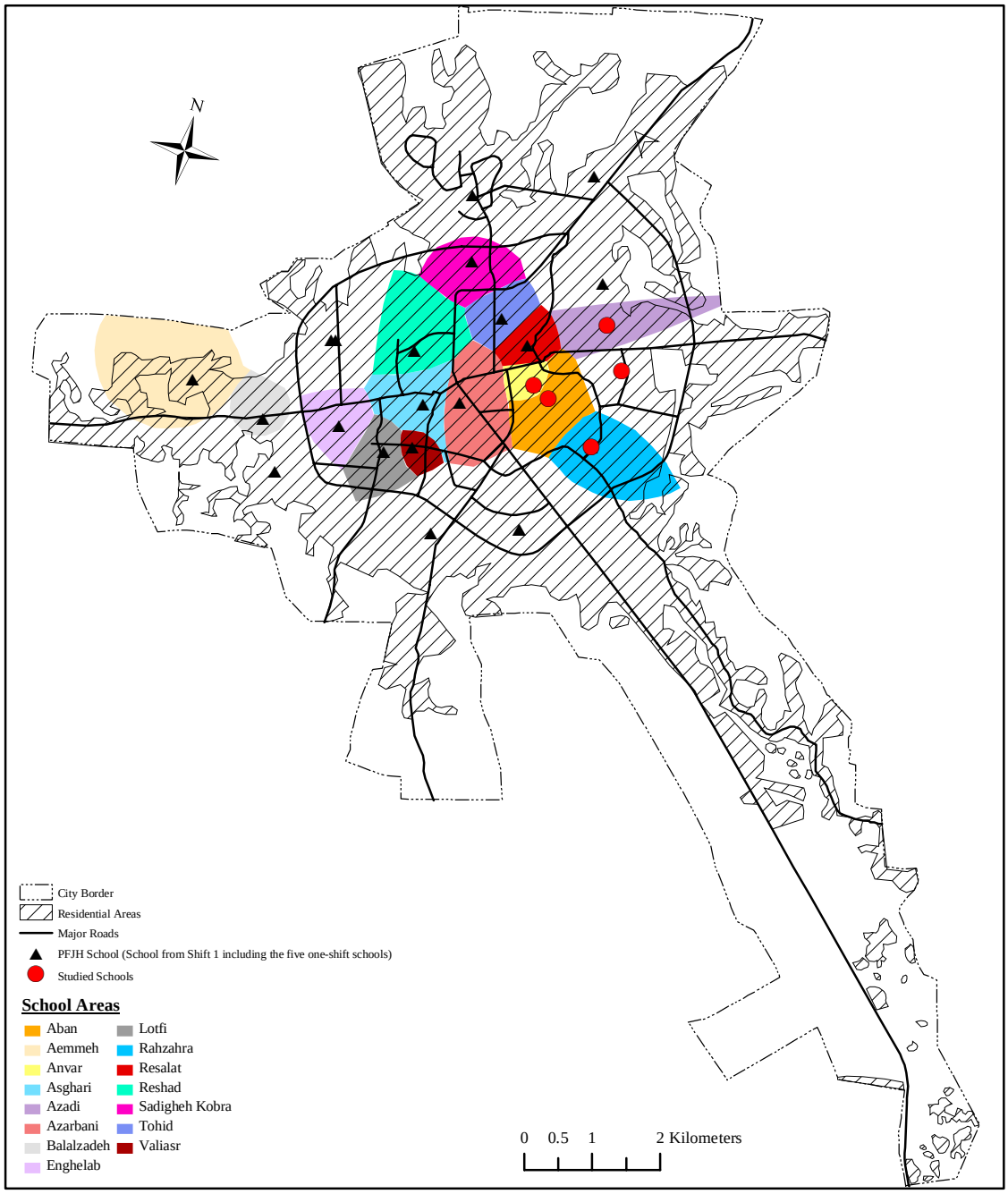


Figure 4-6 Shift 1 Rasht PFJH schools that do not need school buses and their MWVD-based attendance area showing studied school location and city residential areas.

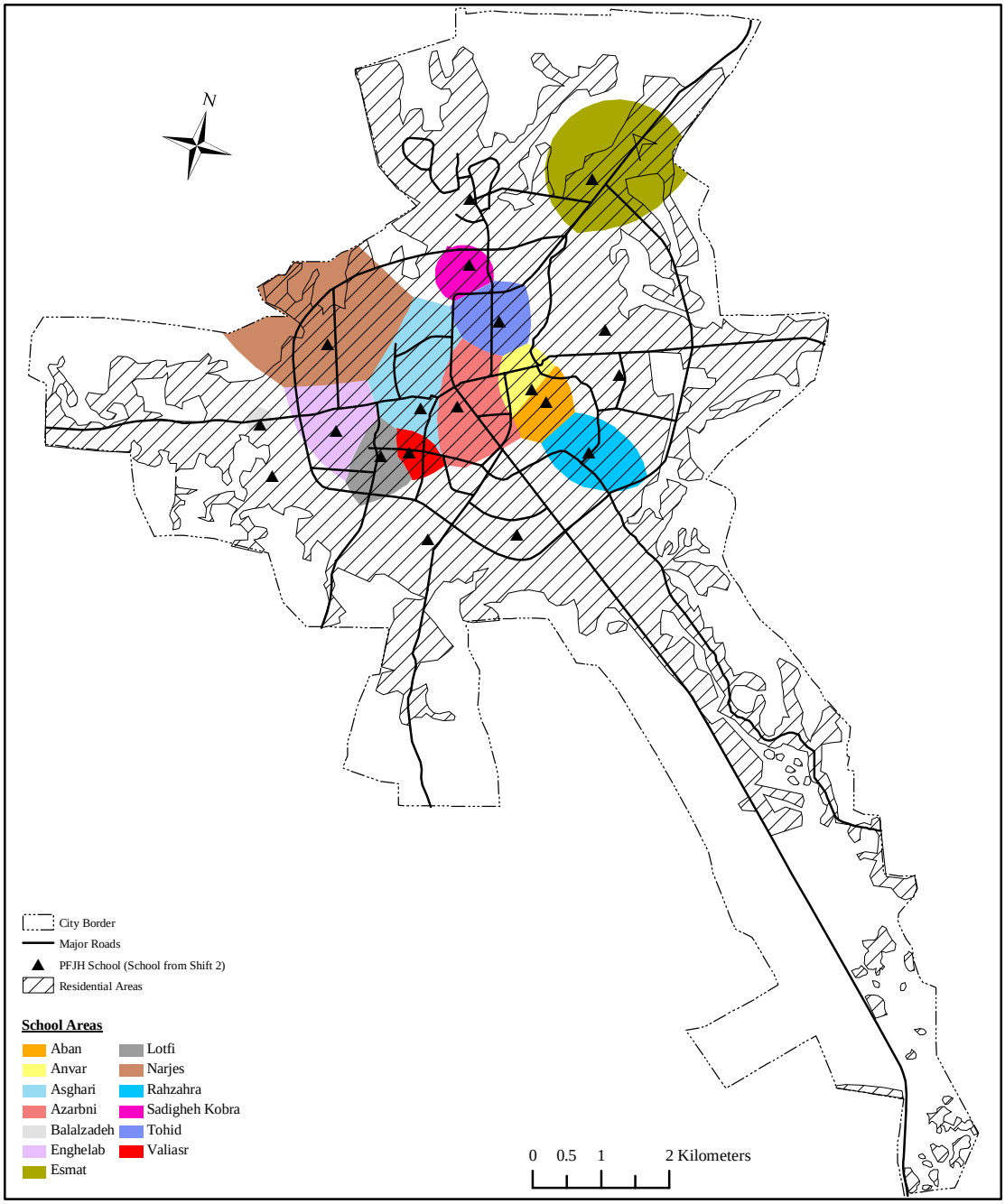


Figure 4-7 Shift 2 Rasht PFJH schools that do not need school buses showing their MWVD-based attendance areas and city residential areas.

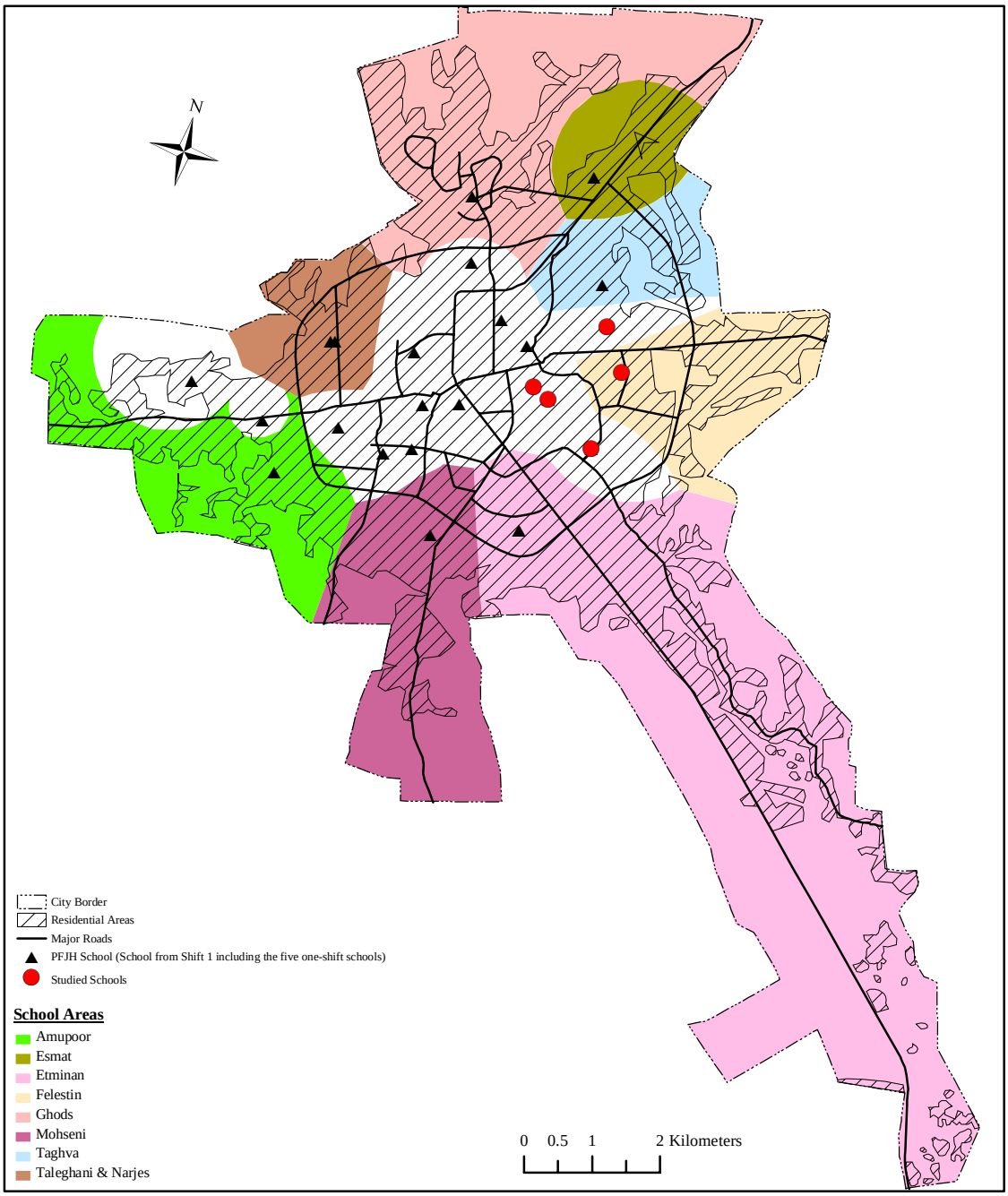


Figure 4-8 Shift 1 Rasht PFJH schools that need school buses for commuters more than 1.7km and their MWVD-based attendance areas showing studied school locations and city residential areas.

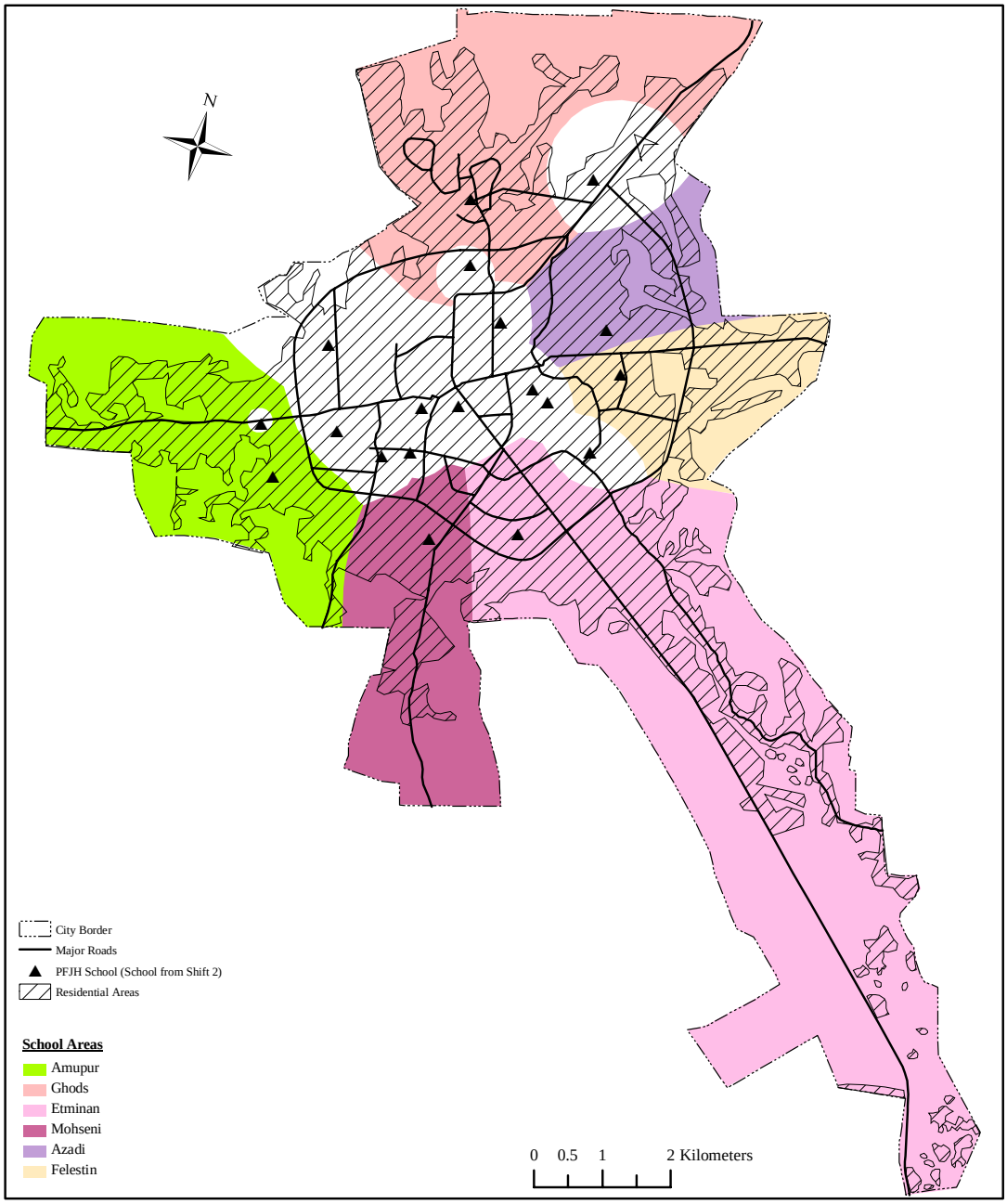


Figure 4-9 Shift 2 Rasht PFJH schools that need school buses for commuters more than 1.7km showing their MWVD-based attendance areas and city residential areas.

Chapter Five

Conclusions

Within the current system of school selection, Iranian parents are the main decision makers in choosing schools for their children. Under the current parental choice system, many students go to schools outside their local areas in distances longer than necessary resulting in inconvenient journeys. This is the case for public female junior high students in Rasht City, too.

Without guidance from the school boards or attendance areas parents are the central decision makers in the choice of schools in Iran. Although this might invoke images of freedom under the current system many female student go to schools outside their local areas. To understand how this happens the research purpose was to analyze the parental choice system to detail its shortcomings and how they generate longer and inconvenient commutes to schools. This can prove the necessity of eliminating parental choice from school selection in the study area.

Given the realities of schools in the Iranian education system the selection is an extremely complicated process for parents forcing them to weigh numerous different factors. In the case of the five studied PFJH schools, the research concluded that the school selection is based on five different criteria by parents; proximity of student's residence to school, accessibility of schools to public transportation, school facilities, school reputation and the journey safety. Though individual interpretation of ranking criteria parents try finding schools that best meet the educational needs of their children. While all factors go into the decision making process for selection of the sampled schools, each had varying degrees of importance for individual parents. The research concluded that school reputation, proximity of student's residence to school, and the journey safety were the most common criteria in school selection representing 38.7%, 32.8%, and 18.3% respectively. In order to answer the question about whether or not the parents in the study area truly resulted in the best schools for children, the research focused on student satisfaction, moves from chosen schools, and the spatial allocation of students within the city.

According to responses on questionnaires, numerous students were in fact unhappy once

school choices were made by their parents. The research concluded that a significant percentage of students (34%) of those attending the five studied PFJH schools of Rasht desired to be enrolled in one of the fifteen other schools. Even when parents did manage to find a school that is their first choice it was not necessarily the best one resulting moves from chosen schools in search of better alternatives. The survey of the five studied PFJH schools of Rasht revealed that 67 of the 919 students questioned were originally from different schools before moving to the present one. This shows that the current parental based choice system is not adequate for satisfactorily addressing the wants and needs of children.

Moreover parental selection has had a significant impact on the spatial allocation of students at schools. In the case of PFJH schools in Rasht, parental choices resulted in flight from local schools in search of the best ones in different parts of the city, spreading students over a wide area.

Another negative effect discovered was that students living in the same residential area were enrolled in different schools despite their shared proximity to closer ones. Responses on questionnaires revealed that numerous students attended more distant reputable schools despite the presence of a closer one nearby. Parental choice of schools in the absence of attendance areas also led to the outcome of students taking longer commutes than necessary. This was especially true for students whose parents chose schools based on favourable reputations.

Seen from the perspective of commutes, the current parental choice system of school selection distributed children over wider areas outside of local residential areas resulting in commutes longer then necessary on dangerous Iranian roads. Investigation into the specific length of commutes found that the commute for 43.6% of students currently enrolled at the studied schools is more than 2 kilometres. The percentage increase is even higher in the case of the more popular schools. Unlike the relatively safe travel along sidewalks a journey to school two kilometres or even longer is a lengthy journey for female students of Rasht. Inordinately long commutes, in turn, increased motorized commutes to school by students.

A review of the travel patterns of female students to PFJH schools shows that an overwhelming majority has to rely on taxis and buses. Some 59.5 % of the students surveyed currently travel to the studied PFJH schools by motorized vehicles. These commuters use public service vehicles like public buses and the common city taxi. In the category of private services, on the other hand, vehicles choices include telephone taxies, shared rental taxies, shared rental minibuses, and the parent’s car. Commuting by vehicle was the favoured means of travelled particularly among students who lived furthest from the studied schools. Though parents tried their best to make the travel shorter by motorizing commutes, the one question that lingered regards its impact. Are public and means of private transport compatible with basic standards of

convenience and safety for students?

Responses on questionnaires revealed that travel on taxis or buses to the five studied schools meant exposure to highly inconvenient and in numerous cases life-threatening rides. For shared rental mini-buses, for example, the complaints were that the rides can be uncomfortable due to such things as dilapidated seats, damaged roofs, and severe overcrowding. Rides in city taxis were potentially treacherous for students since most informal sector drivers drove recklessly without regard for traffic safety. In almost every case, respondents noted that taxis and buses were in need of some sort of maintenance or repair. As a consequence, many mentioned enduring heavy car fumes, loud clanking sounds, or even breakdowns during commutes. In addition to the added sizable monetary expense of daily bus or taxi fees, in every case, commutes in such vehicles also carried the added costs of lateness to school and loss of energy after exhausting rides.

Aside from vehicle hazards, respondents also noted serious traffic and environmental dangers in the case of walks to PFJH schools; making reduction of commutes on foot an equally pressing priority. In Iran not only is there a widespread disregard for yielding to pedestrians in intersections but in many cases vehicles often pass within inches of people at high speeds. For the more than 40% that travelled to the PFJH schools on foot this meant that walking carried the needlessly high risk of getting hit by cars. This risk is further compounded by the fact that there numerous traffic lights not in working order at intersections. Another noteworthy danger of commutes on foot particularly threatening to female students mentioned was frequent verbal harassment by “street boys” in low income areas. Students also noted having to endure the extreme weather in the winter when walking such as heavy rain or snow.

By analysing the travel patterns and the dangers involved under the parental-based system of school selection in Rasht, the research concluded that shorter commutes on foot and elimination motorized commutes were necessary through the construction school attendance areas. The research also discovered that mini-buses are the most popular choice of vehicle for parents and students in motorized commutes.

By analysing the parental priorities in children’s daily commutes to schools the research concluded that if all schools are provided with equal educational environments, parents would naturally prefer to send their children to the closest school. Since the social environment is particularly unsafe for female students, commuting shorter distances on foot is an important consideration for the parents. By allocating students to designated PFJH schools within the attendance areas the aim of this research was to construct school attendance areas that allow students to travel the shortest distance possible on foot, and avoid the inconvenient motorized commutes where possible.

School attendance areas were constructed by utilizing MWVD method. The constructed areas are characterized with some certain features that had to be integrated. The first is that the attendance areas are defined for both morning and afternoon shifts for each school building to reduce commutes for two shift student populations. The second feature of the areas necessary is that they are all based on the current size of each school. This characteristic specifies schools with larger numbers of students will have larger enrolment areas given that they draw more people to its school from wider areas. The third feature of constructed attendance areas required to reduce the troublesome commutes of female students is that with the exception of residential areas on the outskirts of town (outward-city schools), the majority are small in size to allow for shortest journeys possible. To ensure that attendance areas apply to all parents attending PFJH schools equally without exception the fourth necessary feature of attendance areas is that they are contiguous, with is no gap or spaces between them so that enclosing and adjoining all female student residences. The final feature towards this end is that all areas are enclosed and jointed. Thus, all parents are allocated to a local school.

An examination of how many students attending the schools currently travelled from outside the localized areas generated by MWVD-based attendance areas was surprising. The research found that an average of 65%, or an overwhelming majority, of students enrolled at the studied schools attend from other constructed attendance areas. The current spatial distribution within and around the constructed attendance areas provides a clear illustration of how school populations are intermixed with students from outside local areas requiring longer commutes.

Since the MWVD-based attendance areas allow the shortest journeys to each school within its regions, enrolment in a school within the constructed areas should result in a reduction of burdensome commutes that exceed what would otherwise be required. In order to develop a comprehensive picture of walking commutes to PFJH schools in Rasht under the parental based system of selecting schools, the research measured not only the walking average distance from student’s homes but also the time it took to travel such distances.

To show that how the commute time and distance was reduced for the students, the research analyzed the estimated commuting distances within the attendance areas. It showed that the vast majority of the students in the study area will be able to travel under the current average walking commute distance that is 1.7kilometers. This will result in shorter and more convenient commutes for making it possible to travel on more standardized reliable travels. The constructed attendance areas can eliminate the need to travel by vehicle making it possible for the overwhelming majority of the PFJH students of Rasht City. In case of the five studied schools, with the exception of the studied outward-city school of Felestin, the percent of students who would have travel more than 1.7 kilometres within the delimited boundaries dropped to zero.

How many students and schools will this affect? If we generalize the result and recommendations of the research for studied schools the answer to the question is the overwhelming majority of female junior high students in Rasht. The research concluded that of the 43 PFJH schools, students attending 28 schools (including 25 inward-city schools and 3 outward-city schools) will be able to commute under 1.7km and thus will not need any kind of vehicles for their daily commutes. Given a total current student population of 7,521 students at these schools (see Table 4-1) these means that a large volume can walk shorter distances without the need for a vehicle.

As touched upon in Chapter Two, the projected change from reliance on motorized travel to shortened walks within the constructed attendance areas will have considerable implications on the lives of female students that travel to PFJH schools. Travel the lowest possible distances, for instance, can negate the current trend of a large reliance on rented vehicle travel that is costly and unsafe. Walks to neighbourhood schools mean less chance of being struck by cars that often pass within inches of pedestrians within the frenzied traffic environment of Iran. It also affords more peace of mind since parents particularly worried for their children's safety can more easily accompany their children on walks to school to ensure their continued security, alleviating "stranger danger" concerns.

Given that the goal of this research was dealing with any travel on inconvenient vehicles, recommendations for a safe, more serviceable alternative need to be provided as an alternative to continued travel in the hazardous taxis and buses of Rasht. The solution to the problem of convenient low risk transport is best found by looking to the popular standardized commuting option already in use in developed countries; free school bus services. Students in the study area have already shown a preference for groups travel in the company of classmates and friends offered on rental mini-buses, the most popular form of motorized commutes. School buses would therefore be the natural choice of commuting in Rasht. This mode of convenient, reliable travel would be perfect for the small but significant percentage of students in the study area that attend the remaining 15 schools (all outward-city schools) where they would still have to travel more than the 1.7 km average. Thus the research suggested convenient free school buses for students attending these schools.

To ensure that all schools are equipped with the same resources as the most reputable ones so that parents willingly enrol their children to allocated schools within the constructed attendance areas, educational policies that equally distribute qualified teachers and staff to all PFJH schools within the city are also needed. Moreover, government efforts to improve the educational facilities among the existence schools like functioning lights or educational displays is another necessity that should be considered in upgrading the educational policies.

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Dedication

This dissertation is dedicated to those who commit their hands and hearts to making environments safer for school children.

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Appendix

Questionnaire Provided to the Five Studied Schools

Dear Parents;

Enclosed is a questionnaire seeking some basic data and information for an academic research regarding the current school enrolment system in Rasht. It will assist in designing a school attendance areas based on the student's home to school travelled distance that is currently executed in most countries. Please help me in the research by answering the questions sincerely. Please complete it with your child and return it to the school as soon as possible but not later than ……..... You are also free to write down your personal opinion about the subject.

I am looking forward to your reply.
Thank you for your cooperation.

1-School name: ……

2- Name of student (optional)

3-Date of birth: ……..

4-What year are you in? first year ○ second year ○ third year ○

5-Class attended (stream): ……

6-Home address: …….....
Postal code: ……..
Telephone number (optional): ……..

7-Primary school(s) attended:

Name of school: ……

School address: ……

8-Have you ever enrolled in any other junior high school(s)?

No ⬭

Yes ⬭

If Yes:

In what year: ……

School name: ……

School address: ……

Why have you moved to the current school?

9-Is there any junior high school to your home closer than current one?

No ⬭

Yes ⬭

If Yes؛ school name: ……..

Why did you not choose that school?

10-Who chose the current school?

Parents ⬭ Education Office of Rasht ⬭

If parents;

What criteria were considered in the school selection? (You can choose more than one reason)

Proximity of student' residence to school ⬭ Proximity of parent's workplace to school ⬭

Accessibility of school to public transportation ⬭ Presence of siblings ⬭ Journey safety ⬭

School reputation ⬭ School facilities ⬭ other reason ⬭

More explanation (optional):

11- Which school did you prefer to be enrolled in?

12- Have you any problem in your school?

13- Have you faced any problem for the registration of your child at the current school?

14-Which means do you mostly use for travelling to school and how long does it take in going to and from?

Means of transportation		Using per week	Travel time (minute)		Travel cost		Travel distance (km)	
			to school	from school	to school	from school	to school	from school
On foot								
By Bus	Public bus							
	Rental shared mini-bus							
By Taxi	City taxi							
	Rental shared taxi							
Parent's car								
Other vehicle								

15-What is the advantage and disadvantage of each used travel means?

Means of transportation		Advantage of use	Disadvantage of use
On foot			
By Bus	Public bus		
	Rental shared mini-bus		
By Taxi	City taxi		
	Rental shared taxi		
Parent's car			
Other vehicle			

16-Please, draw a sketch of your home address:

17- Please draw a sketch of your travelling way from home to school:

18- Please, write down a personal opinion about the subject؛ problem(s), current enrolment system, suggestion and so on. (Optional)

Thank you