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An Analysis of Public Boys' High School Location Using GIS: Jeddah, Saudi Arabia Case Study

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An Analysis of Public Boys' High School Location

Using GIS: Jeddah, Saudi Arabia Case Study

DISSERTATION

Presented in Partial Fulfillment of the Requirements for

the Degree Doctor of Urban Planning and Environmental Policy

in the Graduate School of Texas Southern University

By

Tharaa Gazzaz

Texas Southern University

2021

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An Analysis of Public Boys' High School Location

Using GIS: Jeddah, Saudi Arabia Case Study

By

Tharaa Gazzaz

Texas Southern University, 2021

Professor Glenn S. Johnson, Advisor

The research study area is the city of Jeddah, Saudi Arabia. Jeddah high schools are separated by gender due to cultural background. In 2018, a research was conducted related to public girls' high schools (Belarem et al., 2018) and the research neglected boys' public high schools which is considered a gap in the study. In addition, the emphasis of this research is on the male population because it is more than the female population in the city which will require more schools for boys in the future. Moreover, and from an urban planner point of view, public schools are part of the city infrastructure and the quality of physical, social, and academic of schools is part of the quality of the city. This research is to study Public Boys' High school physical location distribution and population accessibility to these schools using Geographic Information System (GIS) analysis tools such as euclidian and network analysis. Furthermore, city historical Landsat imagery in the last 30 years to be used to study the city urban sprawl(population) to estimate future urban sprawl (population) direction in the city. Such analysis will enable urban planners and educators to come together to determine future school siting for better quality.

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GLOSSARY

AST: Active School Travel

CBD: Central Business District

DSR: Deanship of Scientific Research

ED: Euclidean Distance

GIS: Geographical Information System

MBR: Michael Bauer Research

ND: Network Distance

PP: Public Participatory

SND: Shortest network distance

SNT: Shortest network time

VITA

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CHAPTER 1

INTRODUCTION

Public schools are part of the city's infrastructure. The quality of the physical, social, and academic activities of schools is part of the city's quality. Schools are considered to be a focal point for the community (Ibrahim et al., 2014). Therefore, planning for school from an Urban planner point of view should be integrated and comprehensive. When planning for school location, many factors must be considered to elevate city quality of life. Social factors such as neighborhood residents, environmental aspects such as school surroundings, and easy accessibility taking into consideration transportation modes to schools. School location in urban planning is considered to be planning for the future. To allocate a school in the optimal location, many urban principles must be applied at the same time and in harmony. These principles must work together in coherence to achieve maximum outcomes.

Urban principles such as urban growth, transportation changes, and the principle of equality are associated challenges that need to be understood. Urban growth is the increase of urban areas, which affects an increase in transportation infrastructure that will cause a change in land cover. Principal of equality with regard to schools is to give all students the same and fair education opportunities and services. To apply such principles, the authorities must adapt to all kinds of associated challenges. Public school location planning is a driving force for urban planners to direct city development direction; city planners could control city expansion to the desired areas in the city if applied correctly. Such an advanced urban planning approach can be made by using statistical analysis and

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Geographical information systems. A school is considered to be a community anchor and a focal point and used for other purposes such as public gatherings, seminars, and programs for adults. Therefore, school location decisions will be beneficial for the entire community.

1.1 Study Area

This case study is about the city of Jeddah, Saudi Arabia. Jeddah has many characteristics that must be considered when planning. Cultural background in Saudi Arabia is the main cause of gender separation in public high schools. In other words, there is no mixed-gender in high schools in Jeddah. Therefore, there are only public boys' high schools and only public girls' high schools in Jeddah. Jeddah is a coastal city with linear development mostly to the north with a waterfront that is stretching 110 KM along the Red Sea (Mostafa, 2017). Jeddah is the main gateway to the holy city (Makkah Al-Mokaramah). Jeddah city has a seaport in the southern part and an airport in the northern region. Jeddah's city plan is to support sustainable development along with improving livability and quality of life (Samaa et al., 2017). Sustainable development is development without compromising future generation resources. Saudi Arabia consists of 13 regions. One of them is the Makkah Al-Mokarramah region. There are 11 governorates in the Makkah Al-Mokarramah region. Jeddah is one of these 11 governorates. Jeddah governorate consists of 113 districts (Aljoufie, 2017); however, Jeddah 95 districts were used in this research because many researchers concentrated their research on Jeddah 95 districts. (Belarem et al., 2018; Hamza et al., 2016)
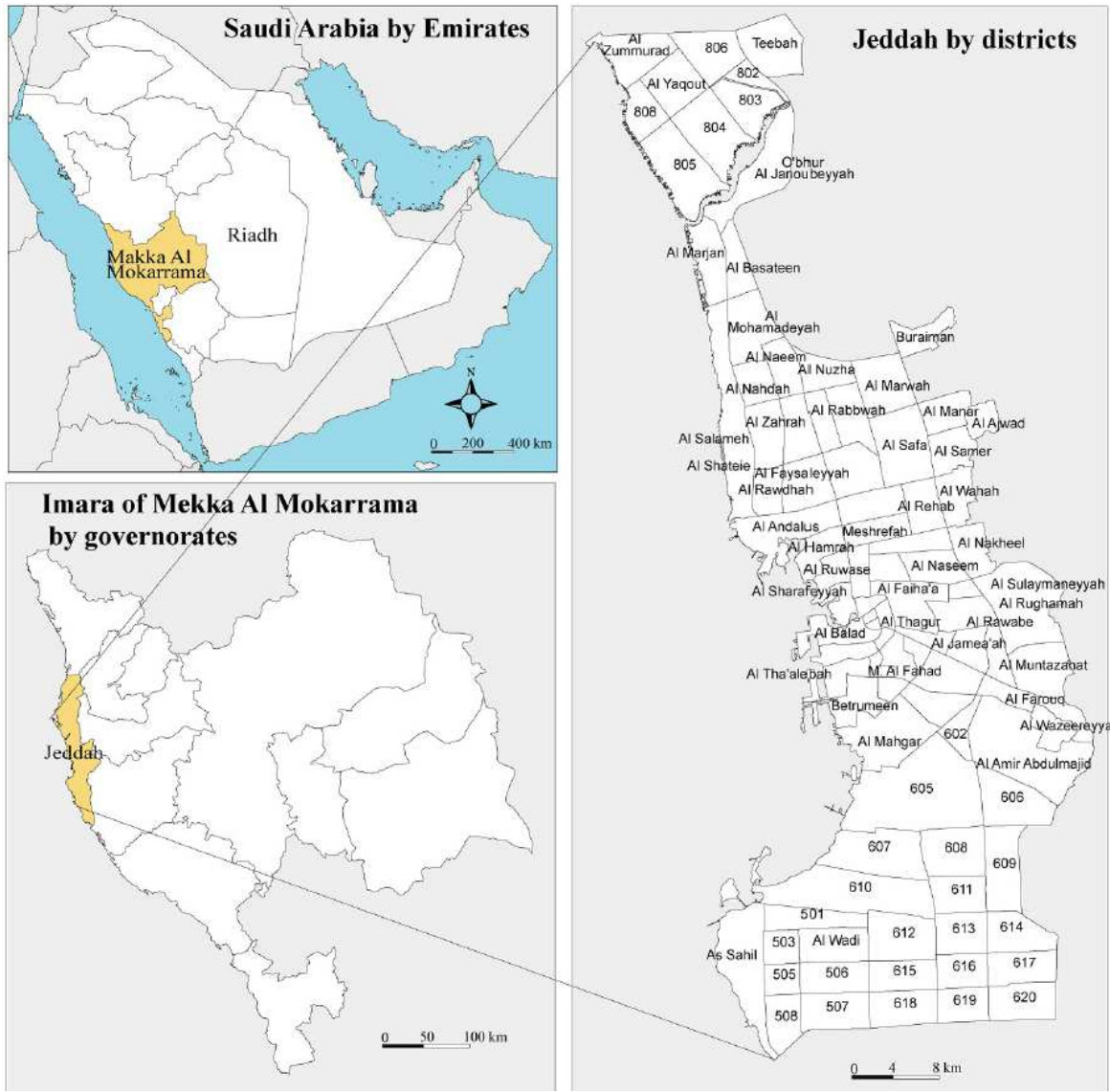
Figure 1: Jeddah (Belarem et al., 2018)

1.2 Justification & Study Rationale

After defining the area of study and the importance of school location in city planning, it is time to take a closer look at schools in Jeddah in an overview. All high public schools are separated by gender. There is no difference in services between genders; the separation is only because of cultural factors; everything else is the same. There is no such thing as a school zone in the city of Jeddah, which means that any student can attend any school if there is a vacancy. School bus service for public schools does not exist (Belarem et al., 2018). The driving age is 18 years which means that by law, students below 18 can not drive to school, and the student age of the last high school is 18. Both boys and girls are driven to school by their parents or by private drivers. Children's safety is the most crucial aspect that parents want for their kids; therefore, parents prefer private cars to commute their children to schools (Ibrahim et al., 2014). A small percentage will use walking and biking to school, and those are the ones who live close to school. This small percentage is negligible, and it is considered an exception. This small percentage is due to the hot weather in Jeddah. (Fatani et al., 2017) The same with public transportation; only a small number of students will use public transit. This small percentage is also negligible and is considered to be an exception. (Belarem et al., 2018) This small percentage is because of the same issue, which is the hot weather (Fatani et al., 2017) since students need to walk a long distance to reach the nearest bus stations.

Spatial sprawl in linear cities, which is most probably due to cities that are next to a sea, tends to have linear development along the sea. Spatial sprawl is when the city expands without adequate planning and spontaneously. In any coastal city, the development would be toward north or south, or development would be toward east or

west. In the case of Jeddah, where the Red Sea is in the west of the city and mountain strips on the east of the city, the development will be toward either north or south. The trend from the past is clear and obvious, which allows us to make a conclusion that it's going to be definitely toward the north. One fact is the historical data of city development in the past which was toward the north, and it's expected and projected to be the same in the coming future (Bahaydar, 2013). Another reason is that the south of the city is becoming the historical museum of old Jeddah. Moreover, the seaport is located in the south. Another reason for the expected development toward the north is that there are many institutions was built north of Jeddah, such as King Abdullah City KAUST, Al-Batarje Medical School, and Durat Al-Aroos. Finally, south of Jeddah, inhabitants are mostly from low-income social levels. Low income is when the employers gain less than what they need, this is happing because most of the work is low pay jobs. We could conclude that the difference between the south and north is the same difference between different social classes among people. Moreover, the south of Jeddah has many unplanned Informal settlements because the south is old Jeddah. Old Jeddah was built before modern planning theories, and it stayed without proper adjustment or development for a long time. Simply, Old Jeddah was built according to the needs of the people without proper urban planning, which was the main cause of such unplanned Informal settlements (Kayvan, 2012).

The principle of equality in urban planning with regard to schools is when everyone has the right to be educated in a public school that provides all school services for free. The principle of equality is in much need, especially in developing countries such as Saudi Arabia. The population is increasing in Jeddah, Saudi Arabia at a very fast-paced growth, city expansion toward the north, not enough schools in the north resulting in long traveling

distance for students. To pre-plan, such movement of the population is the main issue that this research is trying to predict the future needs and to present suitable and sustainable urban solutions. To identify school location problems and its effects on the city and population, afterword, to measure the scale of these existing problem. If these problems are in ''low priority'' in the meanwhile and if nothing happened in the near future to pre-plan a solution, the results in the coming 5 years will be unpleasant to the city, population, and students.

<div align="center">1.3 Gap in Research</div>

About school location planning in Jeddah, there are two major studies to build on. The first study was about all levels of schools in four neighborhoods in north of Jeddah. Spatial distribution of schools in Jeddah city to assist the future planners to manage setting up new school location. Geo database is constructed in ArcGIS environment with raster datasets of demographics, topology, road networks and schools depicted in point, line, and polygon features. Spatial analysis technique is employed to create 'Elliptical Buffers' to capture the density of the population in each residential location. The results exhibit that schools are located without clear pattern in residential areas with respect to the population densities (Al-Enazi et al., 2016).

The second study was to study only girls high school location in the city of Jeddah. Jeddah as long as all other cities in Saudi Arabia has a cultural background that separates girls from boys in schools. This study examined and measured the accessibility to these schools. When evaluating school spatial distribution, results show a notable imbalance of school location and their distribution. When examining the accessibility to girl's high schools, the results show that girls have to commute long distances to reach their high

schools (Belarem et al., 2018). In addition, the results shows that most girls schools are clustered in city center and there is a lack of school existing in the north area of the city. City center is where most of the population exists and have the most density of population, it is like Central Business District (CBD) in the United States. This case study was granted by King Abdelaziz University in Jeddah to study girls high school distribution in the city. This case study only handles public girl high schools and neglect girl private high schools. An obvious gap is that these studies did not consider boys public high school regarding school location and their distribution.

Public High Schools		
	Girls	Boys
Student Gender	Only Girls	Only Boys
Techer Gender	Only Females	Only Males
School Bus	N/A	N/A
Driving Age	18	18

Table 1: Differences between girls and boys in high schools
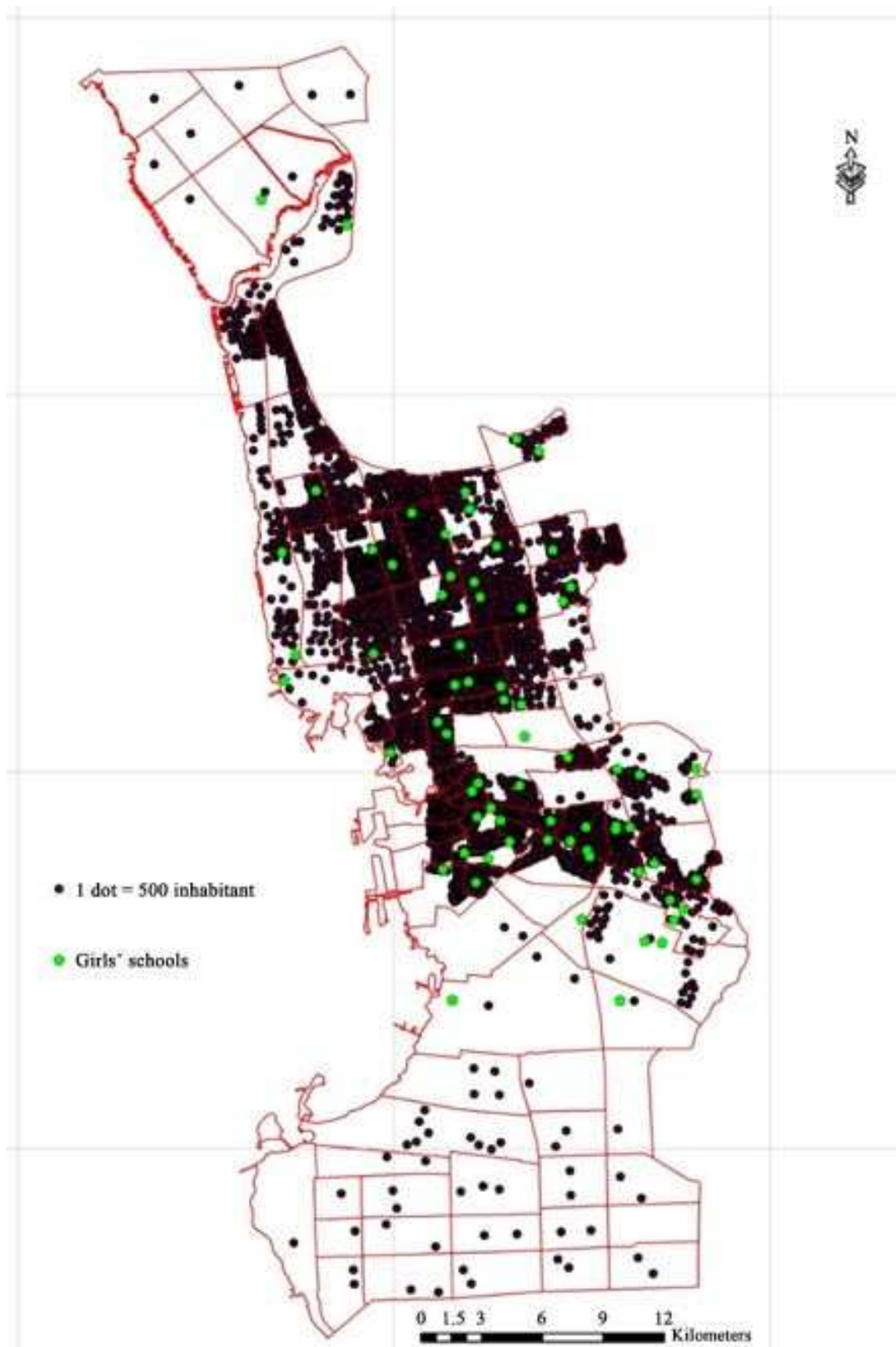
Figure 2: Girls' public high schools' location in Jeddah. (Belarem et al., 2018)

1.4 Aims & Objectives

In Urban planning, there is no such thing as an absolute answer that has no disadvantages, problems, and issues. Each planning methodology well solves several problems but not every problem. The main and important thing is to prioritize the issues that we would like to solve and deal with. The main objective of this research is:

- To study boys' public high schools' location in terms of distribution and accessibility related to population.

- An attempt to assist future planners to manage setting up new school location.

- To act on Jeddah's urban growth and transportation changes as a respond to Jeddah's spatial sprawl in term of school existing and services.

- Applying principle of equality in urban planning regarding schools.

- To participate in reducing travel time to schools, this will help students and parents in their commute to schools. Also, it will help the whole city when reducing city congestion by logical planning.

- Urban planners of cities with high density of population such as Jeddah main target is to expand the city activity by using school location as an attraction.

1.5 Research Questions

Research Question #1:

Are the location of current public boys' high schools serves the current population distribution?

Research Question #2:

What is the best location for future schools given future population projection and given previous years expansion trend?

1.6 Research Hypothesis & Assumptions

This research is based on the following assumption:

Research assumption **#1:**

Distance will be the most important factor to determine which school a student will choose, since there is no school rating regarding school performance in Jeddah.

Research assumption **#2:**

Population data is distributed by districts and as mentioned before, Jeddah have 95 districts and the population will be equally distributed within the district as an assumption.

Research assumption **#3:**

Car will be the travelling mode of this study since Jeddah is a car dependent city. (Aljoufie,2016)

Research assumption **#4:**

All student population who falls in a school buffer zone will attend that school.

CHAPTER 2

LITERATURE REVIEW

Public schools are part of the city infrastructure. The quality of physical, social, and academic of schools is part of the quality of the city. Schools consider to be the focal point for the community (Ibrahim et al., 2014) Location is a very important factor because location will define school accessibility to students and how far is it from their homes; moreover, school location will determine school social environment and determine which transportation modes to be used (Ibrahim et al., 2014) Main pinpoints to determine public preference are home location, workplace location, and school location. Most of the public preferred a location near the city center and this preference will decrease toward the edge of the city (Prasetyo et al., 2016)

2.1 Schools

One of the main factors that decide a school location selection is distance. There are some schools in the outer city area, building schools in the fringe areas causing another type of problems even though it solved traffic congestion and reducing the pressure on clustered city center. It's going to be expensive to travel to this far distance (Makino et al., 2002) Schools considered to be public facilities in addition to clinics, hospitals, public transportation, and recreation centers. School site selection process guidelines are: school size, school location, accessibility, efficiency and quality, design standards, and student population. To enhance school site selection process in order to upgrade student school experience, reduce crime rates, and to increase safety.

School location depends heavily on easy access to students where it should be safe for students to walk or bike to schools. There are many benefits when students depend on themselves to go to school by walking or biking and they are: reduce traffic congestion, increasing students' health and lifestyle, and strengthen the community identity. School is considered to be a community anchor and a focal point, used for other purposes such as public gatherings, seminars, and programs for adults. Therefore, school location decision can be beneficial for the entire community. The recommendation is to use the community's existing resources and to have maximum advantage of these resources in a location decision (Moussa et al., 2017).

Measuring public preference regarding school location in Surabaya, Indonesia. City is trying to increase public schools and they want public to participate in finding the best locations for a new school using public participatory (PP) GIS with the use of a web-based application. Schools are not properly distributed in the city. this is clearly observed in high school level. It can be noticed that in Surabaya, Indonesia that many more private schools than the public schools and elementary schools are in the city center; however, high schools are very far from the city center which conclude longer commuting distances. The main three locations to determine public preference are home location, workplace location, and school location. Other factors were considered such as population, access to public transportation, and how do students get to schools. Most of the public preferred a location near the city center and this preference will decrease toward the edge of the city (Prasetyo et al., 2016).

The existence of private schools considered to be a collaboration between the government and the private sector. This practice is considered to be a healthy environment

for better education, however, there should be limitation. in other words, private schools should never play the role of public school. When we notice the number of private schools are more than public schools in a city or district, a red flag should be raised. For example, in Bangkok, (Makino et al., 2002) there are more private schools than the public schools, this considered to be a problem and a probable cause of corruption. On the other hand, in Germany, there is zero private schools. Schools and their quality is the responsibility of the government, private schools involvement should only help in some niche areas that public schools can't apply such as international schools, spatial need education, and language schools.

2.1.1 Accessibility

There are six factors which parents are looking for when considering a school to enroll their children which are: 1) school location, 2) distance from their house, 3) what are the school facilities, 4) extra activities, 5) school environment, and 6) school academic performance. Children safety it's a most important aspect that parents want for their kids, therefore, parents prefer private cars to commute their children to schools. School planning must consider traffic and transportation when planning for the school location. Schools considered to be the focal point for the community, schools are not only for students to study, it's also a meeting area for parents and can be used as the neighborhood playground. A study used a questionnaire survey as a methodology to understand the relationship between school distance and transportation modes and came to the conclusion that there is a significant relationship. Children can commute to school using public transportation, private vehicles, school buses, cycling, and walking. The study shows that the least

favorable, is cycling with a 4.75% and the most preferred is private vehicles with a 54.75%. (Ibrahim et al., 2014)

School academic performance is the first aspect that parents consider when choosing a school for their children. School rating is the most important factor that parents are looking for when choosing a school for enrolling their children. Location will be the second most important factor and then distance. The school physical and facility is the fourth important factor and then school environment. Extra activity Is the least important factors for parents when deciding on which school they should enroll their children. (Ibrahim et al,. 2014). Parents who allow their children to walk to school are the ones who live near to a school, otherwise they will use the private transportation which is cars. Families from middle class will follow and go after good schools or schools that have high rating in the education system which means that families will go after educational high performance. (Vincent, 2006). For example, in Bangkok, we need more schools but there is no space in the inner city or the central area; therefore, the solution is to build schools in the outer city (Makino et al., 2002). Meeting modern school standards and regulations with regard to size and location such as far away from the main road, far away from gas station, far away from noise and pollution, planners need to solve these problems which is considered to be the most priority. Transportation aspects is everywhere all over the world, low income individual are everywhere in each country; therefore, planners need to find a solution for an inexpensive transportation modes to reach schools in the outer area of the city. For example, in Bangkok, the transportation time to outer city schools is one-hour using public buses (Makino et al., 2002) we could reduce this amount to 45 minutes or 30 minutes using railroads or trains. In addition, school bus might be a solution. Moreover,

the land cost in the inner city is high and it's already been sold to the private sector; however, land in the outer city is still owned by the government or can be purchased for a reasonable amount.

The main factor that decides a school location selection is distance that can be measured using GIS. For example, in India the maximum distance for walking planning from the school to the children house Is between 0.62 to 1.86 miles (1 to 3 Kilometers) in primary schools and in Japan it should not exceed 15 minutes walking distance. As driving time with regard to high schools, 30 minutes considered to be the maximum travel time. (Moussa et al., 2017)   There are some schools in the outer city area, building schools in the fringe areas caused another type of problems even though it's solving traffic congestion and reducing the pressure on clustered city center. It's going to be expensive to the poor families to travel to these far distances that it is one hour using public buses and will cost 14 baht which is 0.45 US Dollars (Makino et al., 2002). Students from K-12 was examined using questionnaires and surveys and the results shown in this case study confirmed that there is a significant relationship between school distance and transportation mode. (Ewing et al., 2004) In Yemen, when using point distance to measure distance between schools and the mean center of population, these results showed that 18 to 20 minutes travel distance between schools and population mean center, where are the standards should be around 8 minutes only. This was calculated by the distance on GIS and the unit is going to be meters and then transferring these meters into minutes by using the formula: walking 100 meters is equal to 2 minutes travel time (Lagrab et al., 2015).

When an individual is looking for a house to live in or an apartment, the first thing that this individual will consider is transportation. He or she will look at how far is his

workplace to his house? Because an individual would like to save time. One of the main important factors and a very decisive aspect when selecting a house location is how close is it to reach points. These reach points are mainly: workplace, house, and schools if there are children. (Prasetyo et al., 2016) The secondary main reach points are facilities such as services (supermarkets), banks, and close to families. The factor of being close do these considerations is the save time, in other words, to make the trip time shorter. For example, an individual would like to rent an apartment that is 10 to 15 minutes close to his workplace. This will be beneficial in saving time by shorter commute and also it will save money on gas. In order to do so, he/she needs to allocate first which school he/she desires to enroll his kids in, therefore, he will be looking for the best school that is near to his workplace or house. Workplace location is a fixed place which means that if an individual is working in point A he would like to find the location of a school for his children which would be point B to be close to point A. House location will be Point C, after the selection process of the best school in the area the parent will calculate his trips between A, B, and C.

However, if the school rating that is near to his workplace is not a high rated school, then, parents most likely will need to find a higher-rated school to live nearby. According to the study of parent criteria, school performance is the most important factor in deciding which school an individual will enroll his kids in even if they must transport or commute for longer distances. (Ibrahim et al,. 2014). This practice will be for people who can afford such longer transportation because in this scenario the cost of transportation will increase due to longer distance. Time is a very important factor because usually work starting time will be around 8 in the morning and schools will be around the same time as well. Therefore, parents will have a problem with time management, therefore, parents would

like to find closer school with high educational performance to their house location in order to shorten travel time. In this case parents will save time to get to their workplace at the right time (Makino et al., 2002).

As driving time with regard to high schools, 30 minutes considered to be the maximum travel time using car as a commuting mode. (Moussa et al., 2017) Average car traveling distance to schools was examined in a study in Gainesville , Florida and the outcome was that its 4.24 miles to Gainesville High School. (Ewing et al., 2004) In another study made regarding school standards and criteria made by International Islamic University in Malaysia, the standard school distance to student location is between .025 to 0.5 miles 0.4 and 0.8 km walking or biking to school in 5 to 10 minutes.(Ibrahim et al., 2014) In addition, the median traveling duration in 14 minutes using car as a traveling mode to schools (Lincove et al,. 2018).

2.1.2 Guidelines

Since there is no school location regulations and standards a recommended standard is to be: traveling distance, traveling time, number of students and students density (Makino et al., 2002). The conclusion of such absence of standardization is always going to be dissemination in school distribution and random selection. Regarding school size requirements, it is considered to be a burden when selecting a school location. For example, minimum school site size requirement for elementary school in the US was 10 acres and for high school 35 Acres to 40 acres. (Vincent, 2006) In addition to an acre for each 100 students. These requirements were too much to handle in terms of cost and finding the right land that meets these minimum requirements. Therefore, by the year 2004, 22 States

no longer use these requirements. In other words, there are no minimum size requirements. (Vincent, 2006)

Another guideline is using "no regulations". Actually, the only regulation in Bangkok is "not regulations", which are "not" close to factories, "not" close to landfills, "not" close to warehouses, and so on. There are no regulations in terms of size, distance, safety, and other criteria that is happening in comparison with other countries such as India and Japan. When planning to allocate a new school, there are some criteria that need to be considered such as noise level, the average sound level in schools is more than the normal or recommended levels! Moreover, the noise will be higher to the classrooms that are close to the streets. 20 random schools were examined in Jeddah and the noise level was (60-89.2 dB) where the standard is (42-55 db). (Noweir et al., 1994) Noise level considered to be an important criterion to school location, simple because high level of noise will affect student concentration and case distraction to the students. Therefore, scientist studied the acceptable noise level in schools and the conclusion was that it should be between 42 dB and 55 db. For example, when planning for a school location, planners will select a location that is away from busy streets. In addition, school standard minimum requirement is a 100m away from a petrol station or any other risky hazard areas (Okan,2012 & Lagrab et al., 2015) Gas stations considered to be a dangerous entity when it is close to schools and especially less than 100 meters, it's considered to be a risk to schools and residential areas. Recent schools in Yemen and Georgia are not applying these standards and guidelines, the implementation of these guidelines must be considerate when building new schools.

Active School Travel is when a student uses walking or biking to go to school. Student in Jeddah are missing out on Active School Travel (AST) which is very important

for student health and also good for the environment by reducing car emissions and many other advantages. (Ikeda, 2019) There is a significant relationship between school distance and Active School Travel and especially walking and biking that increase AST. Moreover, there are other factors that can affect Active School Travel to schools such as neighborhood population density, and neighborhood green or tree coverage. (Ewing et al., 2004; Ikeda, 2019) Moreover, built environment surrounding such as sidewalks the school also has a great impact on transportation modes, especially walking and biking. (Ewing et al., 2004) These sidewalks does not exists in Jeddah and walking and biking facilities are inappropriate and discouraging (Aljoufie, 2017) Another factor that affects AST to schools is school size, when schools are small in a neighborhood, that will attract children to walk and bike. On the other hand, larger schools will be built in areas that are congested and with high traffic capacity; therefore, walking and biking will be difficult for the children who live far away (Ewing et al., 2004) In conclusion, in car dependent areas, student who are walking or biking to school are at a high risk of being in an accident with a car.

2.1.3 School Location Responsibility

Planners and educators should come together in determining school siting for better quality and to achieve better quality and expand city smart growth. In other words, urban planners should be part of the selection process and sometimes could be the leading force in the committee. (Vincent, 2006) School planners must consider traffic and transportation when planning for the school location. Schools consider to be the focal point for the community (Ibrahim et al., 2014). There are some disconnections between the education planning and city planning. The recommendation is that city planner should participate in

finding the right location for schools. "Four key obstacles exist in this regard: the silo planning phenomenon, school site acreage requirements, funding issues, and fluctuating student populations"(Vincent, 2006, p. 434).

Selecting a site for a school can't be done only by educators themselves or by planners themselves, both have to come together to define the best location that serves families and their children. (Vincent, 2006) Ministry of Education should not be the responsible governmental entity with regard to standardization of School location, there should be a committee that includes city planners. Ministry of Education should at least use a planning agency to assist them in this matter however the results show a big gap in the results of the existing School location, which means that educators had the upper hand in deciding School location standards. (Okan, 2012)

<p align="center">**2.2** Case Study: Jeddah, Saudi Arabia</p>

Jeddah as a main gateway to the holy city that is called Makkah Al-Mokaramah. Jeddah city has a seaport and an airport to welcome pilgrimage to Makkah. For these reasons, Jeddah has a potential for exhibiting smart growth with the help of the present master plan the capabilities of recent master plan to support the sustainable development along with the improved livability and quality of life. Three approaches have been adopted to study the objectives and they are: theoretical, analytical, and applied. Based on the findings of the theoretical method support two strategies were suggested for smart growth of Jeddah, first - development of cultural and touristic activities in zones, second – accessibility and transportation networks to enlarge the already congested road networks. The argument on Jeddah Gateway and Urban Development Strategies favored economic sustainability in explicit scales (Samaa et al., 2017).

Urban and social impacts of waterfront development on Jeddah Corniche (Corniche is the locals naming for waterfront) stretching 68 miles or 110 Km along the Red Sea. A qualitative research was conducted, and the results indicate that the Jeddah Corniche waterfront is "part of lifestyle for 75%" of the residents (Mostafa, 2017). Most of the residents like Jeddah Corniche with trees, green areas, sculpture, and artwork, more of a community involvement on cultural and recreational aspects. supports the impact on the urban and social developments near the waterfront areas, which is the driver of the development. The religious head quarter of Makkah located at the south side of Jeddah, nearest seaport city, has influenced the northward development along the seafront and this tendency is more evident with the further northward movement, which needs to be examined (Mostafa, 2017).

2.2.1 Transportation Capacity

There are 6,051,883 daily trips in Jeddah in 2007 (Aljoufie et al., 2013). When the population increases, road infrastructure must increase to serve this population growth. Therefore, Jeddah city road infrastructure growth rate is between 3.5% and 4% annually in the city. (Al-Enazi, 2016) We can describe the city of Jeddah as a low public transportation services city, there are around 50% of Jeddah population who have low access to public transportation system or in some cases they have no access at all. 51% of the population are 800m walking distance from bus stations or the public transportation points. (Aljoufie, 2016) Jeddah could be described as a complex urban growth phenomenon and spatial regression analysis is recommended to investigate the spatial-temporal mutual effects of transport infrastructure and urban growth for Jeddah city. Remote Sensing data and GIS

techniques are employed in this poly-centric city to analyze the global spatial autocorrelation and population growth, spatial expansion, residential land use expansions were considered in the spatial regression model as the function of highway expansion, main road expansion and secondary road expansion to estimate the parameters. The model was tested for opposite effects in reverse regression model. The findings exhibit the population growth and highway expansion effects on temporal-spatial clustering. The results indicate the significant positive global auto correlation for the years 1980-2007 and the spatial clustering is matched with spatial clustering of transportation infrastructure expansion (Aljoufie, 2016).

The article's main goal is to study five indicators which are: 1) population density, 2) car ownership, 3) unemployment rates, 4) poverty, and 5) number of widows and divorced women. Using these five indicators and apply the weight system (high, medium, low) to define each district needs according to these indicators. The author presents other indicators that can be used to study the need of public transportation system, but lack of information and data of other indicators was enough to exclude them. The results show that 49% of the population is between low- and medium-income groups; moreover, 10.5% of the population do not own cars. In addition, the results of this paper show a high population density in many districts which are in need for public transportation services and most of these districts are in the city center. The result of this study also shows that 27% of the population are in high need for public transportation and 38% are in medium need. (Aljoufie, 2014)
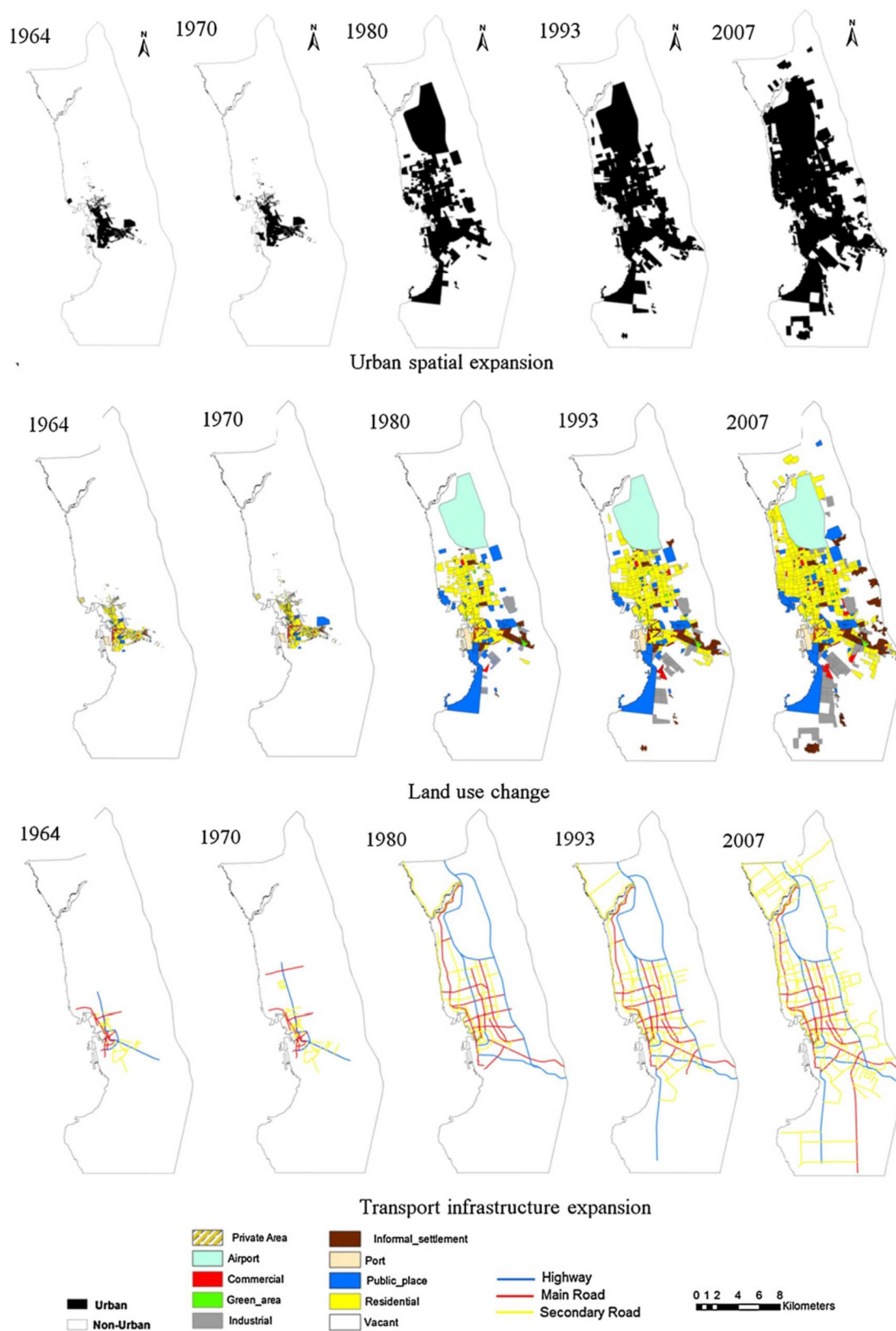
Figure 3: Jeddah Urban, Land use, and transportation (Aljoufie et al., 2016).

Transportation infrastructure is increasing due to population increase. Transportation infrastructure reached 826 km in 2007. Public transportation system will help in reducing economical losses and solve problems such as air pollution and greenhouse gas emissions. Due to mostly car dependent lifestyle in Jeddah the daily trips using public transportation system decreases to reach 2.3% in 2007. In addition, walking and cycling reach 4.6% in 2012. Jeddah is considered to be a car dependent city where 96% of the population are using cars in their daily transportation in 2012. This results in high congestion in streets during peak hours and rush hours, also in non-peak hours. Georeferencing technique is used on the image data from the satellites to develop urban growth and transportation indicators to calculate the annual urban spatial expansion index, annual land use change index, road area density index, urban density trip index, modal split change index to establish the relationships between urban growth and transportation. The findings exhibit existence of significant relationship between urban growth and transportation thus concluding that the enormous spatial expansion caused changes in the daily transportation trips. (Aljoufie et al,. 2012)

When planning, community participation and people views must be put into consideration and that what Aljoufie, 2016 did. To find the best practice according to people's preference to introduce and determine the recommended public transportation planning system. 967 completed questionnaires concluded that the public are willing to walk 5 to 10 minutes to reach the public transport station (Aljoufie, 2016). Moreover 43% prefer metro as the best preferable transport mode that has one transfer point to reach their destination. The study showed that families are willing to use public transport system in Jeddah and around 30% will use it with special requirements which is mainly privacy

requirements. 80% of the participants in this survey income was below $50,000 US dollars annually (Aljoufie, 2016), t here is a potential demand for public transportation system in city center. Trying to find the best practice according to people's preference to introduce and determine the recommended public transportation planning system. Indicators that were excluded are job average, number of job holders Warehouse, income, and other indicators that was difficult to be used. After the year 1980, the expansion of the city road network was happening in the country secondary networks category. In addition, there are some minor expansions in the main road network between 1993 and 2007 (Aljoufie, 2013).

2.2.2 Transportation Modes

Jeddah in terms of population density, existing bus public transportation system, public demand to increase public transportation infrastructure, importance of Jeddah location and the fact that it's a coastal city with a liner urban development, and to study the transportation modes. The main objective of this part is to underline the accessibility to schools using various transportation modes such as cars, walking, biking, and public transportation taking into consideration of the city urban and environmental aspects. Transportation modes throughout the public level will be presented to demonstrate Jeddah transportation issues on its public level. Then transportation to secondary schools and interconnections of modes will be concluded.

The main two bus public transportation methods recently in Jeddah are Saudi Arabian public transport company - SAPTCO and individual private buses. SAPTCO has only around 90 buses that covers a distance of 150 km (93.21 miles) in certain areas in Jeddah. These 90 buses service only eight lines. Private individual buses cover 160 km of

the city and service 10 lines. There are around 1737 Individual small buses that only carries

19 to 21 passengers. These buses are old, and their models are between 1972 and 1982.

Only 5% of these buses are in good condition and valid to carry passengers. (Aljoufie,

2016) This shows how limited is public transportation that is for public use, and it is

negligible when it comes to transporting to schools.

Figure 4: Public Buses in Jeddah - SAPTCO (Aljoufie, 2016).

Figure 5: Public Buses in Jeddah - Individual Private Buses (Aljoufie, 2016).

There are many challenges of biking use in fast-growing and highly dense city such as Jeddah. Visual examination of the bicycle facilities at ten locations in the city of Jeddah was taken up against the AASHTO (2012) guidelines (Aljoufie, 2017). Simultaneously, qualitative methodology in the form of questionnaire was supplied to 886/1250 residents to respond on the commuting attitudes and perception of the obstacles. The findings of the visual examination on the availability of biking facilities show that they are inappropriate and discouraging. While most of the respondents favored biking; however, 92% believed that the facilities are inadequate and it is not safe (Aljoufie, 2017).

Undeniable health and environmental benefits of bicycling. challenges of bicycle use in fast-growing and highly dense city. Visual examination of the bicycle facilities available at ten locations in the city of Jeddah was taken up against the AASHTO (2012) (p.272) guidelines. Simultaneously, qualitative methodology in the form of questionnaire was supplied to 886/1250 residents to respond on the commuting attitudes and perception

of the obstacles. The findings of the visual examination on the availability of bicycle facilities show that they are inappropriate and discouraging. While most of the respondents favored bicycling (88% - good for environment, 90%-good for health, 78% - economical) (p.277), However, 92% believed that the facilities are inadequate and it is not safe and 82.5% (p.278) quoted that the hot weather is the main obstacle for a bicycle ride, resulting in opposing opinions. However, bicycling paths can be considered for planning for shorter trips in neighborhood streets for health, environmental and economic reasons and main roads can be excluded from the bicycling facilities for infrastructure and safety aspects. (Aljoufie, 2017)

In Jeddah, public are willing to walk 5 to 10 minutes to reach the public transport station. (Aljoufie, 2016) 82.5% of 886 participants quoted that the hot weather is the main obstacle for walking and biking. Average temperature in Jeddah throughout the year is 95° Fahrenheit at its maximum and it considered to be high for students to walk to school. (Average monthly temperature in Jeddah (Makkah Al Mukarramah Province, Saudi Arabia. In addition,10.5% of the population do not own cars. (Aljoufie, 2014). there is a small and negligible number of students will attend school using walking and biking.

Due to mostly car dependent lifestyle in Jeddah, daily trips using public transportation system decreases to reach 2.3% in 2007. In addition, walking and biking reached 4.6% in 2007. By 2012 Jeddah is considered to be a car dependent city where 96% of the population are using cars in their daily transportation and all other modes of transportation is only 4%. (Aljoufie, 2014) Therefore, Jeddah considered to be a car dependent city (Aljoufie, 2016) In other word, the level of interconnection is very low and unsound between cars and other transport mods. This results in high congestion in streets

during peak hours and non-peak hours. Personal family cars considered to be the most use transportation modes to schools for both boys and girls. Both genders can't drive until 18 years old which is after finishing high school. Therefore, both genders in transportation are dependent on their family to drive them to schools. In other words, in terms of transportation, gender does not apply and we could join boys and girls under one category which is students. Walking and biking paths can be considered for planning for shorter trips in neighborhood streets for health, environmental and economic reasons and main roads can be excluded from the biking facilities for infrastructure and safety aspects (Aljoufie, 2017).

School bus service for public schools does not exist and it's recommended (Belarem et al., 2018) Unfortunately, there is no school bus in Jeddah. Jeddah is facing a traffic congestion without school buses and the situation will be worse if public school buses inter Jeddah's road network. Jeddah is struggling in the choice of transportation modes on the public level, this will conclude that for traveling to schools the situation is worse. The result, car as a transportation mode is the only traveling mode to schools (Belarem et al., 2018) Al-Enazi studded Al-Rawdah neighborhood to calculate car congestion during the time between 9 a.m. to 3 p.m. The results confirmed that Jeddah struggles with traffic congestion. Traffic congestion is when the capacity of cars is more than what the road network can service at a certain time (Al-Enazi, 2016).

2.2.3 Population in Jeddah

The city of Jeddah is dealing with an increased population and population movement that is happening from the surrounding villages and suburbs around the city because of working opportunities. The opportunity of getting a job in Jeddah is much

higher than in villages around it. Jeddah is the second city in the Kingdom of Saudi Arabia after its capital Riyadh in terms of size. There are 95 districts in Jeddah with a population of 3.4 million people. Population density in Jeddah was measured by two types of GIS mapping methods which are dasymetric maps and the classic choropleth maps. Dasymetric maps are more detailed than choropleth maps because it excludes all building areas that people don't use and exclude the unbuilt areas. Therefore, the density will change because the population density formula is the population over area. Once the area will reduce and area is the dominator, the population density will increase. For example, dasymetric map of Jeddah City (Natural breaks, Jenks classification) population density reach 62,391 people per square meter. On the other hand, choropleth map of Jeddah City (Natural breaks, Jenks classification) maximum population density reaches 57,379 People per square meter. Dasymetric map is more accurate when coming to calculating the population density because it's using satellite images to determine the un-built areas. (Hamza et al., 2016) The theoretical background of the housing demands with regard to choose and affordability in Jeddah is exceptional and reflects the population density. Housing development activities by the government as well the private sector in Jeddah is growing at fast paced to accommodate Jeddah's growing population. Income levels, population growth and housing demands are evaluated. Historic trend pertaining to the period between 1970 and 2001 historical statistics revealed that by 2001 Jeddah had 4.6 rooms per house and 1.16 persons per room (Abdullah Al-Otaibi, 2004).
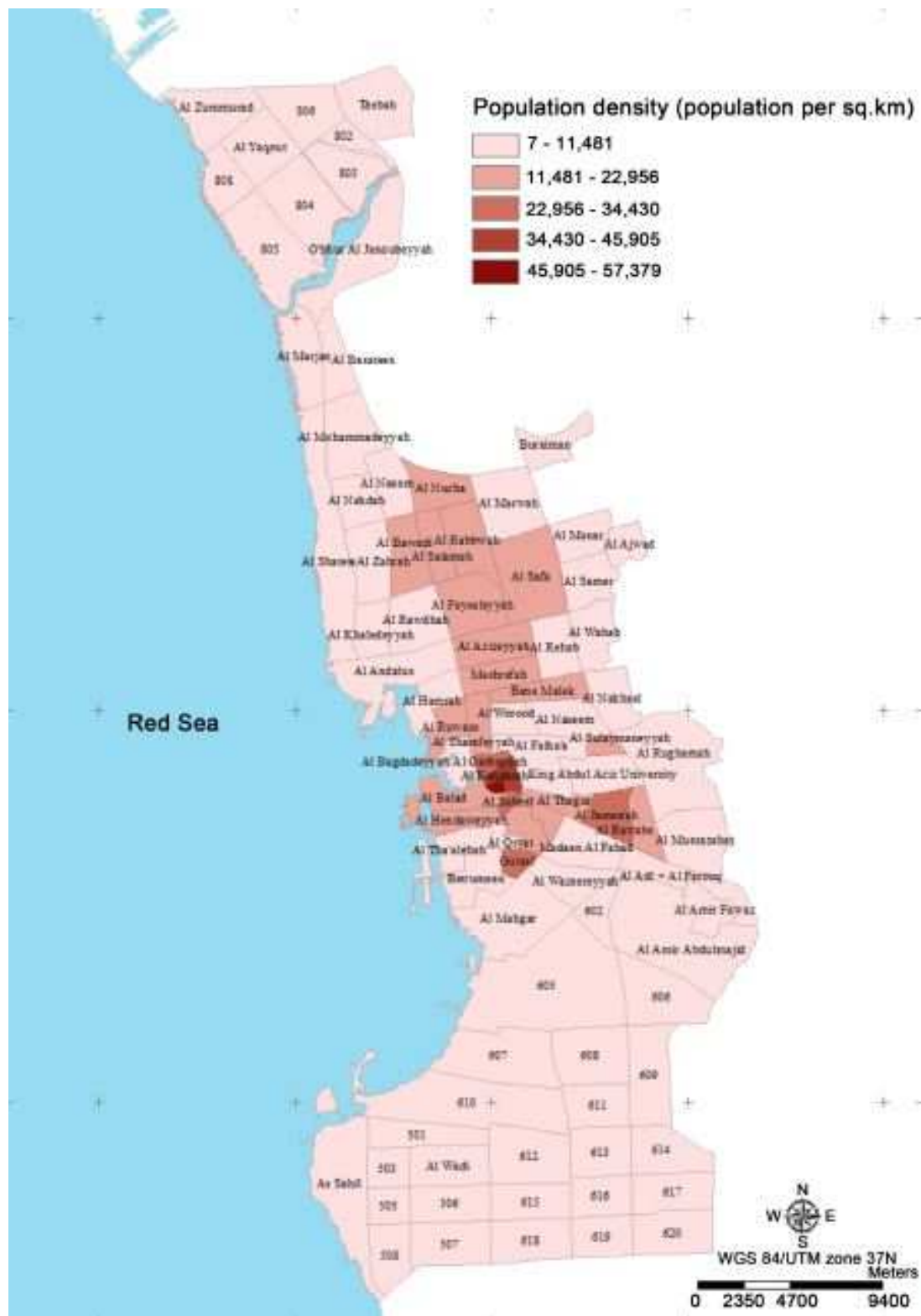
Figure 6: Jeddah population density (Hamza et al., 2016)

2.3 Geographical Information System

GIS spatial tools a useful tool for urban planning, educational sector, city planners and decision-makers. (Lagrab et al., 2015) GIS is considered to be a helpful application with regard to education facility planning and management, GIS enhances the quality of the services. School planning criteria depends on land use, school distance from its surroundings, and population taking into consideration (growth rate). Increasing educational facilities in terms of quantities and quality is something that all educational authorities are taking into account and it is one of their main objectives. Using geographical platform to help educational authorities in siting and selecting location for schools is becoming a fact and a must have application. Moreover, GIS will help in store, present, and analyze all kind of geographical information. Using GPS database into Geodatabase to manage this information efficiently and to transfer information and data into mapping infrastructure that will help in extracting this information later in a very easy way. For example, if you point out one of these schools on the GIS map platform, it will immediately show in a pop-up window number student population, teacher data, and school inventory data and so on of related school information. GIS illustrate information using mapping and tables, therefore, knowing the information will be easy. For example, if you want to know if a school has a conference hall or not, GIS can provide this information easily on a map or from attribute tables.

For example, if there is a playground in that school or not? Another example, if the school had a computer lab or not? Most schools have shortage with their facilities such as playgrounds and libraries. Moreover, student density in schools considered to be high with comparison to the standards. Finally, some schools are operating in the same area

which lead to random distribution of schools which lead to unequal distribution. (Jalal et al., 2018) GIS was used in school location selection in Georgia which is a developing country. "In developing countries, only few GIS projects are successfully applied and utilized for decision-making." (Okan,2012) With these information and database, school location evaluation and analysis will be much easier using GIS rather than trying to figure it out from Excel sheets and tables. Using geographic information system GIS in school location planning that is related to urban and modernization planning is a very simple thing in developed countries. For example, in the United States of America this application could be done within hours; however, in developing countries such as Kuwait, Georgia, and Saudi Arabia it is not the same case. Simply, it has not been done in Saudi Arabia until 2019, using GIS in allocating schools and determining the educational facility location is a reflection of the existing data. GIS is simply taking the available data and connect it to the geographical data. Therefore, using GIS to find the best school location in developing countries is something that might seem easy and minor for the developed country however it's a big step toward urban and city planning in developing countries.

Using GIS in studying school location helps researchers and city planners on finding best location for a school in future and applying school standard. GIS applications can highlight clustering areas in the district, irregular school plotting, school concentration areas, and what is the direction of school distribution. In Yemen which is considered to be one of the developing countries, GIS was used to study kindergarten location. The outcomes of this research were that most of kindergarten did not apply authority standards. In addition, number of kindergartens is less than what is needed or required, and these kindergartens was distributed spatially irregularly. Only two kindergartens in Mukalla city,

where according to the standard and regulations, there should be 9 schools which means a shortage in 7 kindergartens. (Lagrab et al., 2015) Mukalla city which was the area of study in Yemen is Hadramout Providence capital city and it is a coastal city exactly like Jeddah city in Saudi Arabia and its development is considered to be a linear development parallel to the coastline In the East-West direction along a distance of 161,749 Km2. In 2004,) Mukalla city population was 180,000 with a 3.8% growth rate and around 80% of the population lived in City Center. This case study considered to be the first study about school location in Hadramout Providence that used GIS applications. The study concluded that Mukalla city School problems are: Irregular school distribution, not applying school criteria in construction, and number of schools are less than the student population. Principle of equality was used to solve some of these problems. There are four major contributions by using GIS and they are Informative presentation, to help in projection, analysis will be more detailed, and flexible assistant. There are many other advantages by using GIS such as school distribution, where GIS spatial mapping is showing areas that have a lack of schools (Sharma, 2018).

2.3.1 Euclidian-Distance and Network-Distance

Distance to school can be measured using Euclidian-Distance (ED) and Network-Distance (ND) in GIS. ED is a straight-line distance from the student location which is a student house to the school location regardless road network. On the other hand, ND will be reference to road network and it will measure distance using road network. (Upchurch et al., 2004) ND measures actual traveling distance that might affect the school choice, in other words using road network will find out the shortest network distance (SND) to a

school. ND is considered to be more accurate than ED. In addition to SND, there is shortest

network time (SNT) which concentrate on traveling time through road network.
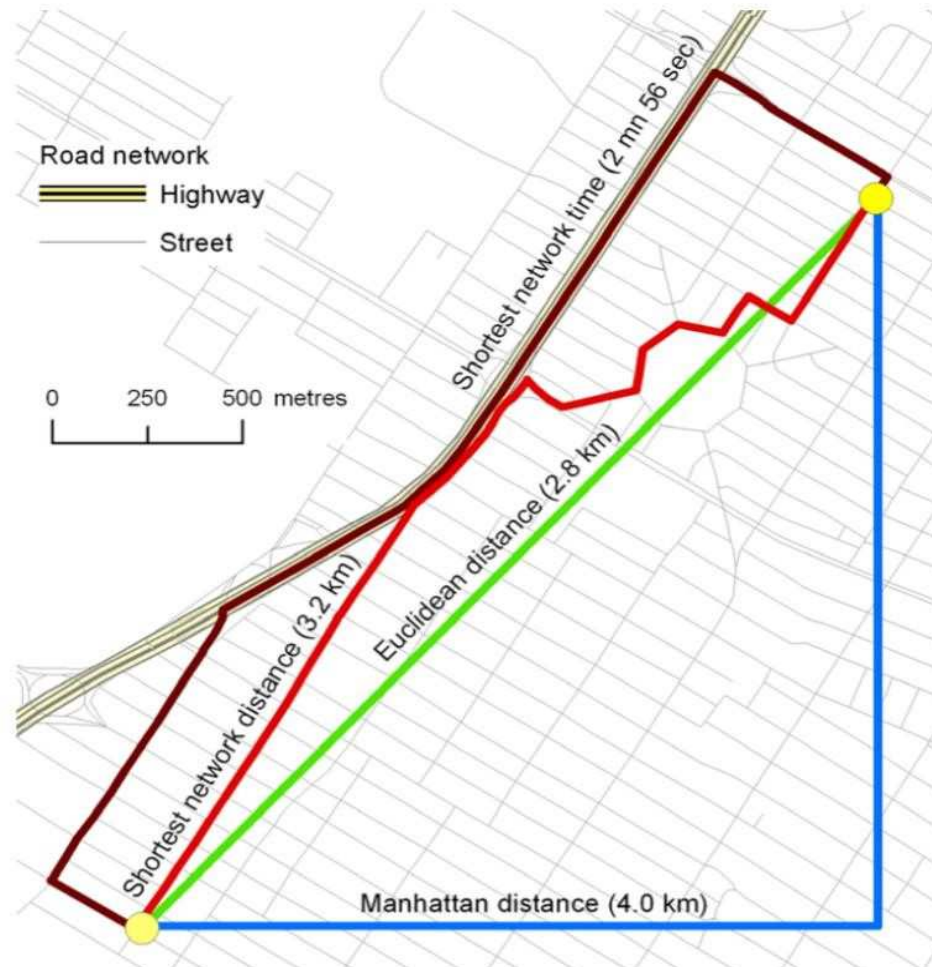
Figure 7: Different types of distance (Apparicio et al., 2008)

In addition, in SND we could also calculate traveling time. Traveling time is going

to be the distance over the average speed within the road Network. Moreover, cost could

be estimated if we know the distance, time, car oil price, and other factors. In SNT and

from a numerical point of view, it should not be called distance, it should be called how

far? Because if we are going to talk about the distance, the numerical unit is in meters or

miles not in minutes or hours, therefore the right description is how far is the school from the house? Buffer is considered to be the service area around a nod which in our case will be school. As shown in the figure below, an ED 800m buffer radius is different from an 800 ND buffer, this is due to the use of road network in ND buffer zone. ND will cover a smaller radius of an irregular circle and the margin of error between ED and ND will be the gap between the two buffers. There is a difference between ED and ND in the range of coverage even though when using the same number as radius. In other words, the result of 400 m buffer might reach a 100m in difference or more between the two methods "Median Euclidean distance to the nearest food bought out of the home outlet was 239.8 m, but 398.8 m when constrained to the street network, and with a much greater range." (Burgoine et al., 2013) Moreover, in less dense neighborhoods, ND is more preferable than ED as an analysis (Burgoine et al., 2013).
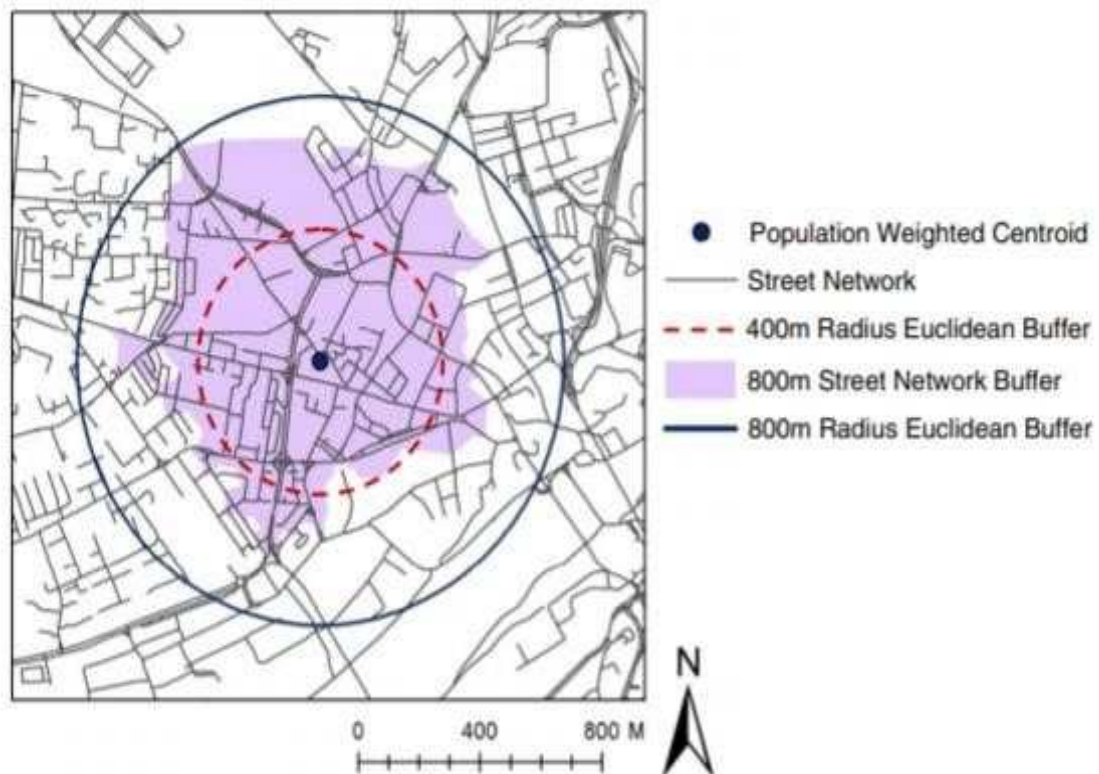
Figure 8: Difference between ED Buffer and ND Buffer (Burgeione et al., 2013)

Thiessen polygons (Upchurch et al., 2004) could be used to minimize buffer intersection. Thiessen polygons when integrated with buffer analysis will be useful. For example, two or more school buffer zones interest or when the same student falls in two or more buffer zones. Euclidian-Distance Buffer zone technique is used to study schools surrounding area and their facilities to evaluate school location. ED Buffer Zone technique was used to evaluate recent school location to gas stations, main road, and industrial areas. An example of a useful ED buffer zone practice is when a 100m Euclidian-Distance buffer zone (also called circular buffer zone) was used to measure distance between schools and gas stations. School standard minimum requirement is a 100m (328.084 feet) away from a petrol station or any other risky hazard areas (Okan,2012 & Lagrab et al., 2015) Gas stations considered to be a dangerous entity when it is close to schools and especially less than 100 meters, it's considered to be a risk to schools and residential areas.

Another example of an Euclidian-Distance buffer zone of 0.3 miles or 500 meters was used to analyze school coverage area. In other words, 0.3 miles is the maximum distance between a school and another school, If there are some areas that are not covered with the buffer zone circle, that means a school is needed to be built in that area. The 0.3 miles buffer zone between schools should cover the whole city residential area. (Okan,2012) The researcher Okan decided that this city buffer zone is 0.3 miles or 500 meters, however, deciding on the diameter of school coverage circle buffer zone is according to the population density and student population density.

Using buffer zones or buffer analysis in GIS around bus stations and public transportation points to evaluate distance. According to the guidelines, it should be 0.25 miles which is 400 meters and its multiples as a walking distance to reach these points. In a case study that took place in Jeddah, the results were, 41% of the city population was within the 0.25 miles which is 400 meters walking distance; however, 51% was within the 0.5 miles which is 800 m buffer zone walking distance (Aljoufie, 2014). GIS could be used in studying and evaluating traffic congestion. Al-Rawdah neighborhood in Jeddah was studied to calculate car congestion between 9 a.m. to 3 p.m. Traffic congestion is when the capacity of cars is more than what the road network can service at a certain time.

Traffic congestion is a result of increased population and modernization lifestyle. The shortest path analysis using Network-Distance buffer zone was used to determine road congestion. The author used GIS mapping applications to study road congestion of Al-Rawdah residential area that depends on road direction. This neighborhood contains streets that are two ways and connected to the main roads. The recommendation of the study was to make an Al-Rawdah street a one-way street that will connect with the main road to reduce congestion. Further studies using GIS can be applied in managing city services and public infrastructure distribution (Al-Enazi, 2016).

CHAPTER 3

DESIGN OF THE STUDY

This research is based on Jeddah administration boundary which consists of 95 districts. The Red Sea is the boundary of Jeddah from the west, city of Rabeq from the north, city of Khrace from the east, and Bahrah from the south. Jeddah population reached 3.4 million individuals as of 2016. (Hamza et al., 2016) This information considered to be the latest population update from a credential institute which is King Abdul Aziz University in Jeddah. Girls school study used the same data set from (Hamza et al., 2016) What might work for a city might not work for another due to different cultural, geographical, and financial aspects. Considering the very conservative socio-culture in particular to Saudi Arabia, preliminary guidelines for sustainable neighborhood with an intervention of bio-climatic conditions (Fatani at al., 2017).

Even though that there are standards for traveling time and distance between schools and prospective student, each city has a unique situation that requires a close attention to its own standards. Jeddah city planner might use standard from other case study cities that are similar to Jeddah. However, the city of Jeddah could raise the roof of standard according to its needs and goals. To do such enhancement in standard quality, Jeddah first needs to know where it stands and what are the actual and real standard that are in place. This is the main goal of this research, is to lay down the real and actual situation and then we are going to set the bar for future enhancement with regard to standards. Jeddah city planners find difficulties when planning to increase walking and biking to schools, where the actual and real situation is that a student need to travel more

than 15 minutes by car to reach a school. It's nice to have such ambitious goals or targets; nonetheless, these targets could be for future achievements. In other words, they can't go from A to C immediately, they need to work in patterns and gradually improve the standards by going from A then B and then we reach C. With regard to developing countries, these countries have two recommended options: to take a successful methodology of another country and adopted it into their system or they have to go into the long trial and error procedure and practice to figure out their mistakes and correct them along the way. These are two different philosophy schools of thoughts, the main problem with the second choice which is trial and error is corruption, and the misuse of governmental funding.

Jeddah city planners can use standard from other cities or could use international or global standards if the city infrastructure is capable of attaining such standards; however, it will be very difficult to apply these standards if we don't have school proper network, public transportation, and public services infrastructure. The reasons that Jeddah have schools in its recent physical location is due to rapid change in land use plan and because of high population demand. According to the literature review, schools in Jeddah was built in an imbalance way. Land use of the city was changed dramatically in the last 50 years and there where multiple master plans for the city (Abdu et al., 2002). The only reasonable approach is to study recent patterns of actual physical school location and from there we can recommend future solutions. One way of evaluating and analyzing a situation is looking into the outcomes and results of actions, if these outcomes or results are not meeting planning criteria, that means something went wrong in the process and a change must be done to fix it. looking into the bottom line of any previous practice and evaluate

the conclusions is the best approach in determining if the previous practice was right or wrong. There are two expected outcomes of such practice which are fixing previous mistakes and avoiding these mistakes in future planning; however, sometimes it's going to be difficult to fix previous mistakes and other alternatives should be considered.

3.1 Planning for cars only

Most of the studies showed that walking distance between 10 to 15 minutes is the time that parents could allow they children to walk or bicycle to school. Many studies discussed active transportation for children by walking or by bicycle to increase physical activity for the kids and their health. Trying to solve transportation congestion around schools in Jeddah by walking or cycling neglecting safety and neglecting that we are living in the private vehicle era is a huge mistake. Cars has proven itself to be the most reliable transportation method in our century. All articles are showing this result that commuting to schools using walking and bicycling is reducing overtime; therefore, trying to find a solution that increase walking and bicycling is swimming in the wrong direction. Jeddah planners should not encourage planning towards increasing a trend that is declining. In other words, it's against what is really happening in the real world. Trying to increase walking to schools and bicycling to schools is against modern way of living, especially in cities and modern cities such as Jeddah.

Jeddah is struggling on public transportation modes for the public, this will conclude that, when traveling to schools the situation is worse. The result, car as a transportation mode is the only traveling mode to schools (Belarem et al., 2018) Studies has shown and proven that there are many obstacles against walking and bicycling to

school even though there are a small percentage of students are still using walking and bicycling as a transportation mode to schools. Urban planners of cities with high density of population main target are to expand the city activity and this is this research target by using school location as an attraction. Building schools outside clustered areas will attract families to live closer to these schools especially if these schools have high performance or have a high rating in the education system. Moreover, guidelines of building new schools depend on population density and distance between these population and schools.

3.2 Research Data

School location standards in a developing country such as Kuwait are defined by the Ministry of Education (MoE). Spatial data analysis points out that there is a huge difference between what has been planned by the Ministry of Education in terms of school location standards and what has been done. The percentage of this attrition from the main point reached 72% in some cases. Therefore, two main recommendations have been concluded and they are relocation of these schools is a must to enhance the services and accessibility. Secondly, to adopt these principles in future school planning (Al-Rasheed et al., 2013).

While the responsibility of schools and all its related aspects in Kuwait is the Ministry of Education (Al-Rasheed et al., 2013), In Bangkok it's a completely different responsibility. Here we have two different administration structures; in Kuwait we have one governmental ministry that is responsible for school location and in Bangkok we have several Ministries. In Kuwait it was very easy to extract school's information from the Ministry of Education and create school mapping; however, in Bangkok case it was not that easy. A Bangkok case study had to go over all database from all participating

Ministries and then came up with one reliable Database. In Bangkok there are metropolitan administration and many other ministries who participate in school location. The effect of such overlapping jurisdiction, database is all over these parties and it is very hard to gather this information into one database. Yamen is similar to Bangkok, school's data was collected from the Ministry of Education, Ministry of statics, General Authority for land survey and Urban planning, and field surveys such as interviews and observations. Ministry of Education provided the data with regard to the location school name and number of children each School. Ministry of statics provides that is related to population densities expected annual population growth rate. General Authority for land survey and urban planning data was to provide the researcher with the land use and to define the boundary of the district. (Lagrab et al., 2015) All of these data must go through data preparation stage which means cleaning and adopting these data to be compatible to GIS data entry regulation.

Georgia was much easier to collect school data than the case of Yemen and Bangkok. It is very easy to find all related data from the Ministry of Education and Science of Georgia in the governor's website that includes number of schools, student's capacity in each school, school physical condition, and so on. Database was extracted on Old Tbilisi District in Georgia to evaluate and analyze school location using GIS and statistical approaches. The only thing that was missing is transferring these data to a geographical format, which is normal practice when using GIS. Database is considered to be the most valuable element in GIS, and it considered to be 80% of work and time required to develop a GIS implementation. The information and data could be there but it's not for the public, the right information and data could be within the governmental authority and it's not an

open source. Another challenge that is facing the developing countries in regard to selecting the most suitable location for schools is lack of proper regulations, standardization, and requirements. All information and data set about public high schools for boys was taken from the ministry of Education in Saudi Arabia. Data set used in this research with regard to the population distribution was in the 95 districts was obtained from two articles which are "Dasymetric Mapping as a Tool to Assess the Spatial Distribution of Population in Jeddah City (Kingdom of Saudi Arabia)" (Hamza et al., 2016) and "Mapping and Analysis of the School Network of Makkah Al-Mukarramah (Saudi Arabia), Jeddah Girls' Secondary Schools as Example"(Belarem et al., 2018).

3.2.1 Data Preparation

In Jeddah public schools, there are regular schools and they are called day schools, special need schools, Quran schools (Religion schools). According to the list from the Ministry of Education in Saudi Arabia there are 152 public high schools for boys in the city of Jeddah. (Appendix B) However; many of these schools are duplicated in that list. The reason of such duplication is that the same physical location of a school is being used for different types of schooling. For example, a physical location of a school will be used as a day school, night school, and a school for special needs. Therefore, duplication is happening in the list from the Ministry of Education in Saudi Arabia, because these three types of schooling will be listed as 3 schools where it's only one school as a physical location. After cleaning the data from Ministry of Education in Saudi Arabia from duplication schools, it was found that 39 schools out of the 152 schools were duplicated and was excluded from the list. Therefore, the number dropped from 152 schools to 113

actual physical schools. This research target is to study school location distribution and only schools with physical location are in the research importance.

In addition, there are many schools that are outside the boundary of the city and still count to be in Jeddah. The reason behind this kind of misleading information is that many schools are in the near villages to Jeddah. Another reason is that the educational boundaries is different from the admiration boundaries of the city. Therefore, there are 15 schools that are outside of 95 Jeddah administration boundaries. These 15 schools are excluded from the list of the Ministry of Education in Saudi Arabia. As a result, out of the 152 schools in the list, 39 were duplicated as discussed before and the number of accepted in research schools reached 113 schools, now out of these 113 schools we have 15 outside 95 Jeddah boundaries. The new number will be 98 schools after subtracting 15 from 113 schools. Out of these 98 schools there are three for religion studies three for special need education and 2 schools are inside jail or prison. These 8 schools will be excluded because these schools are for spatial cases, moreover, the number of students in these schools is very small. After removing 39 duplicated schools, 15 outside boundary schools, three religion study of school, 3 special needs education school, and 2 jail or prison schools, the remaining 90 schools are for day public boys high schools. These 90 schools represent the physical location of schools within the 95 districts (Appendix B).

School Type	Number of Schools
Day Schools	90
duplicated	39
Jail Schools	2
Outside 95 Jeddah Districts	15
Religion Schools	3
Spatial Needs schools	3
Total	**152**

Table 2: Type of public boys' high schools

To use these schools in GIS, X and Y coordinating system which represent the altitude and longitude of school location. Since this research is based on distance between schools and student homes, schools that are outside city boundary and adjacent to Jeddah will be considered in this research. The logical reason behind this is that a student will travel to the nearest school regardless city boundary because Jeddah does not have school zoning. City buffer will be used to include adjacent schools to Jeddah.

3.2.2 Spatial Analysis

The research methodology between cartesian distance (ED & Manhattan) or network distance is often decided based on the availability of data. ND requires a network and in our case, it is going to be road network that can be implied in GIS with all required data. These data have to be correct and up to date to achieve accurate results. These data of road network that is required are for example: the flow of traffic direction, if the road is two ways or only one way, stop signs for both individuals and cars, average speed during

daytime and nighttime with regard to congestion, and public transportation wait time is also required. (Apparicio et al., 2003) Although ND is highly accurate, the data as detailed above is required to calculate the service area of schools. Road network data base will be the most challenging data gathering.

School service area is in other word school buffer zone (Upchurch et al., 2004) both methods (ED&ND) are valid ways to estimate school service areas. There are many case studies that used ED, other case study that used ND, and others that used both. Both can be considered as appropriate for measuring distance (Apparicio et al., 2003, Burgoine et al., 2013, Apparicio et al., 2008) since the Pearson's correlation is 0.964 for ED and ND (Apparicio et al., 2003) in conclusion, for planning analysis, policy making and social studies ED can be adopted (Apparicio et al., 2003). Any of the methods could be justified and have the literature that support it, it will come to the researcher views, study outcomes, and most important is the availability of data. In view of the discussions, it is preferred to adopt ED. In congested cities such as Jeddah and schools are often in highly congested and populated areas, ED is sufficient.

CHAPTER 4

RESULTS AND DISCUSSIONS

Chapter four will concentrate on data analysis. First, population numbers throughout the years in the city of Jeddah 95 districts and the distribution of such population. Second, school information such as enrolment process, student numbers, and schools' numbers. Third, using spatial analysis to study school distribution and the accessibility to these school using euclidian and network analysis. Finally, to use the information from these three steps to simulate a future plan.

4.1 Population Distribution

Jeddah population as of 2014 data set was taken from Saudi Arabia central department of statistics and information (Hamza et al., 2016) and it is considered to be the latest and most recent population data set by the government of Saudi Arabia. This data set was released for research purpose as a grant by the Deanship of Scientific Research (DSR) at King Abdelaziz University, Jeddah. (Belarem et al., 2018). This data set is not for the public, it was released only to the researcher as a grant for research purpose. The name of Saudi Arabia central department of statistics and information was replaced by Saudi Arabia General Authority for statistics. Population latest data set that is released to public by General Authority for statistics was in 2010 and it was about total population at the regional level and it was 3,456,300 inhabitance. None of General Authority for statistics population data sets that are published to public deal with city level or city districts level. In addition, ESRI is a reliable source of information, Michael Bauer Research (MBR) is a business

partner with ESRI where MBR is considered to be the official data provider to ESRI. According to ESRI, Jeddah 95 districts population in 2018 is 3,818,174 people. There are many articles that agree on Jeddah population is 3.4 inhabitance. From 2014 articles to 2020 articles, still, Jeddah population is 3.4 million inhabitances. A simple conclusion, Jeddah population data is not up to date in these articles. Therefore, in this case study, a closer look to such number was a must to verify the 3.4 million inhabitances claimed by these articles. Jeddah population in 2010 was 3,430,697 according to Dr. Mohammed Aljoufie in his study in 2016 (Aljoufie, 2016). Moreover, in another study in 2016 that was about Jeddah population density and spatial distribution of Jeddah population, the author also motioned that Jeddah population is 3.4.

Not only that, but the author also indicates that these 3.4 million inhabitances are within the 95 Jeddah districts. It is well known in research field when writing an article, most of the authors will quote previous studies or previous literature. This was the case in most of the articles with regard to Jeddah population; however, many of these articles were using the same population without applying the proper population projection. For example, when (Belarem et al., 2018) quoted (Hamza, et. Al., 2016) that Jeddah population is 3.4 million inhabitances and there are many other examples, but I will finish with the following one. Again we found that the same author who is Dr.Mohammed Aljoufie uses the same exact number which is 3,430,697 in another article " Integrated Land Use and Transport Planning in Jeddah: Policy Assessment and Simulation" Like there is no increase even for one inhabitance! The same number in 2012 and 2016 by the same author who is also mentioning that the population expansion in the city is 3.5%.

Jeddah Districts
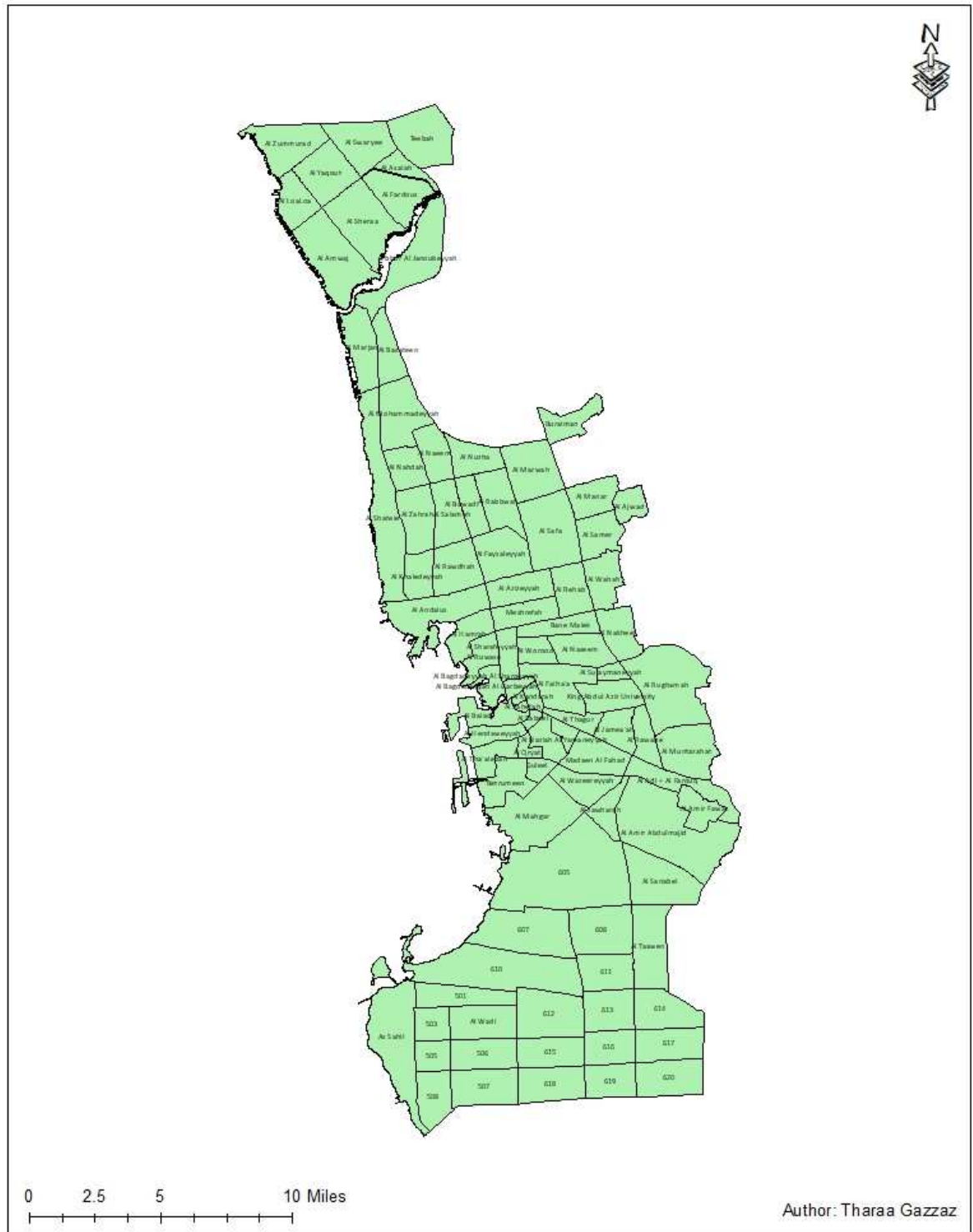
Figure 9: Jeddah Districts (Hamza, et. Al., 2016)

population per district
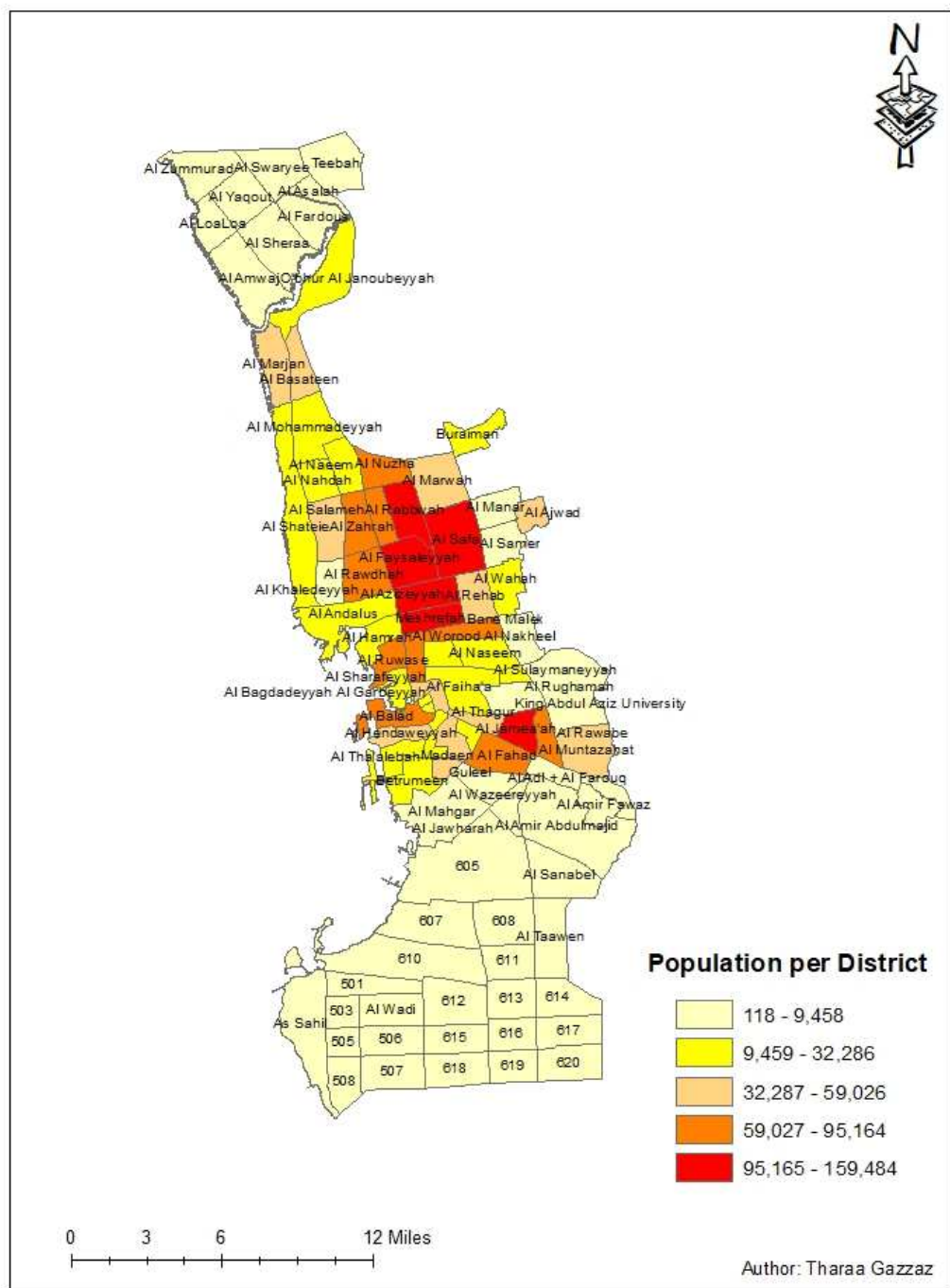
Figure 10: Jeddah Population as of 2014

<u>4.2 Population projection</u>

According to the dataset dated 2014 from Jeddah's 95 districts total population is 2,634,205 inhabitants. Moreover, reference to Jeddah municipality, population growth rate in Jeddah is 3.5%. From these two numbers, 2020 population could by calculated for each district. (Appendix C)

The formula to calculate projected population (Stoto,1983) is:

$$N = N_o e^{(kt)}$$

N= Future Population

No = Original population number

e= natural (a constant of 2.718…)

K = growth rate

t= number of years

The next step is to apply this formula to our case study keeping in mind that the increase will be evenly distributed in all the districts which is not the real case, and this is one of the research assumptions. N is the future population and in our case is the population for the year 2020. This is what we are traying to calculate and to estimate population number for the year 2020 from the dataset that is in 2014. (No) is the original population number or recent population number. In our case it is the population number for the year 2014, therefore, No=N2014. (e) natural is a constant of 2.718 and K is the growth rate and, in our case, its 3.5%; however, in this formula we need to use the decimal form not the percentage form. For example, if the growth rate is 1.7%, we need to divide it by 100 to get 0.017 as the decimal form. In our case, the growth rate is 3.5% as the percentage form; therefore, we are going to divide 3.5% by a 100 to get 0.035. (t) is number of years and in

our case is 7. As a result of population projection shown in Appendix C, 2020 Jeddah population in the 95 districts is 3,351,444 inhabitances. This projected number is very close to announced population by Jeddah municipality on its website which is 3.4 million occupants. Therefore, due to this almost matching result, same population projection will be valid to population by districts projection. Accuracy between actual population and projected population is 98.57%. Projected population could be adjusted to match recent population but there is no need because the 3.5% is an estimate percentage.

There is no official school zoning in Jeddah by the ministry of education; therefore, a student could attend any school that accept him even if it is outside his area. The most important two enrollment requirements are vacancy and school principal approval. If the school capacity is not full and there is vacancy, the chances of getting approved for enrollment is high. Some parents will enroll their kids into a school that is far from their home because of education performance. In addition, some students will go to other schools than the one in in their neighborhood because a particular teacher. For example, some schools will have the reputation of good teachers in math or in physics, as a result some students will try to be admitted into that school to gain better knowledge and to have better results in their grades. Another reason that some students will go to another school than the one in their neighborhood is to be with their friends or relatives.

Most of the students will attend the nearest school to their houses for shorter commuting time. Even though, there are many reasons that student will attend a school that is outside their neighborhood, these are considered to be exceptions because it is subjective to a special situation. Most of the students will attend the school that is closest to their house and to have shorter commuting distance between the school and their house. There

is no official educational grading and school ranking, in other words, all schools are considered to be the same in terms of education and there is no performance gap between a school and another. A parent or a student may argue that this school or that school is better according to their judgment; however, there is no official school grading from the Ministry of Education of Saudi Arabia which simply means all schools are in the same educational level.

<p style="text-align:center">4.3 <u>Students in Jeddah</u></p>

4.3.1 Boys' - High Schools

According to the latest published information (2015-2016) school year from Saudi Arabia ministry of education, there is a total of 78,478 male students who are in high schools in the educational territory of Jeddah. Jeddah educational territory consists of three cities which are Khelas, Rabuq, and Jeddah. Out of the 282 schools, 244 are in Jeddah city (Belarem et al., 2018) This might be misleading information because it's not clear from the first sight. In conclusion, the city of Jeddah educational territory is beyond Jeddah administration boundary. Also, these 78,478 students are distributed among all kind of school types which are public, private, and international. These students are enrolled in 282 schools as a total number of schools in the educational boundary of Jeddah.

Boys' High School		
School Type	Students	Schools
Public	55,168	174
International	8,627	59
Private	14,683	49
Total	78,478	282

Table 3: Number of schools and boys' students in Jeddah (educational Boundary)

4.3.2 Boys' – Middle Schools

High school in Saudi Arabia is only three years not four as in the United State of America. Middle school is also three years and middle school students are the students who will move to high schools and within a three-year period most of the middle school students will be high school students. Therefore, the number of future high school student could be predicted easily by knowing the number of middle school students.

Boys' Middle School		
School Type	Students	Schools
Public	62,610	204
International	9,870	88
Private	13,553	61
Total	86,033	353

Table 4: Number of schools and boys' students in Jeddah (educational Boundary)

According to the latest published information (2015-2016) school year from Saudi Arabia ministry of education, there is a total of 86,033 boys' students in 353 middle schools. Most of these 86,033 students will move to boys' high schools by the year of 2018-2019 since the information is in the school year of 2015-2016. As noticed, there are more middle school students than ~~that~~ in high schools. There are 86,033 middle school students in high school in general and only 62,610 are in boys' public high schools. Compared to 78,478 students in high schools in general and 55,168 of them are in boys' public high schools,

there are 7,442 more students in boys' public middle schools than in boys' public high schools. However, this will not be a problem in the current situation because of the occupancy percentage. Boys' public high school's occupancy percentage is 78.96% which means that current schools can accept 69,868 students which is more than 62,610 which is the number of boys' public middle school students. In case that all the students from public middle school students moved to high schools and the graduation rate was 100%, still the occupancy percentage will be 89.61%. It is worth mentioning that graduation rate in schools are not available.

Boys' students in Jeddah Public Middle Schools	62,610
Boys' students in Jeddah Public High Schools	55,168

Table 5: Number of students in middle and high public schools

In addition, according to the latest published information (2014-2015) school year from Saudi Arabia ministry of education, there are six grades in elementary schools in Saudi Arabia and there is a total of 121,396 boys' students in elementary schools. Most of these students will move to middle school's then high school.

4.3.3 Girls' – High School

Girls' High School		
School Type	Students	Schools
Public	59,782	162
International	3,381	45
Private	7,510	58
Total	70,673	265

Table 6: Number of Girls students and Girls schools

According to the latest published information (2015-2016 school year) from Saudi Arabia ministry of education, there is a total of 70,673 girls' students in 265 high schools. As noticed, there are less girls' students than boys' students in high schools in Jeddah. There are 70,673 girls' students in Jeddah high schools, compared to 78,478 boys' high school students. In public high schools, there are 59,782 girls' students and 55,168 boys' students. The difference between boys and girls public high school students is 4,614 girls' students more than boys' students.

Girls' students in Jeddah High Schools	70,673
Boys' students in Jeddah Public Schools	78,478

Table 7: Number of girls' and boys' students in public high schools

4.4 Schools in Jeddah

Most of boys' students attend public high schools and they are 70% of the entire student population. Out of the 78,478 boys who are in high schools in the city of Jeddah, 55,168 are in public high schools. In private schools, there are 14,683 (19%) of student population who attend 49 (17%) private schools.
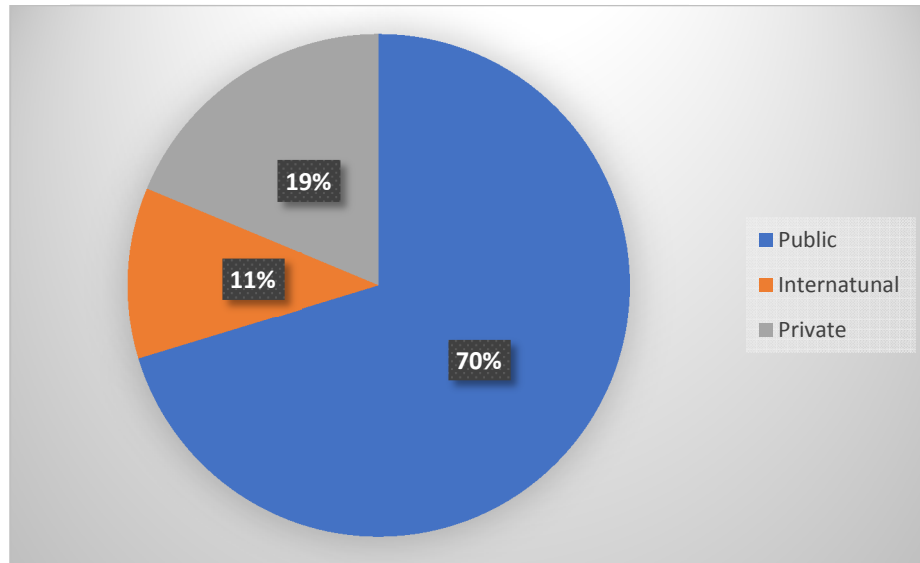
Figure 11: Number of boys' students in Jeddah high schools

International schools are mostly schools for students who have another nationality than the Saudi nationality. Most likely these schools are for foreigner countries such as Philippines, Indonesia, Japan, Ext. There are only 8,627 (11%) student who attend 59 schools (21%). These schools are most likely to be related to the embassy of the foreigner country to teach its language and culture. Average student population per school is 146 students. The number of students indicates school size, and it could be concluded that these international schools are small and most likely that these schools are not a standalone building and they must be within some building such as the foreigner country embassy.
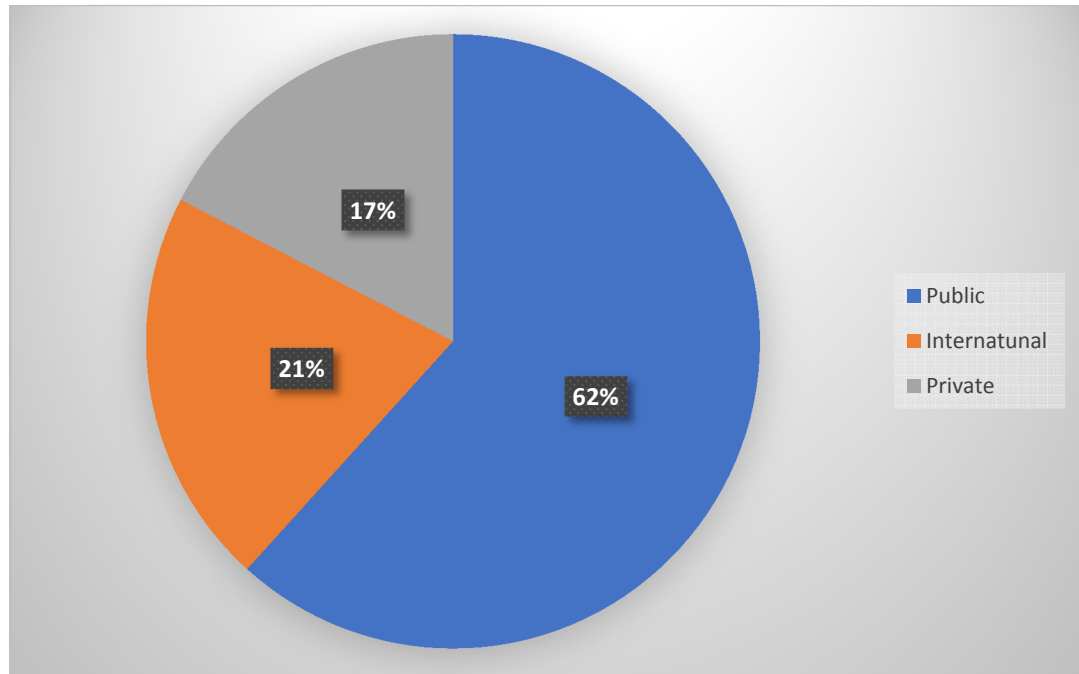
Figure 12: Number of Boys' High Schools (Educational Boundary)

This research concentration is Jeddah administration boundary as discussed before which is the 95 districts; therefore, our concern is the number of students within the 95 districts of the city of Jeddah. In addition, this research focus on the physical public schools which influence the city urban form and act as a community focal point. The level of information with regard to student is the educational boundary level, the ministry of education is providing this kind of information in their website since 2009. This kind of information will not apply to the research administration area, even though, it will give the research many insights and background to build on. The current situation with regard to occupancy percentage and as discussed in middle schools, high school occupancy will accommodate all of the current elementary schools. It might seem that there is no problem since the current high schools can accommodate all middle schools' students and all elementary schools' students without even considering the graduation rate. However, and with regards to the city population growth rate, this will not be the case through 2030 taking

into consideration that the data is from 2014-2015 school year. The research is solving the school distribution until 2030 incompatible with Saudi Arabia 2030 vision. Most importantly, this is the first investigation step in the research and the second part is to study these school's distribution. Therefore, it is not recommended to prejudge without applying the spatial analysis.

<div align="center">4.5 Spatial Analysis</div>

As discussed in the previous section with regard to student numbers in high, middle, and elementary schools, spatial analysis is the second analysis step. The research believes that using spatial analysis such as network and euclidian analysis, the results might be different. In the student numbers section, the conclusion was that there are no issues to schools, and it could accommodate all middle and elementary school's students. There are 95 districts in the city of Jeddah and 90 boys' public high schools. The first step is to examine the number of schools in each district to evaluate the situation. This kind of data evaluation could be extracted using GIS. Such information could by allocated geographically using Geographic information system to know how many boys' public high schools are in each district.

	District	Number of schools
1	609	0
2	620	0
3	614	0
4	508	0
5	618	0
6	802	0
7	505	0
8	As Sahil	0
9	617	0
10	615	0

11	611	0
12	501	0
13	608	0
14	619	0
15	503	0
16	616	0
17	Al Sahefah	0
18	803	0
19	808	0
20	Al Wazeereyyah	0
21	606	0
22	507	0
23	506	0
24	Al Zummurad	0
25	806	0
26	Al Worood	0
27	805	0
28	Al Yaqout	0
29	Al Bagdadeyyah Al Sharqeyyah	0
30	Guleel	0
31	Al Wahah	0
32	612	0
33	610	0
34	Al Hendaweyyah	0
35	Al Wadi	0
36	King Abdul Aziz University	0
37	Al Faiha'a	0
38	Al Tha'alebah	0
39	Al Nakheel	0
40	Al Ruwase	0
41	Al Balad	0
42	Al Nahdah	0
43	Al Bawadi	0
44	Al Basateen	0
45	607	0
46	Al Marjan	0
47	Al Zahrah	0
48	Al Mahgar	0
49	Al Ammareyyah	1
50	Teebah	1
51	613	1

52	602	1
53	804	1
54	Al Kandarah	1
55	Al Sulaymaneyyah	1
56	Buraiman	1
57	Al Ajwad	1
58	Al Manar	1
59	Al Bagdadeyyah Al Garbeyyah	1
60	Al Naseem	1
61	Al Adl + Al Farouq	1
62	Al Jamea'ah	1
63	Al Khaledeyyah	1
64	Al Hamrah	1
65	Betrumeen	1
66	Al Naeem	1
67	Meshrefah	1
68	Al Rehab	1
69	Al Mohammadeyyah	1
70	Al Rawdhah	1
71	Al Shateie	1
72	605	1
73	Al Sabeel	2
74	O'bhur Al Janoubeyyah	2
75	Al Qryat	2
76	Al Nazlah Al Sharqeyyah	2
77	Al Nazlah Al Yamaneyyah	2
78	Al Sharafeyyah	2
79	Al Samer	2
80	Bane Malek	2
81	Madaen Al Fahad	2
82	Al Amir Abdulmajid	2
83	Al Nuzha	2
84	Al Marwah	2
85	Al Andalus	2
86	Al Amir Fawaz	3
87	Al Muntazahat	3
88	Al Salameh	3
89	Al Faysaleyyah	3
90	Al Thagur	4
91	Al Azizeyyah	4
92	Al Rabbwah	4

93	Al Rawabe	5
94	Al Rughamah	5
95	Al Safa	6

Table 8: Number of Boys public high schools in each district

As shown in the table of number of boys' public high schools in each district, there are 48 districts out of the 95 districts that does not have any public boys' high schools within its boundary. Around half of the city districts does not have a boy's public high school. On the other hand, Al-Safa district has six schools within its boundary. Such outcome raises several questions and one of them is why there is many districts that does not have any boy's public high school and others have five or six schools? Therefore, a further investigation is required in the second step, another attribute is needed to understand the situation more which is population density in each district. It is expected that districts with higher population density to have the greatest number of schools within its boundary and districts with low population density to have a smaller number of schools. In the second step, Jeddah population as of 2018 will be used to examine population density per square mile in each district.

	District	Number of Schools	Population Density
1	Al Taawen	0	7
2	620	0	9
3	614	0	24
4	508	0	37
5	618	0	46
6	Al Asalah	0	132
7	505	0	109
8	As Sahil	0	29
9	617	0	70

10	615	0	91
11	611	0	95
12	501	0	109
13	608	0	83
14	619	0	152
15	503	0	239
16	616	0	297
17	Al Sahefah	0	4,431
18	Al Fardous	0	234
19	Al LoaLoa	0	329
20	Al Wazeereyyah	0	378
21	Al Sanabel	0	201
22	507	0	266
23	506	0	346
24	Al Zummurad	0	298
25	Al Swaryee	0	327
26	Al Worood	0	909
27	Al Amwaj	0	236
28	Al Yaqout	0	439
29	Al Bagdadeyyah Al Sharqeyyah	0	4,597
30	Guleel	0	4,805
31	Al Wahah	0	1,592
32	612	0	1,025
33	610	0	541
34	Al Hendaweyyah	0	3,963
35	Al Wadi	0	1,803
36	King Abdul Aziz University	0	2,517
37	Al Faiha'a	0	1,947
38	Al Tha'alebah	0	3,681
39	Al Nakheel	0	3,083
40	Al Ruwase	0	4,689
41	Al Balad	0	3,358
42	Al Nahdah	0	3,779
43	Al Bawadi	0	4,661
44	Al Basateen	0	4,581
45	607	0	1,963
46	Al Marjan	0	3,718
47	Al Zahrah	0	4,081
48	Al Mahgar	0	2,110
49	Al Ammareyyah	1	4,916

50	Teebah	1	267
51	613	1	500
52	Al Jawharah	1	1,136
53	Al Sheraa	1	380
54	Al Kandarah	1	4,904
55	Al Sulaymaneyyah	1	4,693
56	Buraiman	1	1,608
57	Al Ajwad	1	3,108
58	Al Manar	1	2,049
59	Al Bagdadeyyah Al Garbeyyah	1	4,559
60	Al Naseem	1	2,854
61	Al Adl + Al Farouq	1	2,838
62	Al Jamea'ah	1	4,594
63	Al Khaledeyyah	1	4,873
64	Al Hamrah	1	4,677
65	Betrumeen	1	3,348
66	Al Naeem	1	4,338
67	Meshrefah	1	4,775
68	Al Rehab	1	4,631
69	Al Mohammadeyyah	1	3,470
70	Al Rawdhah	1	4,829
71	Al Shateie	1	3,182
72	605	1	1,932
73	Al Sabeel	2	4,434
74	O'bhur Al Janoubeyyah	2	355
75	Al Qryat	2	3,605
76	Al Nazlah Al Sharqeyyah	2	4,818
77	Al Nazlah Al Yamaneyyah	2	4,509
78	Al Sharafeyyah	2	4,842
79	Al Samer	2	3,170
80	Bane Malek	2	4,091
81	Madaen Al Fahad	2	2,902
82	Al Amir Abdulmajid	2	876
83	Al Nuzha	2	4,326
84	Al Marwah	2	2,671
85	Al Andalus	2	3,682
86	Al Amir Fawaz	3	2,419
87	Al Muntazahat	3	1,696
88	Al Salameh	3	4,692
89	Al Faysaleyyah	3	3,744
90	Al Thagur	4	4,723

91	Al Azizeyyah	4	4,678
92	Al Rabbwah	4	4,859
93	Al Rawabe	5	4,434
94	Al Rughamah	5	1,797
95	Al Safa	6	4,414

Table 9: Jeddah districts, number of schools in each district, and population

density in each district per square mile.

From the population density per square mile in each district and the number of

schools in each districts table, it seems that there is no significant relationship between

population density and the number of schools in each district in the city of Jeddah. For

example, O'bhur Al Janoubeyyah district has a population density of only 355 inhabitances

per square mile and has two schools where Guleel district which has a population density

of 4,805 inhabitance per square mile does not have any school. There are two main reasons

not to use any regression modeling in this research and they are: around half of the districts

does not have any school in their boundary and that there is no relationship concerning the

number of schools in each district and the population density as showed in the previous

example. To make it clear, using the same district as an example, Guleel district has 4,805

population density per square mile and does not has any school. So where does Guleel

district boys' student go for schooling? Simply they will attend a school that is near to

Guleel, but how near are the schools that are in the other districts and in which direction is

the movement for schooling is going to be? To answer such question, we need to study the

surrounding neighbor districts to Guleel district and see how many schools are in each

district. Then we need to examine the vacancy in these schools, not only that, but we might

also need to study the schools that are surrounding the surrounding districts and make it a

two layer to a three-layer investigation. This is why using buffer zoning as an analysis tool is more sufficient and it will cover these districts layers. It will cover the surrounding of Guleel district using GIS buffer zone to answer a simple question which is how far? How far are the school from students houses where the school is the center point of the buffer zone.

How far could be measured by distance or time. Distance to school could be measured using euclidian analysis and network analysis in GIS. Euclidian distance is a straight-line from the student location to school location regardless road network. Network analysis will be reference to road network and it will measure the shortest network distance (SND) and shortest network time (SNT). Shortest network distance (SND) will measure the distance and the shortest network time (SNT) will measure the time which concentrate on traveling time through the road network. In this research, distance will be measured using euclidian buffer zone and time will be measured using shortest network time buffer zone analysis. Network analysis could be explained using time and distance and since the research will use euclidian to evaluate distance, time will be explained using the network analysis. Therefore, euclidian and network buffer analysis were used in this research to understand the relationship between population and schools. School distribution in relationship with population distribution is to be under examination in this research.

The next step is to find out the buffer zone radius and such information will be taken from the standards and guidelines of other related studies. After reviewing multiple studies, the research could determine the accepted distance and time between a high school and a student house. Regarding distance, average car traveling distance to schools was examined in another study in Gainesville, Florida and the outcome was that 4.24 miles to

Gainesville high school is the average distance to a high school. (Ewing et al., 2004) Another study on Los Angeles, California students concluded that the average traveling distance is 4.58 miles using car as a traveling mode to schools. (He et al., 2018) Regarding time, the maximum driving time to high school's standard is 30 minutes travel time (Moussa et al., 2017). In addition, the median traveling duration is 14 minutes using a car as a traveling mode to schools. (Lincove et al., 2018) In a study in 2018 made by many researchers who examined around 190,000 students within five major cities in the United States which are Denver, Detroit, New Orleans, New York City, and Washington, DC. The outcomes show that majority of the students' lives within 20 minutes from school using car as a traveling mode to schools. (Blagg et al., 2018) Based on the findings, the standard distance between a school and student location is between 4.24 miles and 4.58 miles. In addition, we can conclude that the standard time between a school and student location using car as a transportation mode is between 14 minutes and 20 minutes as an accepted travel time.

At first, the research will examine student numbers to state recent facts to build on. There are 45,720 boys' students in these 90 schools with an average occupancy of 508 students per school. There are 16 schools that the research took the average due to missing information. In addition, the average school capacity in these 90 schools is 775 students

Minutes	Zone	
30		Red Zone
29		
28		
27		
26		
25		
24		
23		
22		
21		
20		Green Zone
19		
18		
17		
16		
15		
14		
13		Yellow Zone
12		
11		
10		
9		
8		
7		
6		
5		
4		
3		
2		
1		

Table 10: Accepted travel time to boys' high schools by car

and a total capacity of 69,750 students. Only 65.5% of the school's capacity are in use. The

next step is to plot all 90 boys' public high schools in the city of Jeddah using Geographic

Information System (GIS) to examine their location and to apply euclidian and network

buffer standards to find out the relationship between their location and city district population.

From figure 4.5 visual examination which is one of many advantages of using GIS applications, it's very clear that most of the schools are clustered in the center districts of Jeddah. However, north and south districts have much less schools than the central districts, this could be explained, and it was one of the research expectations. Research expectation was based on Jeddah land use in north and south of Jeddah. In the north there is Jeddah international airport and Obhur bay, both are cutting the northern area of the city. Jeddah central business district (CBD) is in the south of the city due to the existence of Jeddah seaport. In addition, the industrial land use which is in the south of Jeddah and most of company's storage building and companies' headquarters are also in the south. In addition, King Abdulaziz University, Efat University, Jeddah Refinery are in the south of Jeddah.

Even though there are high population in central districts, still there are high density population in many districts outside the central areas. No doubt that central districts have the most crowded population than districts in the north or the districts in the south, such crowded city center is considered to be normal behavior in modern cities. Keeping in mind that this city center is not fixed In Jeddah. In other words, the city center will be moving according to urban city development to the north. This crowded population was in the south 20 years ago and gradually moving to the north until it reaches what we call the central Jeddah nowadays.
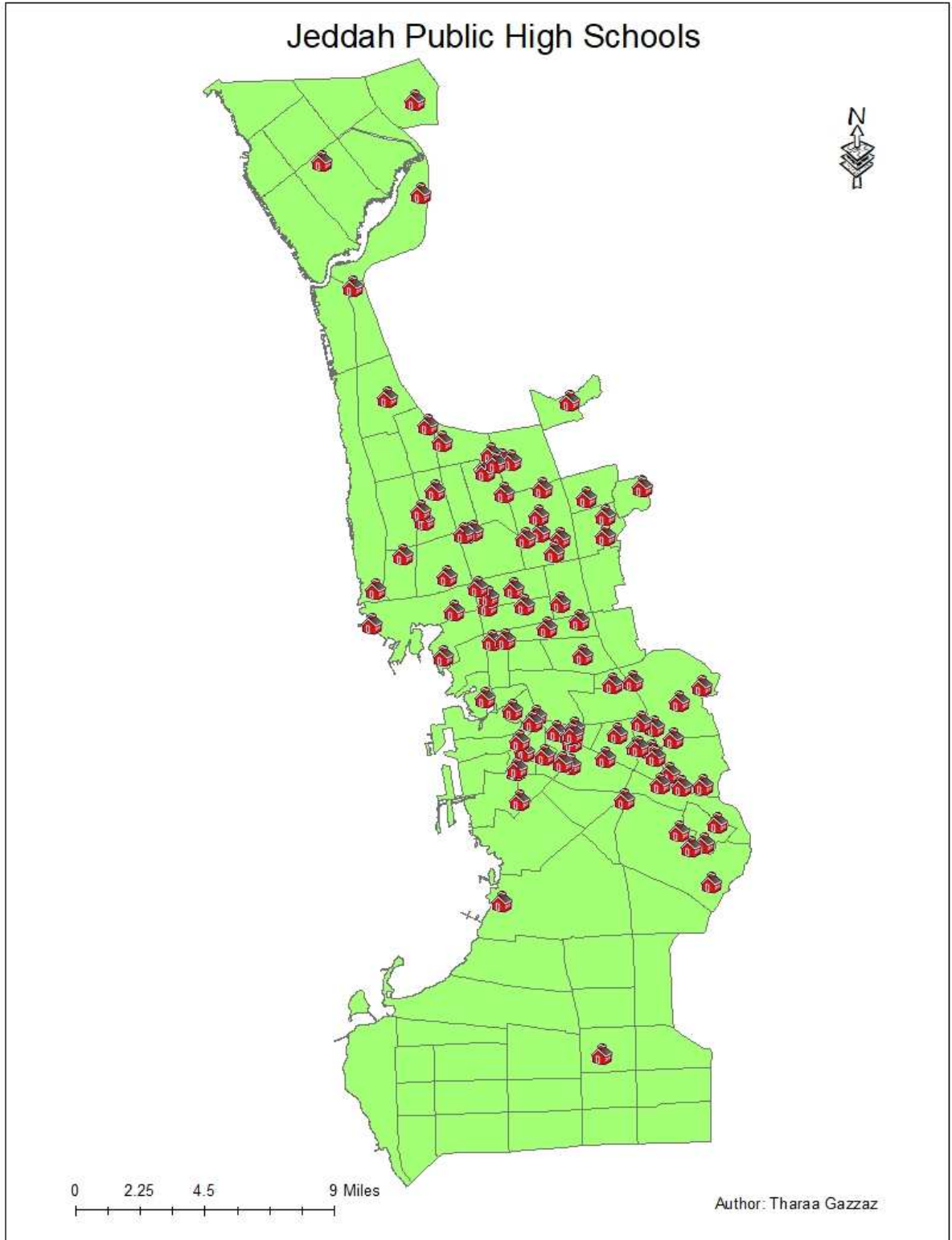
Figure 13: Jeddah Public High Schools

4.5.1 Euclidian Analysis - Outside Boundary Schools

Since the case study is based on distance, all public high schools for boys that are near to the 95 districts of Jeddah will be included. As discussed before, there are two Jeddah governorate boundaries, administration boundary and educational boundary. When we say educational boundary, we don't mean a geographical boundary, we mean that there are some schools which are outside the city administration boundary but belong to the city educational system. There are fifteen public high school for boys that accrues between these two boundaries. However, some of these fifteen schools are too far from the 95 districts of Jeddah, therefore, some will be excluded due to its irrelevant effect to school choices. All schools that are outside Jeddah 95 districts boundary and away by 4.24 miles will be excluded. Based on the findings as discussed before, the standard distance between a school and student location is between 4.24 miles and 4.58 miles. Out of the fifteen schools that are away more than 4.24 miles euclidian buffer zone, there are only seven schools in which falls into the parameters.

Using an average speed of 25 mile per hour, the approximate time that equals to 4.24 miles is 10 minutes. The 25 mile per hour will vary between a driver and another and will be different according to the kind of road such as highway or inner streets. There are some other factors that will add to trip time to school; for example, the walking time from the home either it was a house or an apartment to the car. In addition to starting the car engine and some wait time before moving with the car. Then there is the wait time in front of the school until dropping the student, all of these delays will add up to around five minutes. There are also the unexpected delays on the road to school, all of these will not

be part of our calculations because it varies from an individual to another and because it will not affect the distance between the school and the student home.

1	Alkumrah High school
2	Aldaruiah High School
3	Altibari High School
4	AlAzzizuah High School
5	AlMuatamid Ubn Abad High School
6	King Abduazziz High School
7	Balat Alshuhadaa High School
8	Toal High School
9	Zat Alreqaa High School
10	Zahban High School
11	Saied Ubn AlJubaier High School
12	Asem Ubn Amro Altammimy High School
13	King Abdullah Airbase High School
14	Kaab Ubn Malek High School
15	Yazed Ubn Alsakan High School

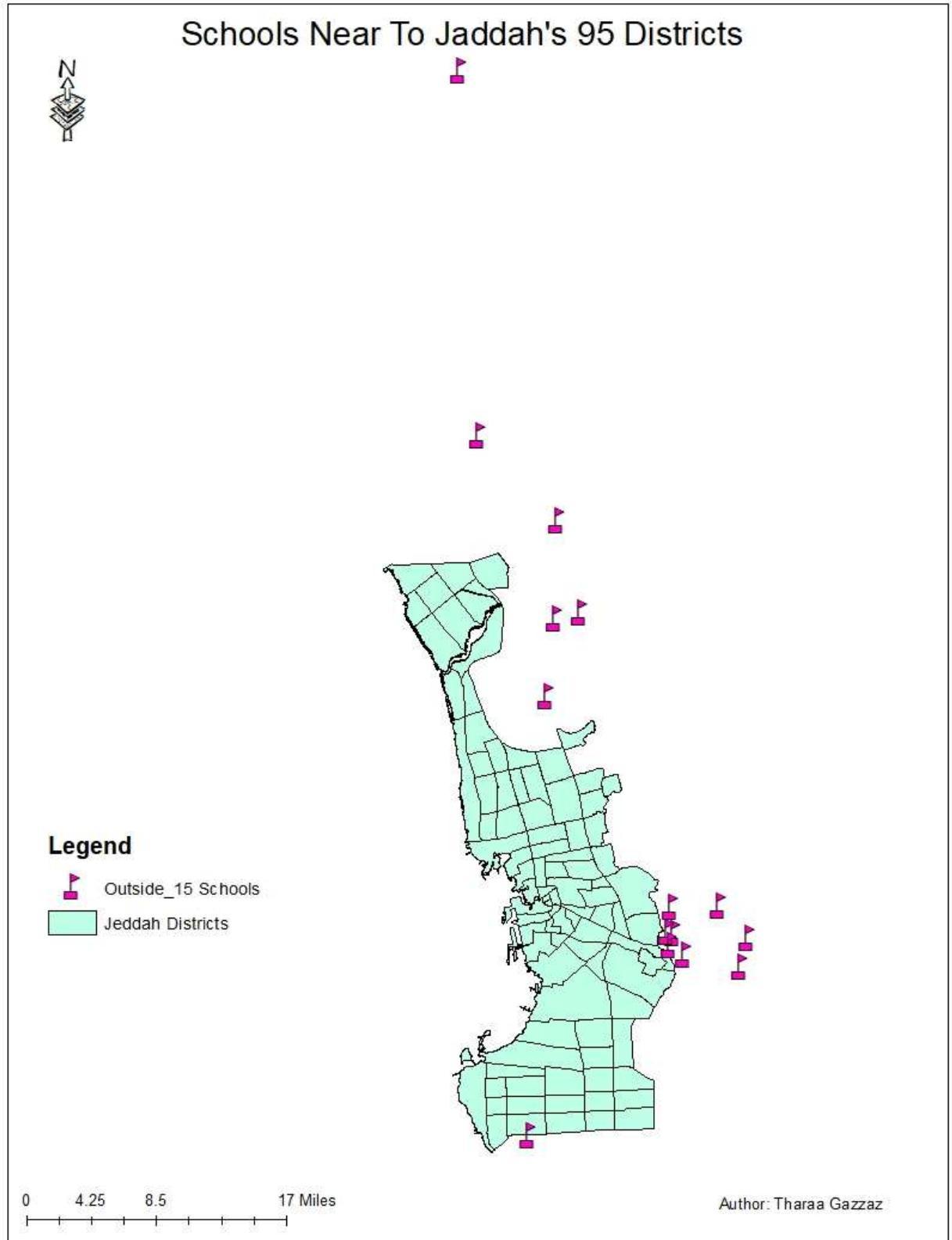Table 11: Schools outside Jeddah educational boundaries
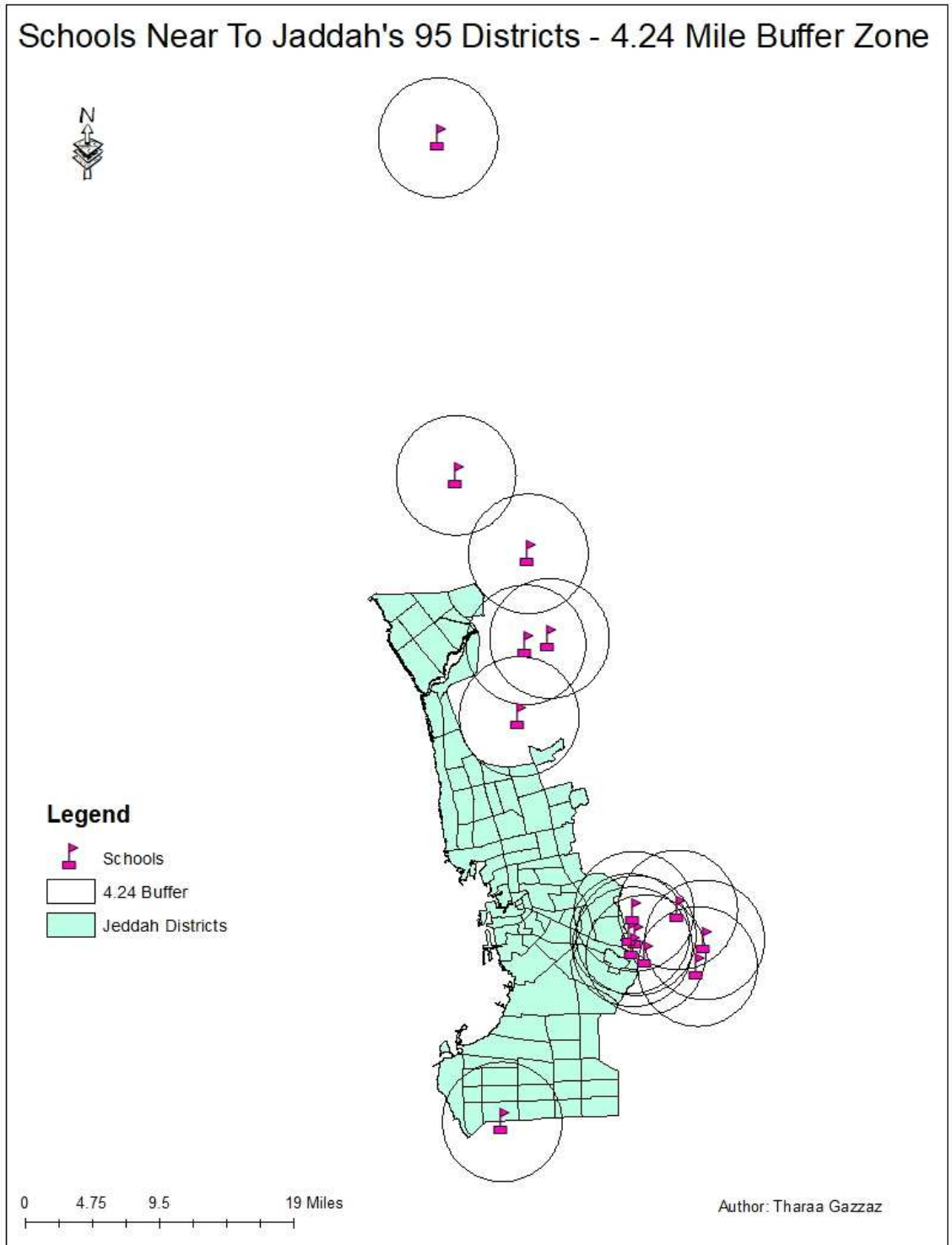
Figure 14: Schools that are near to Jeddah

Figure 15: Schools that are near to Jeddah - 4.24 miles buffer
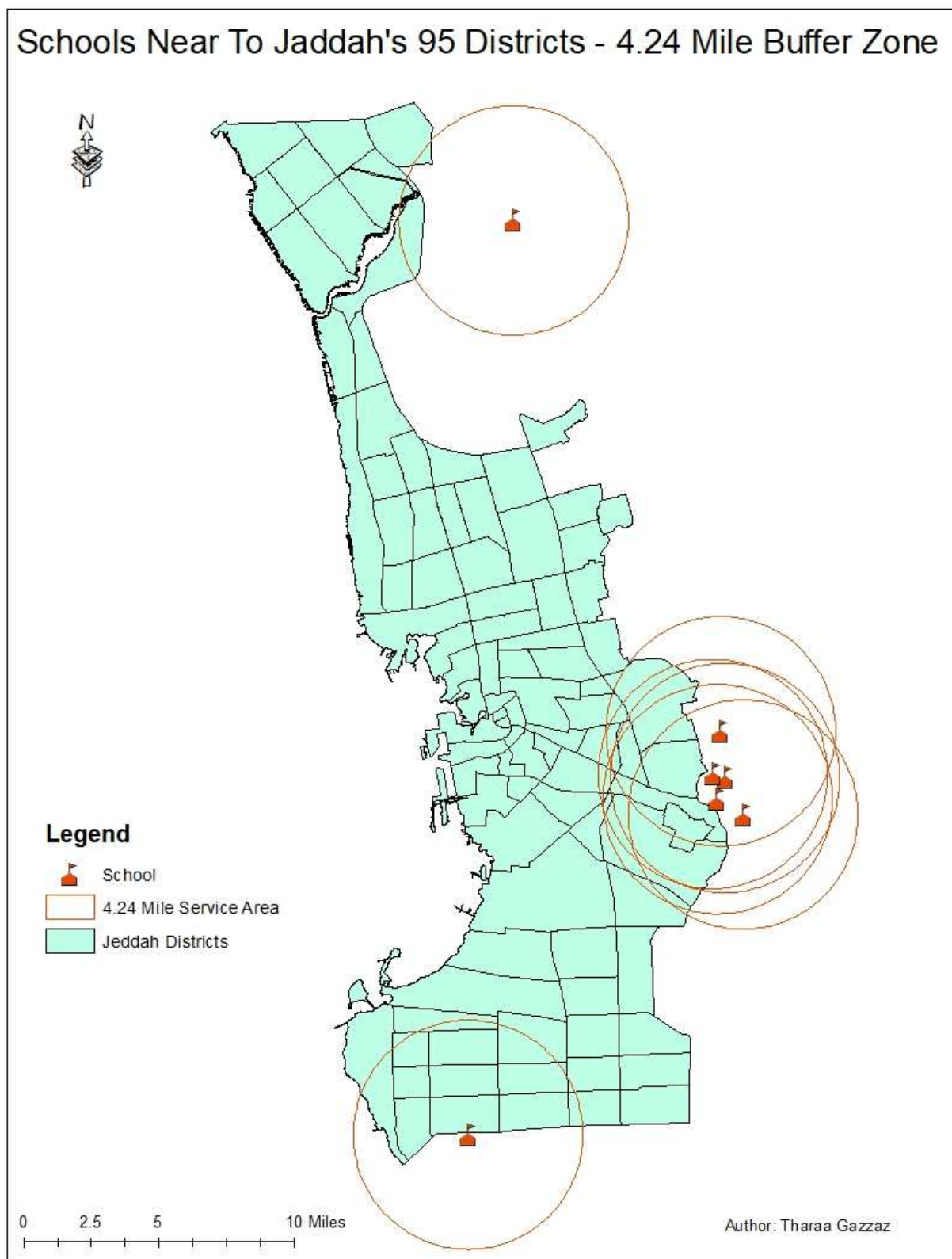
Figure 16: Accepted Schools from outside Jeddah boundary

4.5.2 Network Analysis

ArcGIS was used to find drive time buffer zone around each school. From performing analysis in ArcGIS using proximity tool, there is an option to create drive time areas. Using this option means that Jeddah network is compatible with ArcGIS online and can calculate accurately the time and distance using Jeddah network. In addition, drive time or distance from a particular point means the reach area within street network using traffic update. School starts at 7:30 am in Jeddah; therefore, when using traveling time, we could specify when using traffic, the same exact time in the morning which is 7;30 am to find out the reach out areas. Moreover, stating which day is an option, therefore, Monday will be the default choices. There is also travel direction option which is the direction of the movement from the facility and towards the facility. In other words, the analysis is using up to date transportation. (analysis year: 2021) The approach of this case study is to create drive time area around each school using 5, 10,15 and 30 minutes at the start of school time and end of school time which is 7:30 pm and 2:30 pm. Using such analysis method will examine population coverage reference to school location and their accessibility to and from schools.

Figure 17: School Service area at 7:30 am using a 5-minute network buffer
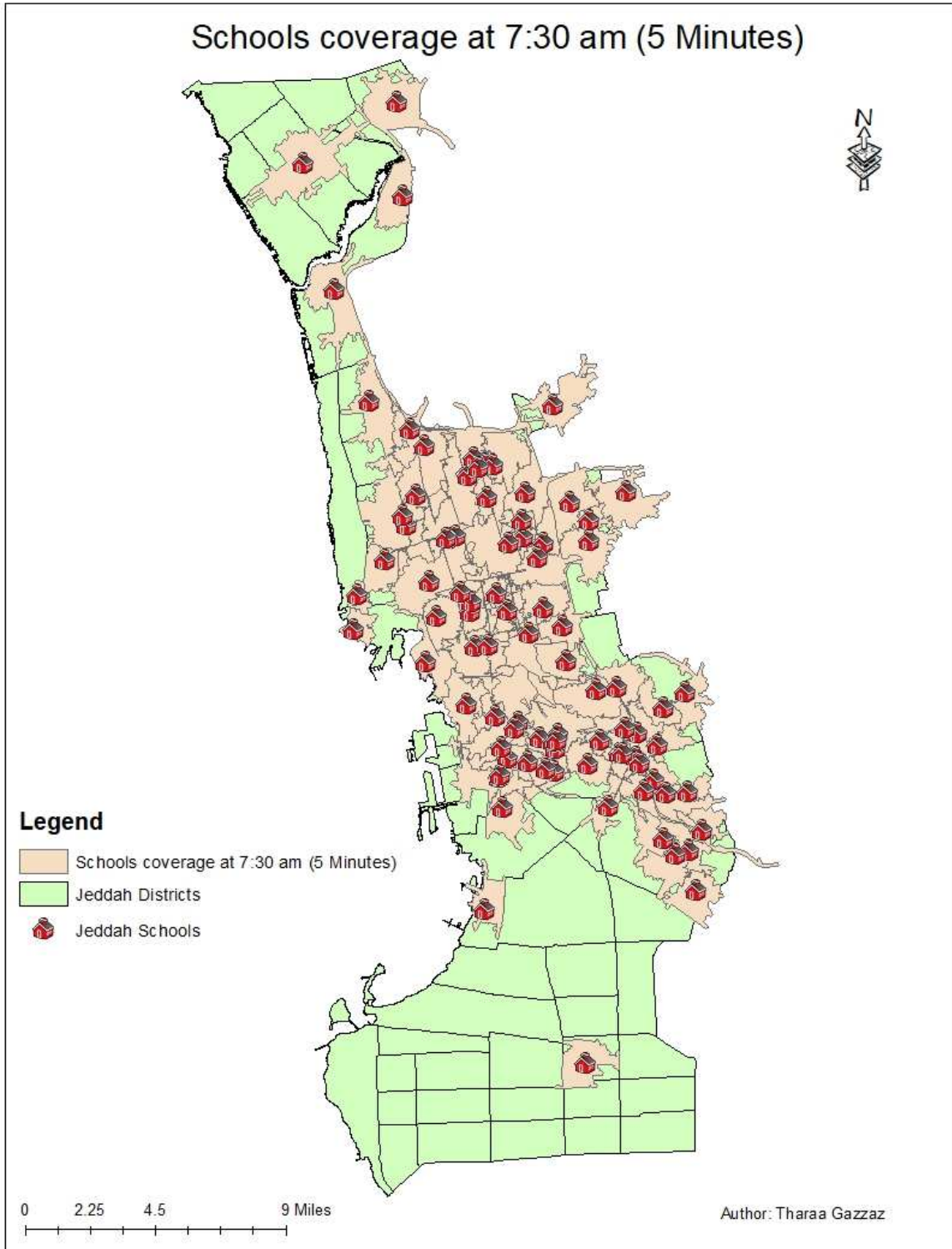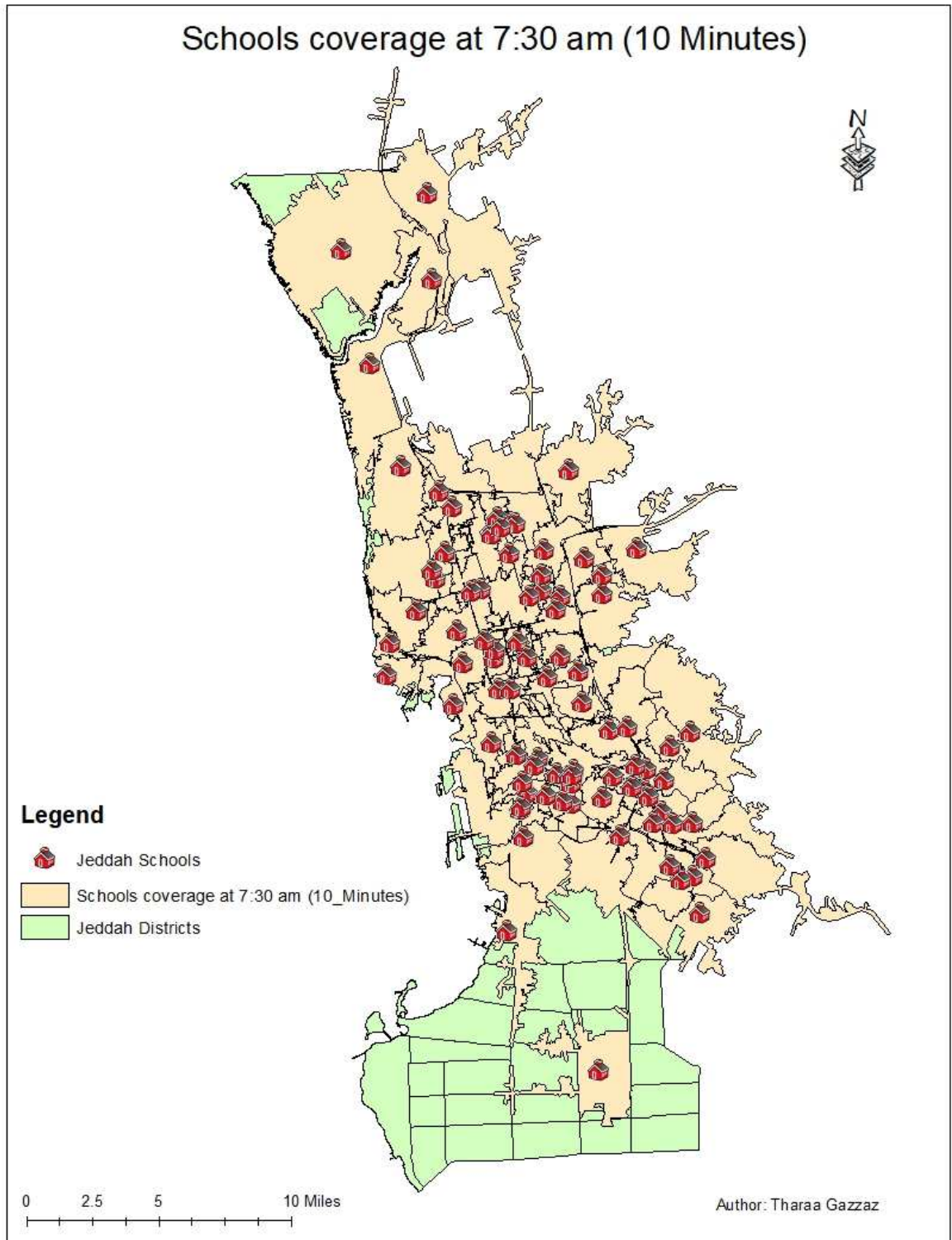
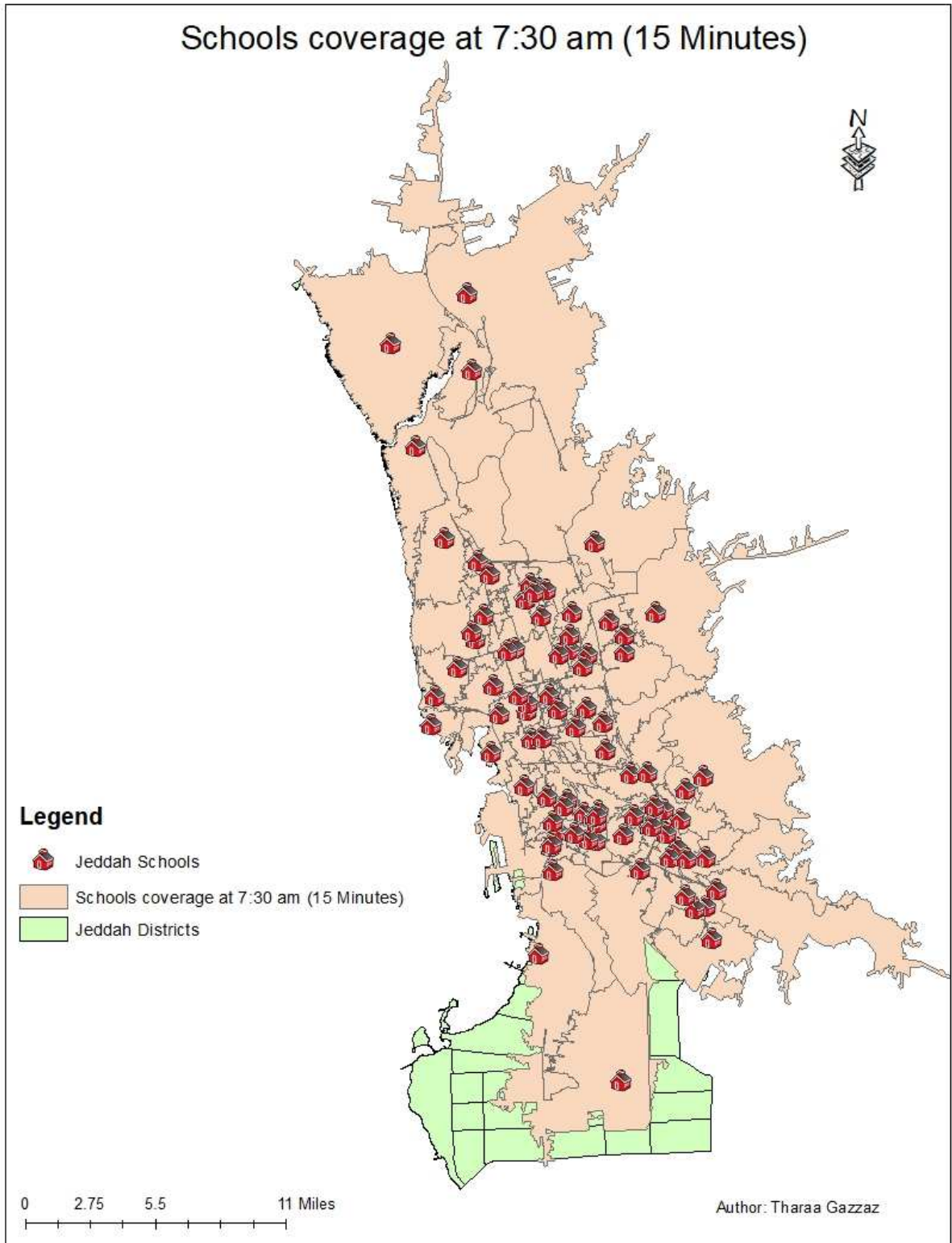Figure 18: School Service area at 7:30 am using a 10-minute network buffer

Figure 19: School Service area at 7:30 am using a 15- minute network buffer

A 5-minutes' drive time toward schools was examined to set the minimum commuting time to schools to compare it to the 10 minutes and 15 minutes. From school coverage at 7:30 am (5 minutes) map, it is very clear that most of the central city is covered with only 5-minutes' drive toward schools. Central city in this content is mostly the center of the city between north and south since Jeddah is a linear development city. This result was anticipated because most of the schools are concentrated in the center of the city. However, northern and southern districts are not covered with a 5-minutes' drive toward schools. This is expected, since a 5-minutes' drive toward schools considered to be a short commute duration to schools.

From school coverage at 7:30 am (10 minutes) map, it is very clear that most of the central city is covered within a 10 - minutes' drive toward schools. In addition, most of the northern city is also covered with 10-minutes' drive toward schools. With regard to the southern districts of the city, a 10-minutes'buffer is not covering most of the districts. From school coverage at 7:30 am (15 minutes) map, most of Jeddah area is covered by a 15 - minutes' drive toward schools. The only part that has a limited coverage area is the southern part of the city. As noted in the map, there are not that many schools in the south of the city, and this is the main reason of the limited coverage. The main plan and approach of this study was to evaluate the school coverage area up to 30 – minutes. However, after finding out that a 15-minutes' drive is covering most of the city, there is no need for the 30 minutes' examination. The main reason to exclude any further evaluating that is more than 15- minutes is that it is expected to cover the hole city and even will include other cities beyond the city of Jeddah. The uncovered areas are caused by absent of schools in these areas not because traveling time.
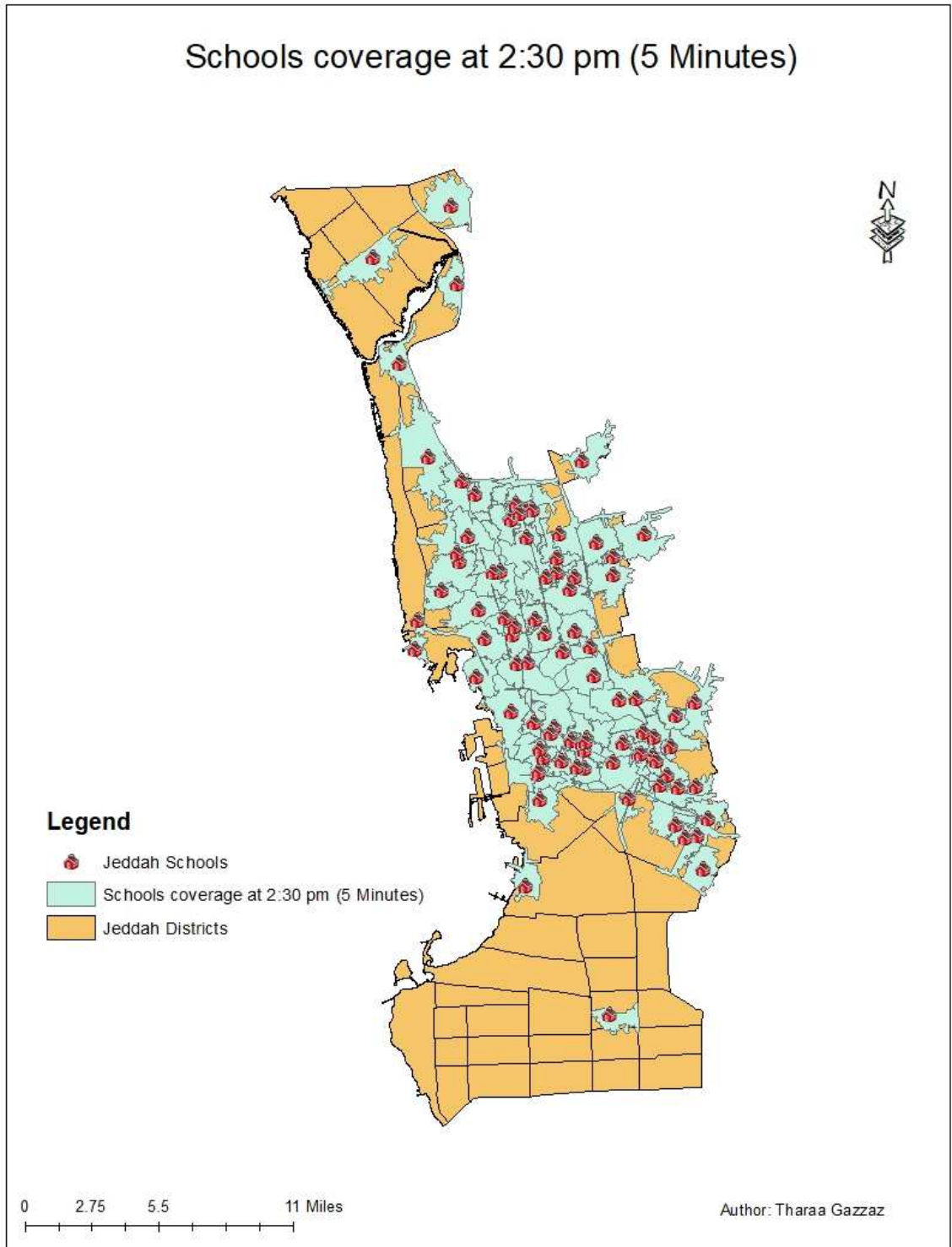
Figure 20: School Service area at 7:30 am using a 15- minute network buffer
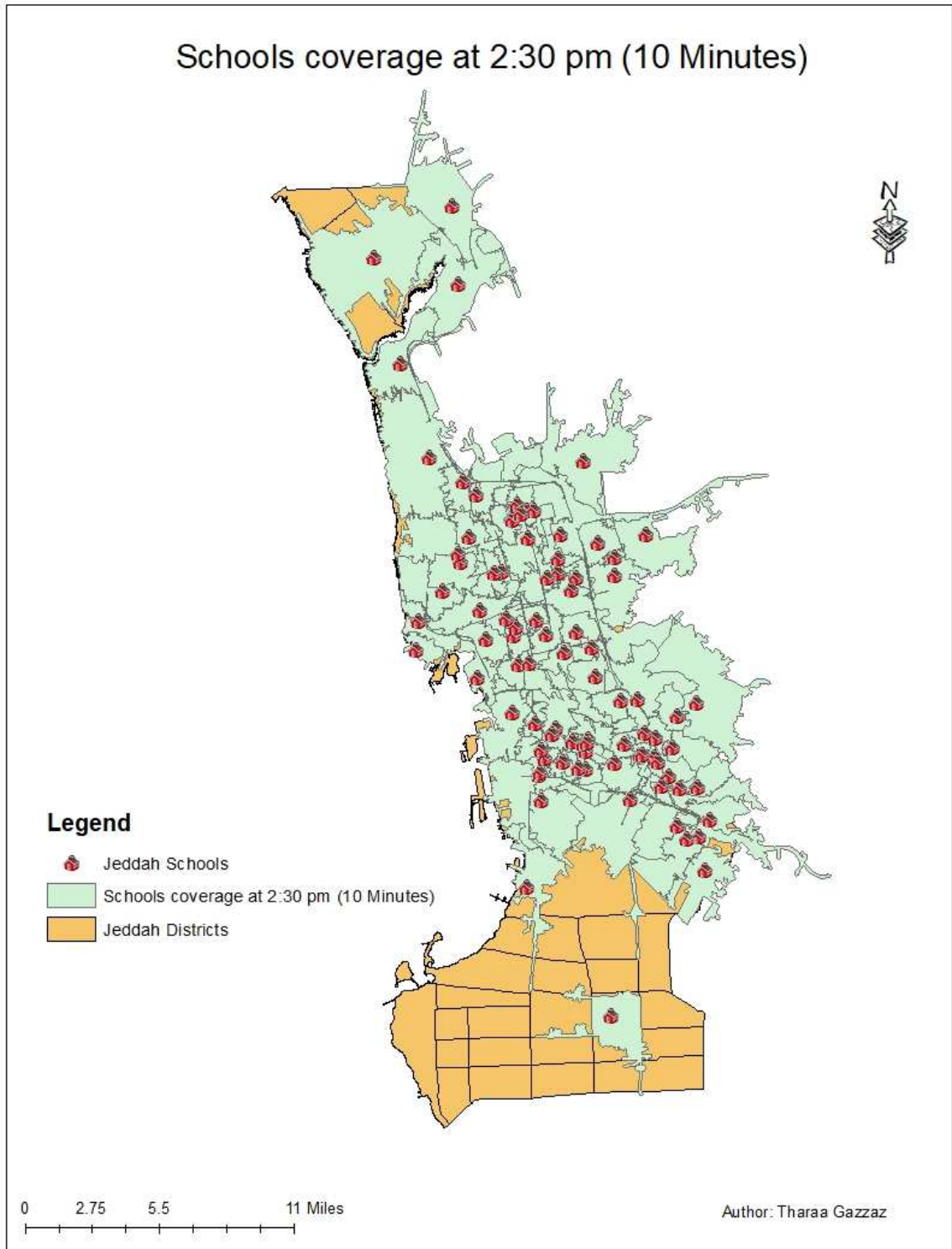
Figure 21: School Service area at 2:30 pm using a 10-minute network buffer
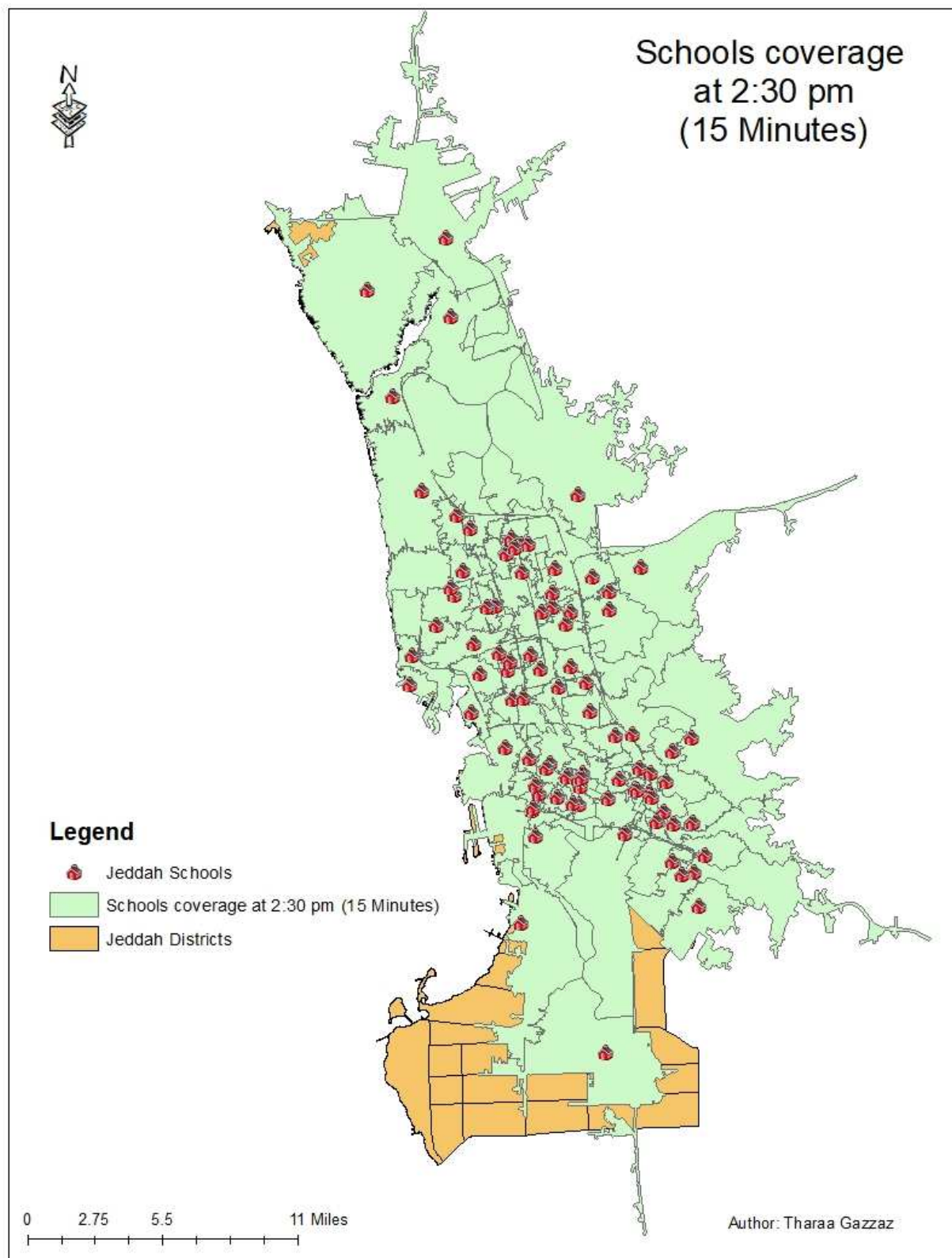
Figure 22: School Service area at 2:30 pm using a 15- minute network buffer

coverage at 2:30 pm (5 minutes) map, which is almost similar to school coverage at 7:30 am (5 minutes) map yet still there is a change due to traffic congestion. It is obvious that most of the central city districts are covered with only a 5-minutes' drive away from schools. City center in this content is mostly the center of the city between north and south districts. This result was anticipated because most of the schools are concentrated in the center of the city. However, northern and southern districts of city districts are not covered with a 5-minutes' drive time away from schools. This is expected, since a 5-minutes' drive away from schools considered to be a short commute to schools. A 5-minutes' drive away from schools was examined to set the minimum commuting time to schools to compare it to the 10 minutes and 15 minutes.

From school coverage at 2:30 am (10 minutes) map, it is very clear that most of the city center districts are covered with 10 - minutes' drive away from schools. In addition, most of the northern city districts are covered with 10-minutes' drive time away from schools. With regard to the southern part of the city, the reach areas are not covered. From school coverage at 2:30 pm (15 minutes) map, most of Jeddah districts are covered by a 15 -minutes' drive time away from   schools. The only part that has a limited coverage area is the southern part of the city. As noted in the map, there are not that many schools in the south and this is the main reason of such limited coverage. The main plan and approach of this study was to evaluate the school coverage area up to 30 – minutes; however, after finding out that a 15-minutes' drive is covering most of the city, there is no need for the 30 minutes' examination. The main reason to exclude any further evaluating more than 15-minutes is that it is expected to cover the hole city and even will include other cities beyond the city of Jeddah. The uncovered areas are caused because there are not enough schools

in these areas not because traveling time. Moreover, the research upon the findings of network analysis, discarded the out-boundary schools in the analysis since the schools which are in-boundary are covering the city.

4.5.3 Future Analysis

Jeddah future urban analysis is the concentration of this section of the research. At first, the reason of such analysis and justification should be clear. Understanding city urban sprawl with integration with city land use will give the research an idea about the city urban expansion amount, direction, and an expectation to where might the population of high growth rate accrue in the city. Therefore, city land use and future iconic projects will be under investigation with regard to city urban sprawl.

From the previous step, it was concluded that schools are covered using network analysis which means that most of the population are covered within a 15 minutes' drive. Moreover, school average capacity is around 78.96% which means that these 90 public school can take more students. For simplicity in this research, 80% will be used as current average capacity in schools. On the surface it appears that there is no problem to solve. First, city land use information is very important to understand the city layout. This is why Jeddah imagery were used to study city characterizes and from allocating city iconic building such as universities, seaport, historical area, airport, and industrial area. As a start all of these iconic places are in the south of the city of Jeddah except of the airport which is in the north of the city. These important city pillars are considered to be fixed pins in the city.

District	2010 Pop	2018 Pop	%
Teebah	785	7,716	883.52
Al Swaryee	128	7,958	6,100.72
Al Zummurad	161	7,813	4,738.97
Al Asalah	242	1,059	337.26
Al Yaqout	229	10,373	4,434.94
Al Fardous	219	5,087	2,218.38
Al Sheraa	459	13,200	2,778.92
Al LoaLoa	128	5,211	3,960.31
Al Amwaj	220	9,253	4,097.23

Table 12: Total population in districys north of Obhur Bay

AS showen in table 4.10, there is a huge increase in the total population in the disticts obove Obhur Bay. This increase is due to many resons, the first resone is the land price. Land price in the district north of the Obhur Bay is less compared to the land price south of the bay. Another resone is stay away from the crowded city south of the bay. This increse is expected to stay at the same piast and keep increasing. North of the bay is still close to the city internatinal airport and all busnises is opening new branches in the north of the bay to answer the increse demand. Jeddah is like a cup that is full of water and it star to spill water and this spill is in the north of Obhur Bay.
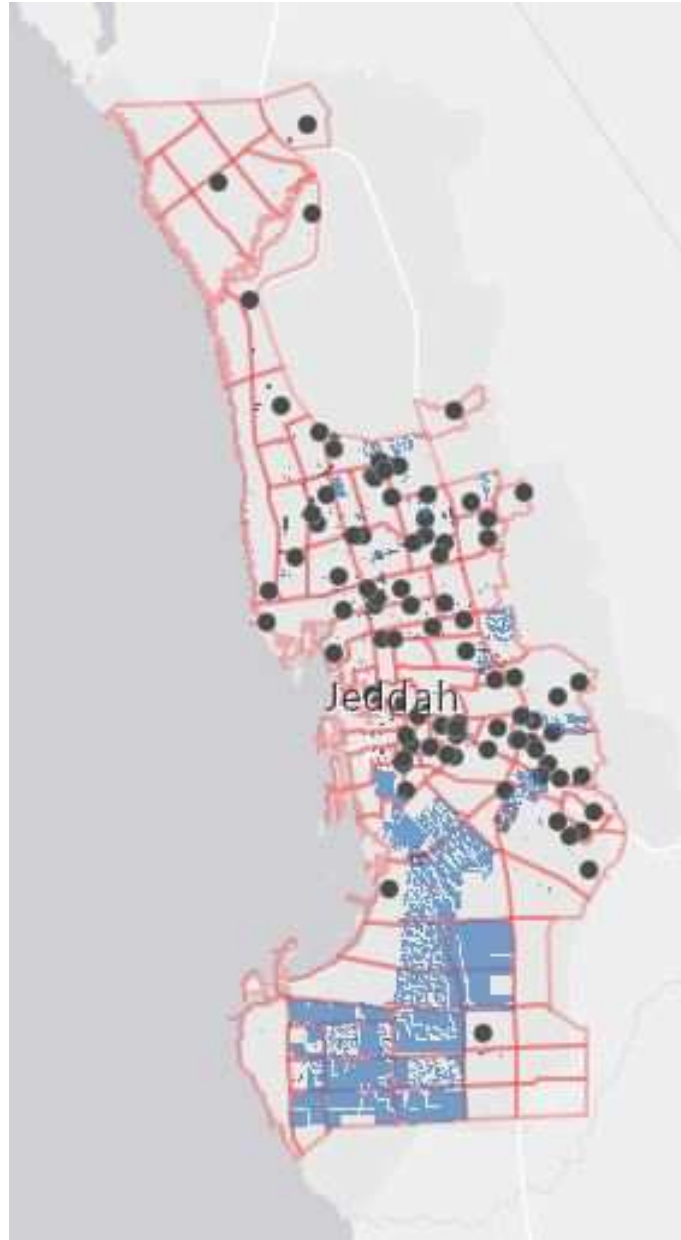
Figure 23: Industrial Land Use and Schools in Jeddah
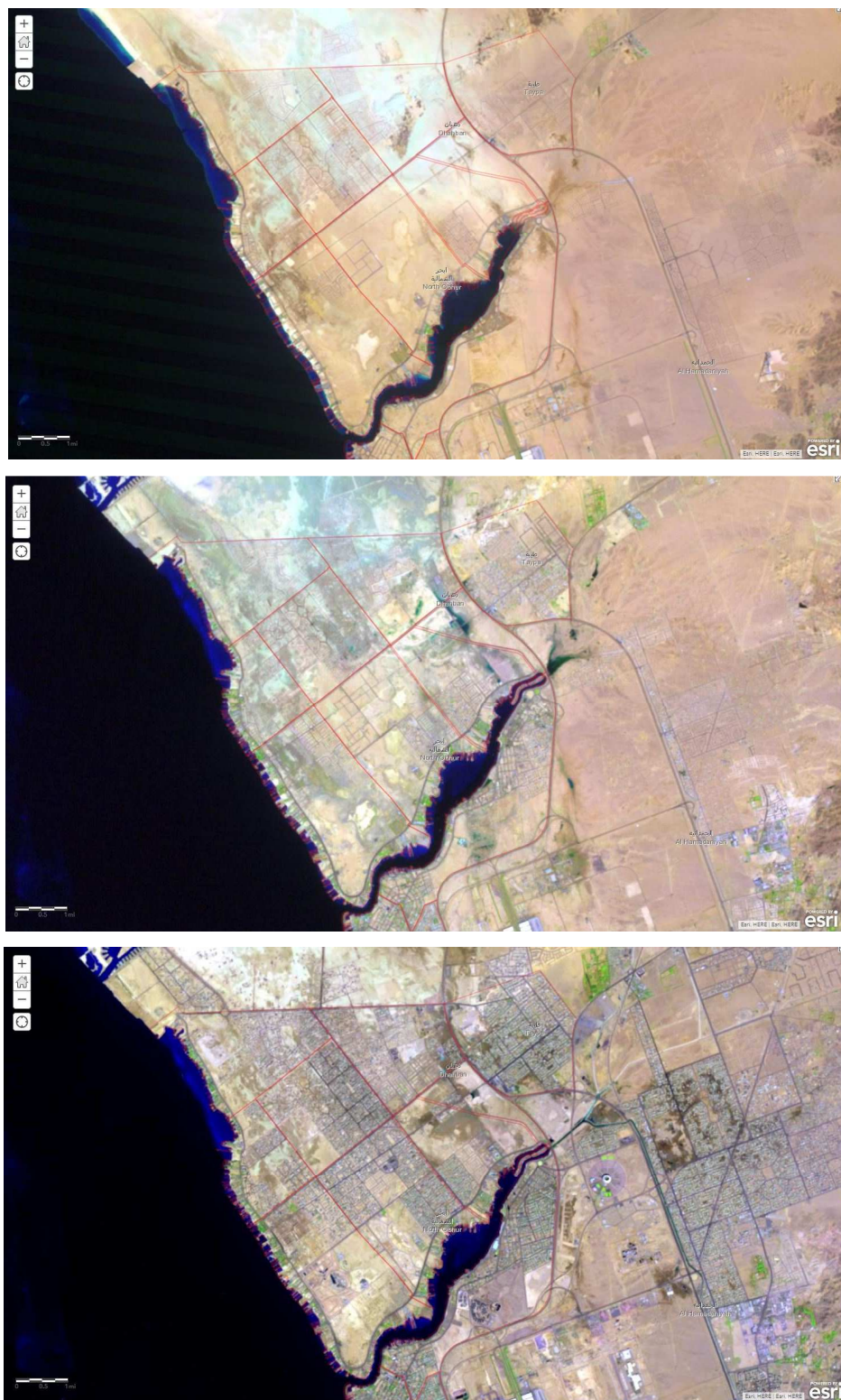
Figure 24: Jeddah Landsat imagery that shows' three decades

Three Landsat imagery that shows' three decades

90's	Sep 10, 1990 image
2000's	Jan 30, 2005 image
2010's	Nov 30, 2019 image

The Sprawl in clear toward the north and east. However, the east sprawl has come to an end due to high strips of mountains. It could be concluded from Jeddah imagery that the districts in the north of Jeddah have a higher growth rate more than any other districts in the city. If this pieces of information is added to the fact that the city sprawl direction is toward the north of the city, the research is depending on car as a transportation mode and it is based on distance and as shown in Jeddah north side, Obhur Bay is cutting the far north of the city. Obhur Bay does not have any bridge to connect the city. There are 78,478 high school students in the city of Jeddah as missioned before in table 4.1 and or 3,584,518 inhabitances in the city as of ESRI 2018 data set. Which means that around 2.2% of the population in high school students. Also, as mentioned before in figure 4.1, 70% of these students will attend public high schools. Upon this information and apply it to the nine districts in the north of Obhur Bay, Total population in these districts is 67,670 inhabitances. Out of these people, there are 1,488 high school students distributed in private, international, and public schools. 70% of these high school students attend public high schools and that wight 1,042 students out of the 1,488 students. In these nine districts, there are only two public high schools and one of them is 95% occupied with 1,409 students. It is noticeable that only one school in the north districts have more student than the expectation. It was expected that 1,042 male students will attend public high schools;

however, 1,409 students are. Again, the number in north Jeddah is passing every number by a lot.

As concluded from the previous section, its recommended to build more schools in north Jeddah and to concentrate on north of Obhur Bay. After the location of the recommended new schools has been known, the next step is to find how many schools to build in north of Obhur Bay and where exactly to build them. There are nine districts in north of Obhur Bay with 67,670 inhabitances in 2018 as the information from ESRI data base as showed in the table 4.11.

District	2018 Pop
Teebah	7,716
Al Swaryee	7,958
Al Zummurad	7,813
Al Asalah	1,059
Al Yaqout	10,373
Al Fardous	5,087
Al Sheraa	13,200
Al LoaLoa	5,211
Al Amwaj	9,253
Total	67,670

Table 13: 2018 Population in the nine districts north of Obhur Bay

Using population projection formula N =No e^(kt), the research will project 2030 population in these nine districts to estimate the number of future schools. The results are as follows:

$$N = N_0 e^{(kt)}$$

N= Future Population

No = Original population number

e= natural (a constant of 2.718…)

K = growth rate

t= number of years

To find future population, growth rate is 3.5% and the maximum growth rate will be 5% due to the two factors that has been discussed earlier and they are the current growth rate, population movement to the city.

District	2030 Pop. 3.5%	2030 Pop 5%
Teebah	11,743	14,059
Al Swaryee	12,111	14,500
Al Zummurad	11,891	14,235
Al Asalah	1,612	1,930
Al Yaqout	15,787	18,900
Al Fardous	7,742	9,269
Al Sheraa	20,089	24,050

Al LoaLoa	7,931	9,494
Al Amwaj	14,082	16,859
Total	102,987	123,295

Table 14: Jeddah 2030 projected population

population in 2030 is between 102,987 and 123,295 inhabitances as shown in table 4.12. Reference to the public high school student percent from total population which is 2.2%, total projected public high school student population in 2030 is between 2,266 and 2,712 inhabitances as shown in table 4.13. Building schools that will accommodate 1000 student per school, which means that three schools will accommodate these future students.

2.2% high school	2,266	2,712
number of schools (1000 students)	3	3
occupancy percentage	76	90

Table 15: Number of Future Schools

Now that the number of schools are known, the next step it finds out where exactly to build these three schools in north of Obhur Bay. There are two public high schools for boys north of Obhur bay. The research used GIS location allocation technique to find the best future location with reference to districts projected population and network analysis. Location allocation is a terminology which means finding the best suitable location taking into consideration suggested inputs or constraints. In this case study the inputs are 15 minutes driving time, current school location, the number of future schools and

recommended future school location. Best location practice will find the three locations from the proposed future locations and eliminate the rest. The proposed location for future schools are the center of each district and there are nine districts in north of Obhur Bay. Which means that there are nine proposed future school locations and they are the center of each district. To summarize, there are two fixed locations and nine proposed locations, using 15 minutes driving time to choose three out of nine as future school location.   The result was to build three school in Al Zummurad, Al Yaqout, and Al Amwaj districts. These districts are the far north and far west of the city that does not have schools. Building new three schools will create new jobs for teachers and administrators to run the schools and this will impact the city economy.

Figure 25: Schools North of Obhur Bay
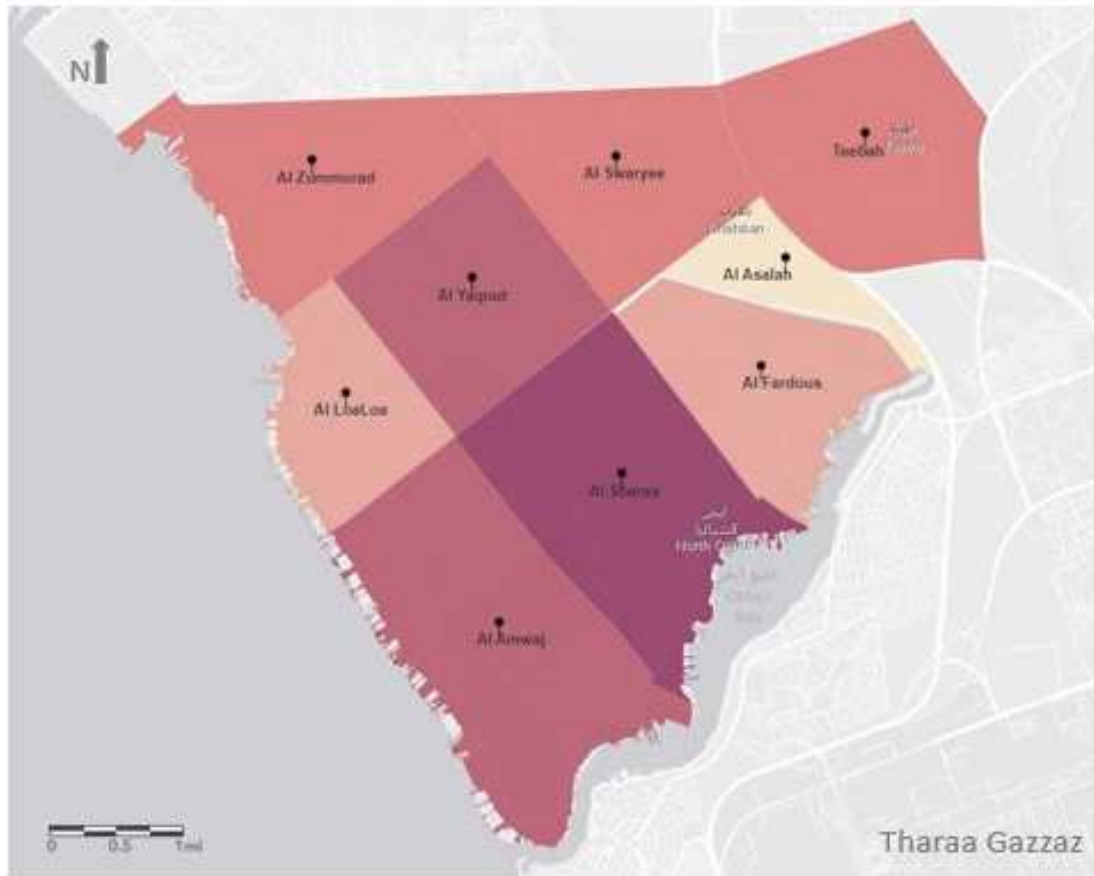
Figure 26: Proposed New Schools Location
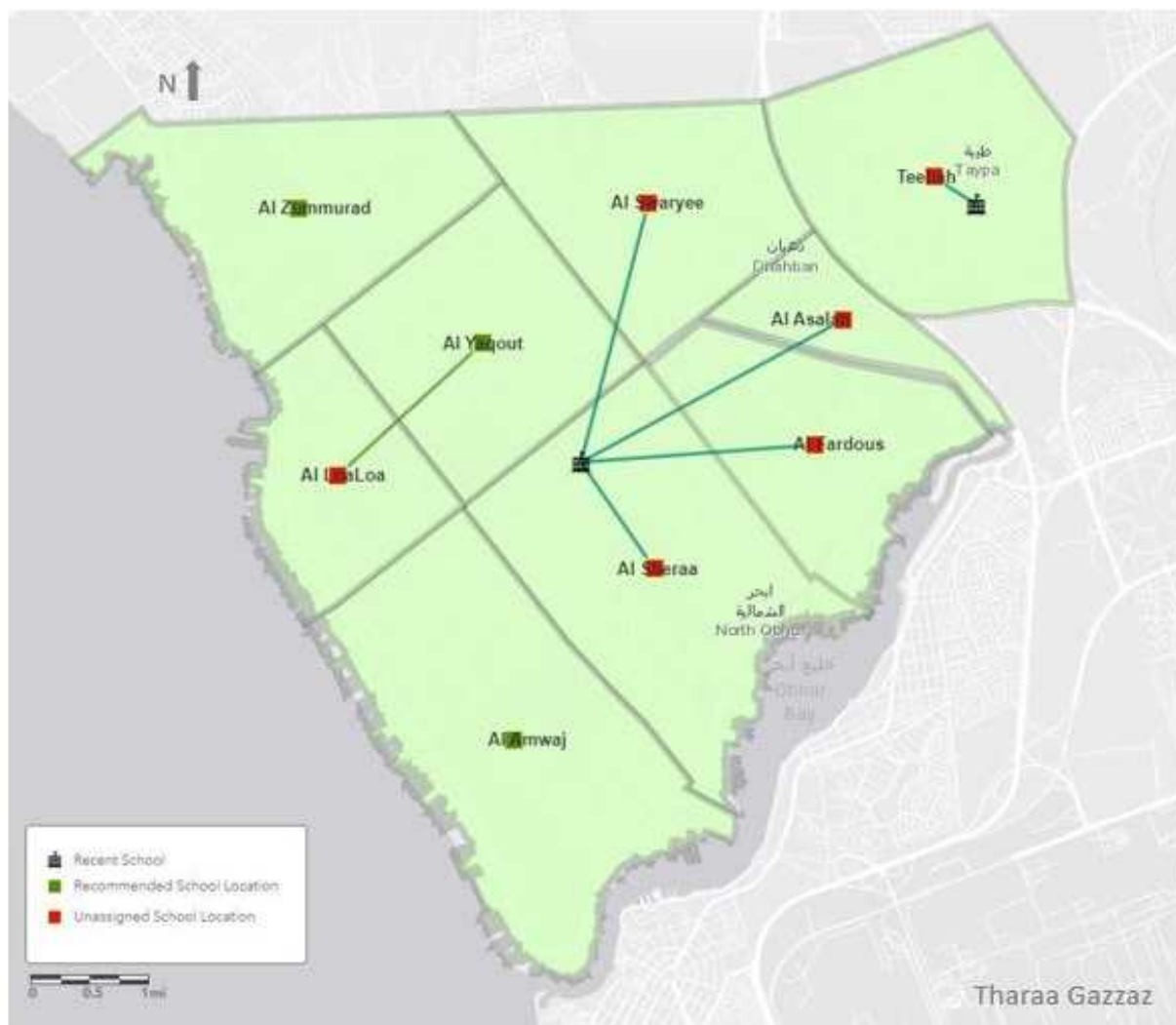
Figure 27: Recommended Future Schools

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATION

Public high school students and teachers in Jeddah are separated by gender due to cultural factors. The research intention is to make a contribution to Boy's public high school distribution in contrast with population distribution and student numbers in the city of Jeddah, Saudi Arabia. A contribution to define existing problems and to solve them to achieve healthy community and to serve future generation with future plans. Boy's public high schools are more than girl's public high schools. Principle of equality in urban planning with regard to schools is when everyone has the right to be educated in a public school that provides all school services for free. Population is increasing in Jeddah at a very fast paced, city expansion toward the north, not enough schools in the north which result in long traveling distance for students, and to pre-plan such movement of population are the main objectives of this research trying to predict future needs to present suitable and sustainable urban solutions. To identify school location problems and its effects on the city and population, afterword, to measure the scale of these existing problem. If these problems are considered to be in ''low priority'' in the meanwhile and if nothing happened in the near future to pre-plan a solution, the results in the coming 5 years is going be unpleasant to the city, population, and students.

5.1 Summary

Public schools are considered to be a very important element in any city scheme. The research is built on school location as public schools are part of the city infrastructure and the quality of physical, social, and academic of schools is part of the quality of the city.

The research used GIS which is considered to be a helpful tool with regard to education facility planning and management where GIS enhances the quality of the services. Using GIS in studying school location helps researchers and city planners on finding best location for a school in future and applying school standard. GIS applications can highlight clustering areas in the district, irregular school plotting, school concentration areas, and what is the direction of school distribution school planning criteria depends on land use, school distance from its surroundings, and population taking into consideration (growth rate).

Increasing educational facilities in terms of quantities and quality is something that all educational authorities are considering achieving as future goals. Jeddah population data set was taken from Saudi Arabia department of statistics and information and schools data base was collected from the ministry of education. All of these data must go through data preparation stage which means cleaning and adopting these data to be compatible to GIS data entry regulation. The city of Jeddah is dealing with an increased population due to population movement that is happening from the surrounding villages and suburbs around the city because of working opportunities. The opportunity of getting a job in Jeddah is much higher than in villages around Jeddah. In addition, many retails and companies are opening in the north of the city due to reasonable land price compared to the south of the city. As a result, jobs are created, and employees are needed to fill in these jobs and that will cause increase in population. In addition, population will be encouraged to move to the north due to acceptable rent price compared to the south of the city. Accessibility to schools using various transportation modes such as cars, walking, biking, and public transportation taking into consideration of the city urban and environmental aspects. In

addition, there is no official school zoning in Jeddah by the ministry of education; therefore, a student could attend any school that accept him even if it is outside their area. Therefore, income has no direct effect on school choice.

5.2 Conclusion

There are two things that we need to consider with regard to population in the city of Jeddah. The first is the annual growth rate that is determined by the Municipality of Jeddah which is 3.5%. The second element is population movement, as discussed previously that there is population movement to the north. Due to these two elements with regard to population the study concluded that there are nine districts in north of Obhur Bay that need a direct attention and solutions from the educational and planning authority in the city to match such high growth rate in these districts.

The first research question was about the location of current public boys' high schools' distribution and if it is serving the current population distribution. From the two articles that the research was built on its case to investigate, the result of these two studies was that Jeddah schools were dissemination and in great imbalance with population distribution. However, the result of this study shows that it is serving the population distribution and the schools are distributed with alliance with population distribution. The only part that requires attention is north of Obhur Bay as shown in chapter four. Schools' current distribution does not match the expanded population growth and distribution in north of Obhur Bay. On the other hand, it was concluded that school's distribution in south of Obhur Bay is matching and answering the population distribution. The second research question was to find the best location for future schools given future population projection

and given previous years expansion trend. The answer to this question was in two parts, the first part is where the need for future schools and the answer is was north of Obhur bay in nine districts. The second part was how many schools are needed using population projection in these districts that are north of Obhur Bay. The answer was that the city of Jeddah needs at least three boy's public high schools only in the north of Obhur bay. South of the bay, the city has enough schools and it is covering the population distribution according to the network analysis in chapter four.

Research assumptions are distance, travelling mode, student population, and population distribution. Distance will be the most important factor to determine which school a student will choose, since there is no school rating with regard to school performance in Jeddah. Jeddah is struggling on transportation modes on the public level, this will conclude that, when traveling to schools the situation is worse. The result, car as a transportation mode is the only traveling mode to schools (Belarem et al., 2018) In addition, car will be the travelling mode of this study since Jeddah is a car dependent city. Third is the student population assumption, all student population who falls in a school buffer area will attend that school. Finally, population data is distributed by districts and as mentioned before, these nine districts population projection will be equally distributed within the districts as an assumption.

When using geographical analysis, accessibility to school is in reach of city population and school service area is covering the hole city within 15-20 minutes' drive time and 4.24 miles buffer zone. In Jeddah, driving time to schools is less than 30 minutes which is the maximum traveling time, this outcome is acceptable due to high population density in Jeddah. To find the best location for future schools using ArcGIS is by using the

best facilities option. The main theory behind the best facility location stands on maximizing coverage or minimizing travel time. Studies has shown and proven that there are many obstacles against walking and bicycling to school even though there are a small percentage of students are still using walking and bicycling as a transportation mode to schools. Urban planners of cities with high density of population main target is to expand the city activity and this is the research target by using school location as an attraction. Building schools outside clustered areas will attract families to live closer to these schools especially if these schools have high performance or have a high rating in the education system.

5.3 Policy Implication and contribution to research

There is a research about north districts schools in Jeddah, Saudi Arabia. Secondly, there is a research about public girls' high schools in Jeddah, Saudi Arabia. This study is a contribution on studying the location of public boys' high school location in Jeddah, Saudi Arabia. In this section of the research, all the dots will be connected to contribute with what the research believes in as policy implications which will help the city to enhance its services. Since school zoning is not fair to some students and there are many books and articles as mentioned before those shows the segregation and differences in zoning. In integration with the issues of school zoning and the principle of equality in urban planning with regard to schools as discussed earlier. The research agrees and support the current condition regarding school enrolment process if some limitations were considered. The first policy implication is to add the parents workplace distance to school, which means to accept the student how is in a 30 minutes or less traveling time from one of the parents

work place and that parent is the one who drop and pick his child from the school. As discussed previously, this research was to build on minimal change to the existing situation and make small changes but effective changes.

Building on the principle of equality as a fundamental rule in community development and the research was building on such theory. The research does not recommend school zoning for many reasons as discussed earlier, but a small brief is necessary at this stage to lay down the research though process. The city of Jeddah is non-zone city so there is no need to complicate things at this stage where around 3.5 million inhabitances is living in a small area. It is not recommended to change thing dramatically but to build on what is there and this is the one of the fundamentals that the research was building on. In other words, to build on what has been achieved and through the accumulated development, the city will mature and serve the population needs. The next foundation is related to the previous one, the research does not want to invent the wheel. The research wanted to respect the previous plans and not to point out the mistakes and setbacks. In the content and regarding student enrollment process, all student applications should be considered out of equality and to understand the reasons of applying if the house location is more than 30 minutes driving time. A school committee should study the case and understand the student situation before rejecting the request.

Transportation aspects is everywhere all over the world and planners are encouraged to find a solution that is inexpensive so everyone could use it. Another policy implication is to adapt school bus services to boy's high schools, it could be started as a program with three schools to adapt school bus as a test project. Planners and educators should come together in determining school siting for better quality and to achieve better

quality and city smart growth. In other words, urban planners should be part of the selection process and sometimes could be the leading force in the committee. Selecting a site for a school can't be done only by educators themselves or by planners themselves, both have to come together to define the best location that serves families and their children. School location depends heavily on easy access to students where it should be safe for students to walk or bike to schools. There are many benefits when students depend on themselves to go to school by walking or biking such as: reduce traffic congestion, increasing student's health and lifestyle, and strengthen the community identity. Therefore, adding bike lines and walking lines for students is a recommended policy. This dependent method to reach schools will help students how at least live near to schools not only to be present at school but also to participate in after school services. As discussed before, school is considered to be a community anchor and a focal point and used for other purposes such as public gatherings, seminars, and programs for students and adults. Therefore, school location decision will be beneficial for the entire community. The recommendation is to use the community existing resources and to have maximum advantage of these resources in a location decision. (Moussa et al., 2017)

5.4 Limitation and Recommendation for Future Studies

Education information was limited to city level; therefore, availability of data sets is one major limitation to this research. One of Saudi Arabia 2030 vision is digitalizing all possible data. Saudi Arabia 2030 vision is led by Saudi Arabia crown prince Mohammed Ben Salman Ben AbdAlaziz who is the son of the current Saudi Arabia King Salman Ben AbdAlaziz. Saudi Arabia ministry of education is considered to be one of the first Saudi

governmental entities that provide digital data base to the public in its website and this what makes this study possible. However, education information was limited to city level; therefore, the level of information is one major limitation to this research. The level of information from the Saudi Arabia ministry of education could be in more depth. If the level of information were to the district or block level for example, the outcome will be more accurate. Municipality of Jeddah on the other hand is not copping with the city development in terms of data update and availability of data. Population data set was the second limitation in this research because the latest data set with regard to city population was old dated. Therefore, its recommended to establish city population per districts data set. One way to accomplish such goal is by using Jeddah imagery from the past and then detect all buildings using GIS. Once GIS detect city buildings, then classifying these buildings reference to city land use to know average number of residents in residential land use by using the average household capacity for each building.

In addition, this study is about boys' public high schools and it is a gender base examination, therefore, gender is considered to be a study limitation. A qualitative research is recommended as a future study to ask high schools' students and to measure their responds. High school students are old enough to give feedback and build on their responds a qualitative research that might help in understanding their input. Such a qualitative research will definitely add to the research some unnoticeable angels that could contribute to the solutions. Some of the important aspects to study in a qualitative research is the cultural background and the differences between male and female. In addition, qualitative research will add a depth to this study especially with regard to cultures and the differences between boys' and girls' high schools. It is recommended to investigate on how to get to

schools using walking and biking. This could be achieved by interviewing the students and their parents to get the student perspective on transportation. Using Intensive interviewees or focus groups to my research would provide a more comprehensive perspective on how urban sprawl impacts the planning for schools in the North of Saudi Arabia. The focus groups would include groups of 10-12 people in a room to brainstorm on the pros and cons of 1) building new schools, 2) alternative modes of transportation,3) and possibly expanding distant learning, virtual learning, remote learning. They could also have a hybrid model for distant learning too. The interviews and focus groups can be done via of face to face or virtually. Finally, qualitative research can be used to supplement the researcher's quantitative research.

It is worth mentioning that since 2019 and because of COVID-19, online schooling in public schools is becoming one of the options and solution that Saudi Arabia ministry of education is considering for future schooling strategy. This kind of information is still under examining by the ministry of education according to the latest information from the minister of education and it is something that needs research by urban planners and community developers to study the ins and outs of such approach and to evaluate the benefits and the loses if such strategy will be implemented. In addition, time and money are another major limitation to the research because such research is a continuous research and there are many aspects to it that could be included such as a qualitative research. More time will add the scope of the research to add more value to it because there are other angles that could be included especially in a such an important subject as schooling and education. Moreover, there are many articles with regard to education, student, and schooling that could be included but was not due to time factor and the accessibility to these studies.

Moreover, there are many good articles which has been written in high school, education, and transportation but it requires money to read them. Therefore, money is another limitation to this study and research, if there is an access to these studies and articles this will increase the scope of the research and help the research to bring in more value to the study.

APPENDIX

A. PUBLIC BOYS' HIGH SCHOOLS

According to the list from the Ministry of Education in Saudi Arabia (Saudi Arabia Ministry of Education) there are 152 public high schools for boys in the city of Jeddah.

Fax number	Phone number	Neighborhood	Office of Education	The government's support	Statistical figure	School	
6335452	0126812544	Cities of The Cheetah 2 – Western	South Jeddah-Benin	Jeddah Province	32546	The high school boy.	Details
6295441	6295441	Al-Naseem 2	Naseem-Benin	Jeddah Province	132012	Ibn Habban High School – Courses	Details
	0554442488	Eastern Influenza 2	South Jeddah-Benin	Jeddah Province	32652	The son of The Ashkeloni High School.	Details
6891696	6891696-101	Eastern Influenza 2	South Jeddah-Benin	Jeddah Province	33095	Ibn Al-Ashkalani High School – Intellectual Integration	Details
6891696	0126891696	Eastern Influenza 2	South Jeddah-Benin	Jeddah Province	32954	Ibn Al-Ashkalani High School – Courses	Details
6251323	6230209	Justice	East Jeddah-Benin	Jeddah Province	33042	I'm A High School Packages – Deaf Fusion	Details
6251323	6230209	Justice	East Jeddah-Benin	Jeddah Province	132015	I'm Packing High School – Courses	Details
6711666	6711666	Supervisor 6	Central Jeddah-Benin	Jeddah Province	532571	Ibn Khaldun High School – Courses	Details
No	6310251	Virtue	South Jeddah-Benin	Jeddah Province	33119	The son of a high school in front of him.	Details
No	6786069	Al-Samer 4	Safa-Benin	Jeddah Province	32955	I'm Perspective High School – Courses	Details
6400990	6400990-101	Trachea 3	East Jeddah-Benin	Jeddah Province	32556	Dad Isaac High School.	Details
No	There's no.	Two golds.	North Jeddah-Benin	Jeddah Province	32974	Abi Mahjan Al-Thafi High School/Night Reform	Details
No	2901928	Snares	East Jeddah-Benin	Jeddah Province	33248	Abi Muslim Al-Khorasani High School	Details
6240612	6240612-012	Al-Rawabi 2	Naseem-Benin	Jeddah Province	32562	Ahmed Bin Hanbal High School	Details
6240612	6240612-101	Al-Rawabi 2	Naseem-Benin	Jeddah Province	32886	Ahmed Bin Hanbal High School/Night	Details
6707741	6707741	Azizia 10	Central Jeddah-Benin	Jeddah Province	33015	Sevilla High School	Details
6437570	6437570	West Baghdad i.e.	South Jeddah-Benin	Jeddah Province	133835	Ibrahimia High School – Courses	Details
2634583	2634583	Red 1	Central Jeddah-Benin	Jeddah Province	32548	Sons of secondary air defense	Details
No	6090000-3985	King Faisal Naval Base	South Jeddah-Benin	Jeddah Province	32643	Sons of King Faisal Naval High School	Details
107	6778471-101	5 السامر	Safa-Benin	Jeddah Province	32582	Al-Ahnaf Bin Qais High School – Courses	Details
0126778471-107	0126778471	5 السامر	Safa-Benin	Jeddah	132053	Al-Ahnaf Bin Qais High	Details

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				Province		School/Night	
107	6778471-101	المسامر 5	Safa-Benin	Jeddah Province	32924	Al-Ahnaf Bin Qais High School – Intellectual Integration	Details
6370857	6370857	Alemanic Flu 2	South Jeddah-Benin	Jeddah Province	32600	Imam Hafs High School for Memorization of the Qur'an	Details
No	0126025343	Gap 2	Naseem-Benin	Jeddah Province	33079	Imam Abdullah Bin Saud High School	Details
No	6025343	Gap 2	Naseem-Benin	Jeddah Province	33142	Imam Abdullah Bin Saud High School – Intellectual Integration	Details
No	6393044	Safety 2	North Jeddah-Benin	Jeddah Province	33065	Imam And high school workshops to memorize the Qur'an	Details
2120900	2120900	Al-Rawabi 1	Naseem-Benin	Jeddah Province	32986	Prince Turki bin Abdullah High School	Details
6203461	0126203461	Prince Fawaz South District 2	East Jeddah-Benin	Jeddah Province	132027	Prince Fawaz Bin Abdulaziz High School - Courses1.2	Details
6284239	6284239	Safa 7	Safa-Benin	Jeddah Province	32866	Prince Mashal Bin Majid High School	Details
6062292	6062292	Beach 1	Central Jeddah-Benin	Jeddah Province	33170	Secondary dessert	Details
6775594	6775594	Safa 8	Safa-Benin	Jeddah Province	33168	Governor Al-Maruzi High School	Details
No	0122905113	الرغامة 2	East Jeddah-Benin	Jeddah Province	32925	Secondary Hat– Intellectual Integration	Details
No	0122905113	الرغامة 2	East Jeddah-Benin	Jeddah Province	33051	High School –Courses	Details
No	2906465	Al-Quzin	South Jeddah-Benin	Jeddah Province	32579	Secondary Winery	Details
6428848	6428848	Al-Ammariya 1	South Jeddah-Benin	Jeddah Province	32578	Secondary trench	Details
		Credit	East Jeddah-Benin	Jeddah Province	132045	Secondary Shield - Intellectual Integration	Details
2801819	2801819	Credit	East Jeddah-Benin	Jeddah Province	32953	Secondary Shield – Courses	Details
6389543	6389543	Quarry	South Jeddah-Benin	Jeddah Province	32224	Al Razi High School – Courses1	Details
6936869	6936869	الصفا 6	Safa-Benin	Jeddah Province	32865	Secondary Uterus	Details
No	6673448-104	Kindergarten 1	Central Jeddah-Benin	Jeddah Province	33092	Zahrawi Secondary/Night	Details
2842029	6673448-104	Kindergarten 1	Central Jeddah-Benin	Jeddah Province	532547	Zahrawi High School - Courses	Details
00000000	6406406	Ministery 1	East Jeddah-Benin	Jeddah Province	32594	Secondary/night beach	Details
6473306	6473306	Route 2	South Jeddah-Benin	Jeddah Province	32525	Secondary Martyrs	Details
No	6473306	Route 2	South Jeddah-Benin	Jeddah Province	32598	Secondary/night martyrs	Details
122800484	122800484	Parks 1	East Jeddah-Benin	Jeddah Province	33103	Sheikh Mohammed bin AbdulWahab High School – Intellectual Integration	Details
0	2800848	Parks 1	East Jeddah-Benin	Jeddah Province	532565	Sheikh Mohammed bin AbdulWahab High School – Courses	Details
No	2883095	Al-Muhamed	East Jeddah-Benin	Jeddah Province	33061	Al-Tabari High School	Details
132089@jedu.gov.sa	0501052750	Riyadh	North Jeddah-Benin	Jeddah Province	132089	Azizia High School – Courses	Details
6819627	6881457-012	Gap 2	Naseem-Benin	Jeddah Province	32573	Secondary Opening	Details
6819627	6881457-012	Gap 2	Naseem-Benin	Jeddah Province	32888	Secondary Opening - Optical Integration	Details
No	0122881416	Taiba 1	North Jeddah-Benin	Jeddah Province	33062	Al-Fazari High School	Details
No	6206393	اروابي 5	Naseem-Benin	Jeddah Province	33016	Al-Fadil Bin Iyad High School	Details
6655049	6655049	Honorable 3	South Jeddah-Benin	Jeddah Province	32574	Al-Faisal High School	Details
2614835	2614835	العزيزية 3	Central Jeddah-Benin	Jeddah	325145	Al Faisaliah Secondary - Courses	Details

				Province			
No	6208241	Prince Fawaz North 2 – Eastern	East Jeddah-Benin	Jeddah Province	132013	Jerusalem High School – Courses	Details
6070105	6070105	Marwa 2	Safa-Benin	Jeddah Province	32567	Secondary Mirror	Details
.There's no	0500024555	Um al-Salam	East Jeddah-Benin	Jeddah Province	33049	Accredited Bin Abad High School	Details
6160993	6160993	Knoll 6	Safa-Benin	Jeddah Province	33018	Al-Megrazi High School	Details
6724112	6724112	Bani Malik 4 – Al-Sharqi	Naseem-Benin	Jeddah Province	132255	King Saud High School – Courses	Details
6200494	6200494	Credit	East Jeddah-Benin	Jeddah Province	32560	King Abdulaziz High School	Details
6542979	6542979	Picnic1	North Jeddah-Benin	Jeddah Province	32900	High School – Intellectual Integration	Details
6542979	6542979	Picnic1	North Jeddah-Benin	Jeddah Province	32576	Nahrawan High School – Courses	Details
6393521	6393521-100	Al-Faisaliah2	North Jeddah-Benin	Jeddah Province	33140	Um Minor Villages – Intellectual Integration	Details
6393521	6393521-100	Al-Faisaliah2	North Jeddah-Benin	Jeddah Province	32572	Um Minor Villages – Courses	Details
No	0505672601	Jewel (Jewel of Jeddah)	East Jeddah-Benin	Jeddah Province	33171	Os bin Habib High School	Details
6918292	6918292	Al-Faisaliah2	North Jeddah-Benin	Jeddah Province	32553	Badr High School – Courses	Details
No	0122902439	Salhia	Safa-Benin	Jeddah Province	33169	Secondary Martyrs' Court	Details
No	0122902439	Salhia	Safa-Benin	Jeddah Province	132170	Secondary Martyrs Court – Optical Integration	Details
No	6246191	المنتزهات 2	East Jeddah-Benin	Jeddah Province	32561	High school.	Details
No	No	Thuwal	North Jeddah-Benin	Jeddah Province	32536	Thule High School	Details
No	No	Thuwal	North Jeddah-Benin	Jeddah Province	132177	Thule High School – Intellectual Integration	Details
No	No	Thuwal	North Jeddah-Benin	Jeddah Province	33070	Secondary/night thule	Details
6653325	6653325-13	Andalusia 1	Central Jeddah-Benin	Jeddah Province	32569	Jeddah High School – Courses	Details
6209250	6209250	Al-Rawabi 1	Naseem-Benin	Jeddah Province	32543	Greer High School	Details
0126805276-100	0126805276	الزنة اليمانية 3	South Jeddah-Benin	Jeddah Province	32544	Hattin High School – Courses	Details
No	6551608	Picnic 3	Safa-Benin	Jeddah Province	33147	Hamza bin Abdulmutallab High School/Night	Details
6592776	6551608	Picnic 3	Safa-Benin	Jeddah Province	32580	Hamza bin Abdulmutallab High School – Courses	Details
No	2570974	Al-Faisaliah2	North Jeddah-Benin	Jeddah Province	33228	Khalid Bin Alwaleed High School	Details
	2570974	Al Faisaliah 1	North Jeddah-Benin	Jeddah Province	132017	Khalid Bin Alwaleed Night High School	Details
No	2882930	The guards.	East Jeddah-Benin	Jeddah Province	33117	The high-end.	Details
0	0	The guards.	East Jeddah-Benin	Jeddah Province	132054	Secondary/night-time	Details
No	0504696097	.Two golds	North Jeddah-Benin	Jeddah Province	32586	Two high school golds.	Details
0	6715289	Rehab 4	Central Jeddah-Benin	Jeddah Province	32599	The Secondary Norin to Memorize the Qur'an	Details
6933046	6933046	الصفا 5	Central Jeddah-Benin	Jeddah Province	32597	Radwa High School/Night	Details
6933046	6933046	الصفا 5	Central Jeddah-Benin	Jeddah Province	33094	Radwa High School – The Integration of The Hearing Impaired	Details
6933046	6933046	الصفا 5	Central Jeddah-Benin	Jeddah Province	532522	Radwa High School – Courses	Details
6288965	6288965	Breman 4	Safa-Benin	Jeddah Province	32551	Zaid Al-Khair High School	Details

6363143107	6363143	Alemanic Flu 2	South Jeddah-Benin	Jeddah Province	32902	Zaid Bin Al-Aydal	Details
6378319	6378319	Villages 1	South Jeddah-Benin	Jeddah Province	33057	Zaid Bin Sahl Al Ansari High School - Courses	Details
		Villages 1	South Jeddah-Benin	Jeddah Province	132047	Zaid Bin Sahl Al Ansari High School - Intellectual Integration	Details
6234078	6234078	Um al-Salam	East Jeddah-Benin	Jeddah Province	32526	Saeed Bin Jubeir High School	Details
2715232	2715232-101	Marwa 2	Safa-Benin	Jeddah Province	33019	Suhail Bin Abdullah High School	Details
2124344	2124344	Prince Abdul Majid	East Jeddah-Benin	Jeddah Province	32554	Sicily High School	Details
0126071960	0126071960	Prince Abdul Majid	East Jeddah-Benin	Jeddah Province	533059	Toledo High School - Courses	Details
		Al-Hamdania	Safa-Benin	Jeddah Province	132077	Assem Bin Amr Tamimi High School	Details
No		Al-Qurainiya	South Jeddah-Benin	Jeddah Province	32626	Abad bin Bishr High School	Details
0126752380	0126752380	بني ملك 3 - الشرقي	Naseem-Benin	Jeddah Province	532869	AbdulRahman Al-Dakin Secondary - Courses	Details
6204637	0126204637	المنتزهات 2	East Jeddah-Benin	Jeddah Province	32550	Abdulrahman Al-Ghafqi High School	Details
6201959	6201959	Parks 1	East Jeddah-Benin	Jeddah Province	32903	Abdullah bin Abi Al-Sa'ih High School	Details
0	0568553241	الثغر 1	Naseem-Benin	Jeddah Province	32645	Abdullah bin Al-Harith High School/Night	Details
	0505356883	الثغر 1	Naseem-Benin	Jeddah Province	132028	Abdullah Bin Al-Harith High School - Courses1.2	Details
6830461	6830461	الربوة 4	Safa-Benin	Jeddah Province	33172	Abdullah Bin Anis High School	Details
		الرحاب 1	Central Jeddah-Benin	Jeddah Province	132810	Osman Bin Afan High School - Integration of Autism	Details
		الرحاب 1	Central Jeddah-Benin	Jeddah Province	132046	Osman Bin Afan High School - Intellectual Integration	Details
-	6732468	الرحاب 1	Central Jeddah-Benin	Jeddah Province	133290	Osman Bin Afan High School - Courses	Details
6658476	6658476	العزيزية 2	Central Jeddah-Benin	Jeddah Province	32930	Arafat High School - Optical Integration	Details
6658476	6658476	العزيزية 2	Central Jeddah-Benin	Jeddah Province	32549	Arafat High School - Courses	Details
6328546	6328546	Candra 3	Naseem-Benin	Jeddah Province	33243	Ata bin Abi Rabah High School	Details
2715980	6935094	الصفا 2	Safa-Benin	Jeddah Province	532570	Ali Bin Abi High School Student - Courses	Details
0000000	0000000	North Sail	North Jeddah-Benin	Jeddah Province	32577	Omar Bin Abi Rabia High School	Details
6930102	6930102	الصفا 10	Central Jeddah-Benin	Jeddah Province	33141	Omar Bin Khattab High School - Intellectual Integration	Details
6930102	6930102	الصفا 10	Central Jeddah-Benin	Jeddah Province	32575	Omar Bin Khattab High School - Courses	Details
No	6393536	Knoll 6	Safa-Benin	Jeddah Province	32566	Omar Bin Abdulaziz High School	Details
6121416	6121416	الربوة 5	Safa-Benin	Jeddah Province	32985	Amoria High School	Details
2653546	2653546	Al-Manar 3	Safa-Benin	Jeddah Province	33229	Auf Bin Malik Al-Ahadi High School	Details
6600746-101	6600746	Honorable 3	South Jeddah-Benin	Jeddah Province	32595	Palestine Secondary/Night	Details
6600746-101	6600746	Honorable 3	South Jeddah-Benin	Jeddah Province	532540	Palestine High School - Courses	Details
6969500	6969500	Air base	Safa-Benin	Jeddah Province	32558	King Abdullah High School	Details
6695264	6694716	Red 1	South Jeddah-Benin	Jeddah Province	132016	Quraysh High School - Courses	Details
6233899	6233899	Stalagmites	East Jeddah-Benin	Jeddah Province	33080	Supa Bin Malik High School	Details
6208587	6208587	المنتزهات 3	East Jeddah-Benin	Jeddah Province	32552	High school	Details

6208587	6208587	المنتزهات 3	East Jeddah-Benin	Jeddah Province	33234	Secondary/night time	Details
0	0	.Two golds	North Jeddah-Benin	Jeddah Province	33022	Malik Bin Al-Rib High School/Night Prison	Details
6999706	6999706	Orchards 3	North Jeddah-Benin	Jeddah Province	33082	High-school sailing complex	Details
6392328	6392348-200	السلامة 3	North Jeddah-Benin	Jeddah Province	32559	Prince Sultan High School Complex - Courses	Details
6992607	6992607	Muhammadiyah 1	North Jeddah-Benin	Jeddah Province	532568	Prince Mohammed Bin Saud Grand High School Complex - Courses	Details
6992607	6992607	Muhammadiyah 1	North Jeddah-Benin	Jeddah Province	132176	Prince Mohammed bin Saud Grand High School Complex - Sir	Details
6060187	6060187-20	Khalidiya 2	North Jeddah-Benin	Jeddah Province	532541	Secondary Gap Complex - Khalidiya - Courses	Details
6876643-102	6876643	الثغر 5	Naseem-Benin	Jeddah Province	32537	Secondary Gap Complex - Makkah Road - Courses	Details
No	6392085	Safety 2	North Jeddah-Benin	Jeddah Province	533017	Secondary Safety Complex - Courses	Details
6876406	6876406-101	Ministery 1	East Jeddah-Benin	Jeddah Province	33143	Secondary Beach Complex - The Integration of The Hearing Impaired	Details
6876406	6876406	Ministery 1	East Jeddah-Benin	Jeddah Province	532523	Secondary Beach Complex - Courses	Details
6374426	6363783	Villages 1	South Jeddah-Benin	Jeddah Province	32545	Siddiq Secondary Complex	Details
No	6916062-400	السلامة 3	North Jeddah-Benin	Jeddah Province	33083	Secondary Light Complex	Details
6991271	012-6991271	The delight.	North Jeddah-Benin	Jeddah Province	32557	Mohammed Bin Idris High School	Details
	0122889103	Sail	North Jeddah-Benin	Jeddah Province	132110	Mohammed Bin Al Qasim High School - Courses	Details
No	6887073	Al-Fahd Cities 3 - Al-Sharqi	South Jeddah-Benin	Jeddah Province	33204	Cheetah High Schools	Details
	0551599922	University 3	Naseem-Benin	Jeddah Province	132801	Moaz Bin Jabal High School	Details
2647498	2647498	Al-Ajawad 2	Safa-Benin	Jeddah Province	33244	Moaz Bin Amr High School	Details
0126930870	0126932918	الصفا 6	Safa-Benin	Jeddah Province	32895	Al-Amal Secondary Institute	Details
6820968	6820954	Prince Abdul Majid	East Jeddah-Benin	Jeddah Province	132627	Institute of Intellectual Education 2 Secondary - Autism	Details
6820968	6820954	Safety 2	North Jeddah-Benin	Jeddah Province	33101	Institute of Secondary Intellectual Education 1	Details
6820968	6820954	Safety 2	North Jeddah-Benin	Jeddah Province	33137	Institute of Secondary Intellectual Education 1 - Multiple Disability	Details
6820968	6820954	Safety 2	North Jeddah-Benin	Jeddah Province	33136	Institute of Secondary Intellectual Education 1 - Autism	Details
2165282	2165282	Prince Abdul Majid	East Jeddah-Benin	Jeddah Province	132010	Institute of Secondary Intellectual Education 2	Details
		Prince Abdul Majid	East Jeddah-Benin	Jeddah Province	132071	Institute of Secondary Intellectual Education 2 - Multiple Disability	Details
	966504619187	South Sail2	North Jeddah-Benin	Jeddah Province	33245	Makki Bin Abi High School Student	Details
6969442	6969443	Air base	Safa-Benin	Jeddah Province	32644	Armed forces officers at the secondary/night air base	Details
2510455	2510455	الرغامة 4	East Jeddah-Benin	Jeddah Province	32555	Tiger High School	Details
No	0126296869	Sulaimaniyah 1	Naseem-Benin	Jeddah Province	32564	Nahund High School	Details
0126202239	0122801800	Al-Rawabi 1	Naseem-Benin	Jeddah Province	32864	Hawasan High School	Details
No	No	.The guards	East Jeddah-Benin	Jeddah Province	33226	Yazid Bin Secondary Housing	Details

About.

B. PUBLIC BOYS' HIGH SCHOOLS BY DISTRICT LOCATION

According to the list from the Ministry of Education in Saudi Arabia (Saudi Arabia Ministry of Education) there are 152 public high schools for boys in the city of Jeddah. However, many of these schools are duplicated in that list. There are 90 public High Schools as physical locations in Jeddah within the 95 district and they are as follows:

	School Name	District Name
1	Ahmad ibn Hanbal Secondary School	Al Rawabe
2	Alabnaa Air Defence	Al Andalus
3	Alabnaa King Fisal Sea Base	605
4	Alfudel Ibn Ayadh	Al Rawabe
5	Alfausaliah High School	Al Azizeyyah
6	Um AlQura	Al Faysaleyyah
7	Hitten secondary school (credit system)	Al Nazlah Al Yamaneyyah
8	Hamzah Ibn Abdamutleb	Al Nuzha
9	Suhail bin Abdullah Secondary School	Al Marwah
10	Ali bin Abi Talib Secondary School	Al Safa
11	Omar bin Abdul Aziz Secondary School	Al Rabbwah
12	Mujamaa Prince Sultan	Al Salameh
13	Althaqer Makkah Road	Al Thagur
14	Al-Salamah School	Al Salameh
15	Mohammed Ibn Alqassem	804
16	Hawazen High School	Al Rawabe
17	Ibn Al-Bitar Secondary School	Madaen Al Fahad
18	Ibn Hibban High School	Al Naseem
19	Ibn Hajar Al-Asqalani High School	Al Nazlah Al Sharqeyyah
20	Ibn Hazm Secondary School	Al Adl + Al Farouq
21	Ibn Khaldoun High School	Meshrefah
22	Ibn Qudamah Secondary	Al Sabeel
23	Ibn Manzoor secondary school	Al Samer
24	Abi Ishaq High School	Al Rughamah
25	Abi Muslim Al-Khorasani Secondary	Al Amir Abdulmajid
26	Seville High School	Al Azizeyyah
27	Abrahamic secondary school	Al Bagdadeyyah Al Garbeyyah
28	Al-Hanaf bin Qais secondary	Al Samer
29	Imam Abdullah bin Saud Secondary School	Al Thagur
30	Prince Turki bin Abdullah Secondary	Al Rawabe
31	Prince Fawaz Bin Abdulaziz Secondary	Al Amir Fawaz

32	Prince Mishaal bin Majed Secondary School	Al Safa
33	Secondary sweetener	Al Shateie
34	Al-Maruzi Secondary School	Al Safa
35	Al-Hatim Secondary School	Al Rughamah
36	Secondary trench	Al Ammareyyah
37	Al-Razi Secondary School	Betrumeen
38	Secondary Rahmania	Al Safa
39	Al-Zahrawi Secondary School	Al Rawdhah
40	Secondary martyrs	Al Sabeel
41	Sheikh Mohammed bin Abdul Wahab secondary	Al Muntazahat
42	Secondary conquest	Al Thagur
43	High school Fazari	Teebah
44	Al-Faisal Secondary School	Al Sharafeyyah
45	Secondary Jerusalem	Al Amir Fawaz
46	Secondary education	Al Marwah
47	Al-Maqrizi Secondary School	Al Rabbwah
48	King Saud Secondary School	Bane Malek
49	Secondary Nahrawan	Al Nuzha
50	Ous bin Habib High School	602
51	Badr High School	Al Faysaleyyah
52	Secondary Thaqeef	Al Rughamah
53	Secondary Jeddah	Al Andalus
54	Jarir High School	Al Rawabe
55	Khalid bin Al-Waleed High School	Al Faysaleyyah
56	Radwa Secondary	Al Safa
57	Zaid Al-Khair Secondary School	Buraiman
58	Zaid bin Al-Arqam Secondary School	Al Nazlah Al Yamaneyyah
59	Zaid bin Sahl Al-Ansari Secondary School	Al Qryat
60	Secondary Sicily	Al Amir Abdulmajid
61	Secondary Toledo	Al Amir Fawaz
62	Abbad bin Bishr secondary	613
63	Abdul Rahman Al-Dakhil Secondary School	Bane Malek
64	Abdul Rahman Al-Ghafiqi Secondary School	Al Rughamah
65	Abdullah bin Abi Al-Sarh Secondary School	Al Muntazahat
66	Abdullah Bin Al-Hareth Secondary School	Al Thagur
67	Abdullah bin Anis secondary school	Al Rabbwah
68	Othman bin Affan secondary school	Al Rehab
69	Arafat High School	Al Azizeyyah
70	Atta bin Abi Rabah secondary school	Al Kandarah
71	Omar bin Abi Rabiah secondary school	Al Azizeyyah
72	Omar bin Al-Khattab Secondary School	Al Safa
73	Amoria High School	Al Rabbwah
74	Auf bin Malik Al-Ashja'i secondary school	Al Manar

75	Secondary Palestine	Al Sharafeyyah
76	Quraish Secondary	Al Hamrah
77	Obhur secondary complex	O'bhur Al Janoubeyyah
78	Prince Muhammad bin Saud Al Kabeer	Al Mohammadeyyah
79	Al-Thaghr Secondary Complex - Al-Khalidiya	Al Khaledeyyah
80	Al-Shateaa Secondary complex	Madaen Al Fahad
81	Al Seddik Secondary Complex	Al Qryat
82	Al-Noor Secondary complex	Al Salameh
83	Mohammed bin Idris high school	Al Naeem
84	Madain Al-Fahd secondary school	Al Nazlah Al Sharqeyyah
85	Moaz bin Jabal secondary school	Al Jamea'ah
86	Moaz bin Amr secondary school	Al Ajwad
87	Makki bin Abi Talib High School	O'bhur Al Janoubeyyah
88	Secondary Mutah	Al Muntazahat
89	Secondary Numrah	Al Rughamah
90	Nahawand High School	Al Sulaymaneyyah

C. JEDDAH POPULTION PER DISTRICT

District Name	Pop.	District Name	Pop.	District Name	Pop.
501	150	Al Amir Fawaz	5,221	Al Rawdhah	76,660
503	222	Al Ammareyyah	16,826	Al Rehab	43,659
505	176	Al Andalus	14,423	Al Rughamah	3,900
506	287	Al Azizeyyah	128,852	Al Ruwase	63,340
507	133	Al Bagdadeyyah Al Garbeyyah	18,869	Al Sabeel	23,678
508	195	Al Bagdadeyyah Al Sharqeyyah	36,221	Al Safa	159,484
602	145	Al Balad	72,121	Al Sahefah	24,725
605	265	Al Basateen	43,976	Al Salameh	90,099
606	165	Al Bawadi	95,164	Al Samer	9,458
607	139	Al Faiha'a	23,720	Al Sharafeyyah	83,507
608	122	Al Faysaleyyah	107,201	Al Shateie	29,077
609	231	Al Hamrah	31,451	Al Sulaymaneyyah	26,298
610	244	Al Hendaweyyah	50,363	Al Tha'alebah	22,989
611	232	Al Jamea'ah	124,622	Al Thagur	46,431
612	123	Al Kandarah	53,067	Al Wadi	243

613	278	Al Khaledeyyah	8,121	Al Wahah	11,643
614	118	Al Mahgar	1,178	Al Wazeereyyah	4,300
615	224	Al Manar	2,000	Al Worood	21,469
616	190	Al Marjan	47,851	Al Yaqout	221
617	233	Al Marwah	37,724	Al Zahrah	52,968
618	165	Al Mohammadeyyah	27,478	Al Zummurad	156
619	122	Al Muntazahat	48,130	As Sahil	188
620	144	Al Naeem	32,286	Bane Malek	62,585
802	234	Al Nahdah	31,100	Betrumeen	28,650
803	212	Al Nakheel	3,285	Buraiman	13,368
804	443	Al Naseem	13,644	Guleel	59,026
805	213	Al Nazlah Al Sharqeyyah	24,348	King Abdul Aziz University	700
806	124	Al Nazlah Al Yamaneyyah	58,710	Madaen Al Fahad	67,387
808	124	Al Nuzha	72,184	Meshrefah	121,479
Al Adl + Al Farouq	1,200	Al Qryat	12,317	O'bhur Al Janoubeyyah	15,962
Al Ajwad	40,612	Al Rabbwah	112,694	Teebah	758
Al Amir Abdulmajid	1,100	Al Rawabe	66,085	Total	2,634,205

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