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Evaluation and Development of the Road and Transport Network in Al-Beida, Libya Using Geographic Information Systems

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تقييم وتطوير شبكة الطرق والمواصلات في البيضاء، ليبيا باستخدام نظم المعلومات الجغرافية

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Abstract

This study aims to assess the current state of the road and transport network in the city of al-Bayda in Al Jabal Al Akhdar region, Libya. Also to verify the presence of any problems in this network through field monitoring through two methods. Daily monitoring; this was conducted within the study area during different times of the day to identify everyday problems. This method was limited to part of the road network. Also, an intensive monitoring was also carried out on specific parts of the network. Through this method, the study focused on some vital intersections within the roads. Geographic Information Systems is a technology that is accredited for its role in such studies related to urban development within cities. GIS was used during this study to plan a new transportation system and reference the existing road network. It is used to represent the assumed transportation service area and the neighbourhoods served in clear maps and to analyse their components. The study concluded that the most serious difficulty facing the city's road and transport network is the loss of one of the most safety standards necessary at the city's intersections also the ineffective and weak public transportation system. It is recommended to use geographic information systems when planning such networks. This is proven by the solutions proposed in this research. The information collected during the field study is used to propose GIS-based solutions. This study's results can be applied within cities or even when planning long-distance roads to connect cities.

Keywords: Geographic Information Systems, Planning and Management, Transport and Roads Network,.

الملخص

تهدف هذه الدراسة إلى تقييم الوضع الحالي لشبكة الطرق والنقل في مدينة البيضاء في منطقة الجبل الأخضر، ليبيا. وكذلك التحقق من وجود أي مشاكل في هذه الشبكة من خلال المراقبة الميدانية باتباع طريقتين. المراقبة اليومية؛ تم إجراء ذلك داخل منطقة الدراسة خلال

أوقات مختلفة من اليوم لتحديد المشاكل اليومية. وكانت هذه الطريقة مقتصرة على جزء من شبكة الطرق. كما تم إجراء مراقبة مكثفة على أجزاء محددة من الشبكة. ومن خلال هذا الأسلوب المركز ركزت الدراسة على بعض التقاطعات الحيوية داخل الطرق. نظم المعلومات الجغرافية هي تقنية معتمدة لدورها في مثل هذه الدراسات المتعلقة بالتنمية الحضرية داخل المدن. تم استخدام نظم المعلومات الجغرافية خلال هذه الدراسة لتخطيط نظام نقل جديد والإشارة إلى شبكة الطرق الحالية. تم استخدامها لتمثيل منطقة خدمة النقل المفترضة والأحياء المخدومة في خرائط واضحة وتحليل مكوناتها. وخلصت الدراسة إلى أن أخطر الصعوبات التي تواجه شبكة الطرق والمواصلات في المدينة هي فقدان أحد أهم معايير السلامة الضرورية عند تقاطعات المدينة، وكذلك نظام النقل العام غير الفعال والضعيف. ويوصى باستخدام نظم المعلومات الجغرافية عند التخطيط لمثل هذه الشبكات. وهذا ما تثبته الحلول المقترحة في هذا البحث. يتم استخدام المعلومات التي تم جمعها خلال الدراسة الميدانية لاقتراح الحلول القائمة على نظم المعلومات الجغرافية. يمكن تطبيق نتائج هذه الدراسة داخل المدن أو حتى عند تخطيط الطرق الطويلة لربط المدن.

الكلمات الدالة: التخطيط و الإدارة, شبكة الطرق و المواصلات, نظم المعلومات الجغرافية.

Introduction

The road network is the heart of any city or country worldwide; there won't be a connection without it. According to

Bouzidi (2019), it is important to understand the road networks and their function before planning for them. It is important to use effective tried applications that used in similar fields and consider everything related to it, such as good planning and successful management. On the other hand, the role of transportation itself is not limited to providing ways for the movement of people and goods, but it also affects the patterns of growth and the level of economic activity through long-term access to the ground (Banister, 2005). According to (Miller and Wu, 2000) and (Haddoush, 2021), transportation systems exist to improve accessibility by following the shortest path in the shortest time. Therefore, these networks must have the best features and security to perform their intended aims. The purpose of transportation is to be faster, safer, smarter, and convenient. Al-Beida city was chosen to implement this study because its road and transportation network have many problems. As well as the increase in traffic congestion as a result of the displacement of a large number of families from other cities to the study area. The road and transportation network in the city of Al-Beida does not meet the minimum conditions that must be met in road and transportation networks. Academic research over the past several years has made a significant contribution to the application of new technologies such as GIS. This technology is used in the areas of public participation like urban planning and transportation (Meyer and Miller, 2001). Therefore, it is highlighted via this paper how to use some of the GIS capabilities in managing road and transport networks. Geographic Information Systems are of great importance in such studies (Haddoush, 2021). It is a technology that is widely used for planning and managing public services such as road planning (Jebur, 2021). It is not just a tool or application to use for mapping or data analysis; GIS is a science. According to GISGeography (2023), Burrough and McDonnell (1998), and Lucinda and Johnson (1990) Geographic Information Systems is a science that helps in collecting, displaying, interpreting, and analysing data related to the same spatial location to deduce information of great importance in decision-making. According to (Tanga and Watersb, 2005) Geographic Information Systems has become a common use to analyse and plan road and transport systems, and they are very important when studying such networks (Mohammed, 2013). The field of Geographic Information Systems is concerned with describing, explaining, and predicting patterns and processes at spatial scales (Paul *et al.*, 2004) and (Haddoush, 2021). Geographic Information Systems is a science, technology, and applied methodology for solving spatial[(1)] problems. Due to the effectiveness of GIS in many countries, it has been used in many fields and proved its effectiveness. The Kingdom of Saudi Arabia, Kuwait, Palestine and European countries use this technology/ science in various sectors. This paper includes a statement of the current problems resulting from poor

planning and the absence of proper management of the road and transportation network in Libya in general and in the city of Al-Beida in particular. As well there is an application for how to use geographic information systems to manage road networks and transport by developing solutions using them. It also includes a declaration of how to plan such networks well and highlights the positive impact of using it in planning and management processes. Monitoring and observations were recorded on a daily path at different times of the day for a critical points of the road and transportation network, as well as for some of the most important active parking lots in the city. Focus was also placed on traffic movement during holidays and religious seasons. The idea of this paper can be generalised to all cities spread throughout Libya and outside Libya easily.

The Research Aims

1. Monitor the current status of roads and transportation in Al-Beida city and determine the weak points.

2. Fix the weaknesses of the current transportation system.

3. Dividing the network roads into branches according to their length and give each a different colour (this is in preparation for distributing the new assumed bus stops on these roads' platforms served by buses having the same branches' colour).

The Research Objectives

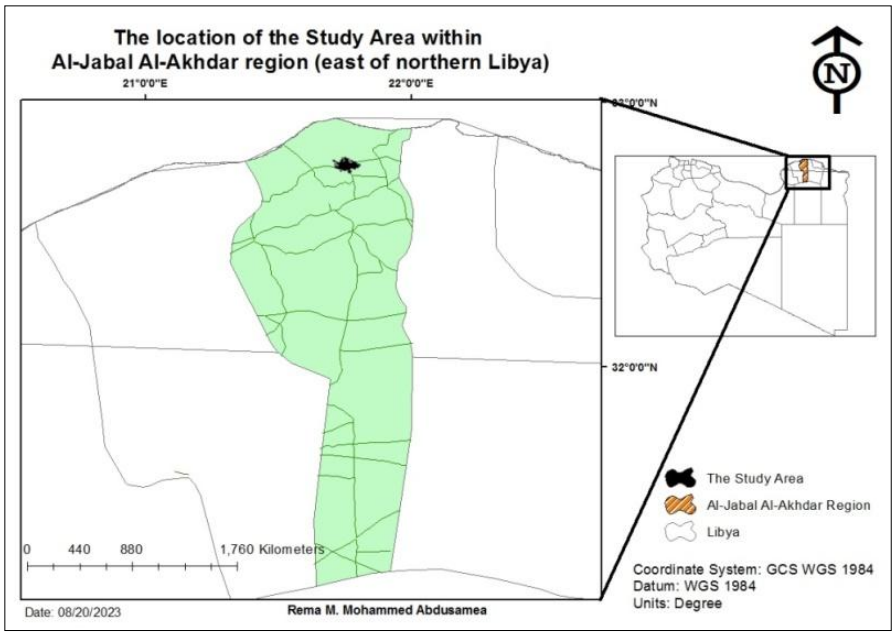
1. Choosing some important intersections within the road network to study traffic near it and through it in the absence of roundabouts.

2. Planning for future transportation needs and designing a new path for transport to serve all the city's neighbourhoods.

3. View through a map the proposed road division with their lengths and colours using the GIS applications.

Study Area

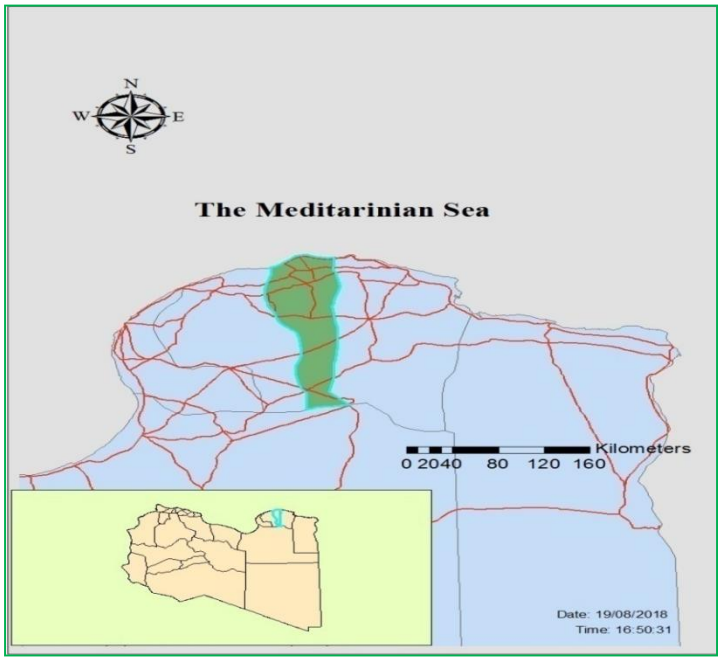
The study area is located in the northern part of Al- Jabal Al-Akhdar region (Fig. 1) and is called Al-Beida. It takes its name because the snow covers it white in winter, Al-Beida = The white. The city contains specific borders and its spatial shape within the Jabal Akhdar region. Al-Beida is also considered the capital city of the Al-Jabal Al-Akhdar region, located in the northeast of Libya.



Source: Designed by the author using Arc Desktop V.10.7 (2023)

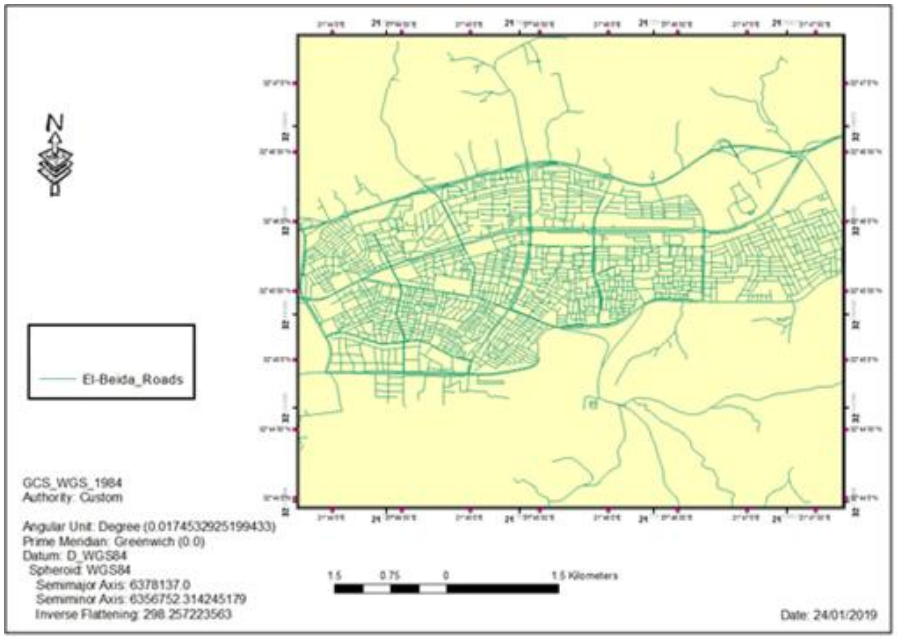
Figure 1: Shows the location of Al-Beida inside Al-Jabal Al-Akhdar and Libya.

The road network in Al-Beida city is a part of Al-Jabal Al-Akhdar road network as a whole and an extension of it (Fig- 2, Fig- 3).



Source: Designed by the author using ArcGIS desktop V.10.3 (2018)

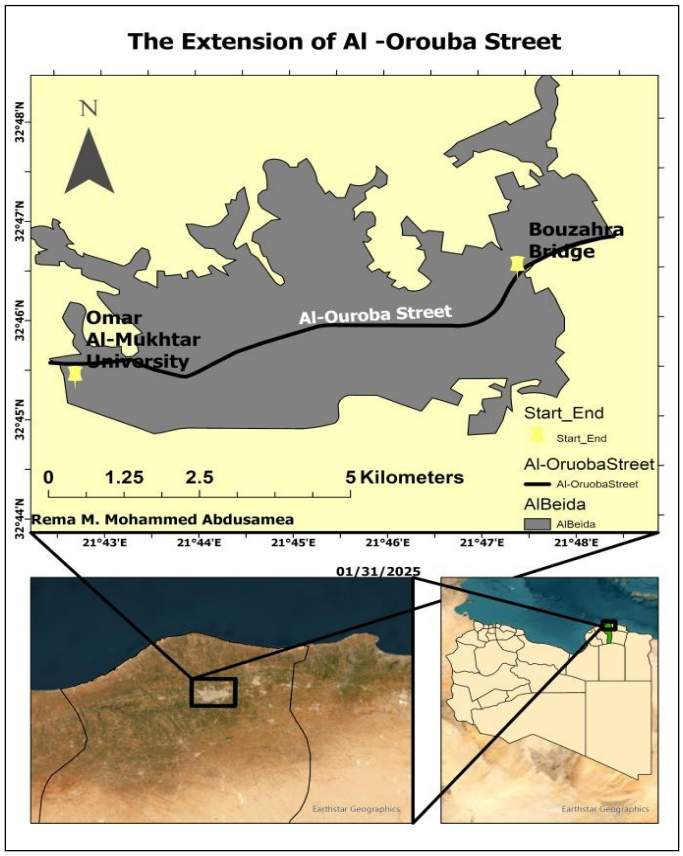
Figure 2: Shows the road network in Al-Jabal Al-Akhdar region.



Source: Designed by the author using Arc desktop V.10.3 (2019)

Figure 3: Shows the road network in Al-Beida city; Minor roads are highlighted in thin lines main roads are highlighted in bold.

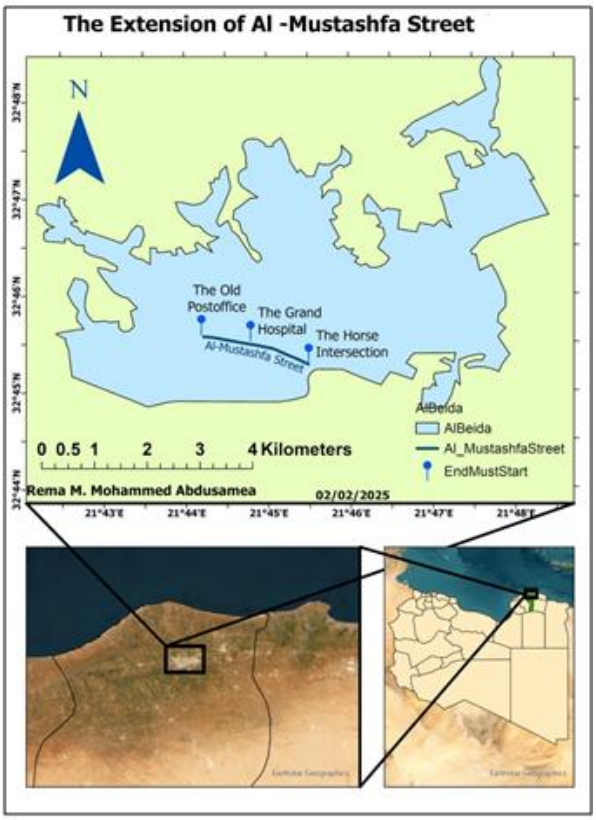
The road network in the city of Al-Beida, like any network around the world, consists of main roads, side roads (the branches), and a highway. There are two main roads in Al Beida: the longest is Al-Orouba Street, and the shortest is Al-Mustashfa Street. Al-Orouba Street extends from the western entrance of the city "near Omar Al-Mukhtar University (the old campus) and passes through the city and extends until it ends after about 1,123.34 meters from a bridge called Bouzahra Bridge, east of the city at Al-Beida Al-Jadeeda area (Al = the, Jadeeda = New) (Fig- 4).



Source: Designed by the author using ArcGIS Pro V.3.0.0 (2025)

Figure 4: Shows the extension of Al-Orouba street.

While Al-Mustashfa Street (Mustashfa = hospital), it is a street that takes its name from its location, as it passes in front of the largest government hospital in the city, (known locally as Al-Mustashfa Al-Kabear = the Grand Hospital). It is a road that starts from an area known as 'Al-Bareed Al-Kadeem = The Old Post Office', passing in front of Al-Beida Grand Hospital, and ends at an intersection near an elementary school ‘named Omar Bin Al-Khattab’, this intersection known locally as the Horse Intersection (Fig- 5).



Source: Designed by the author using ArcGIS Pro V.3.0.0 (2025)

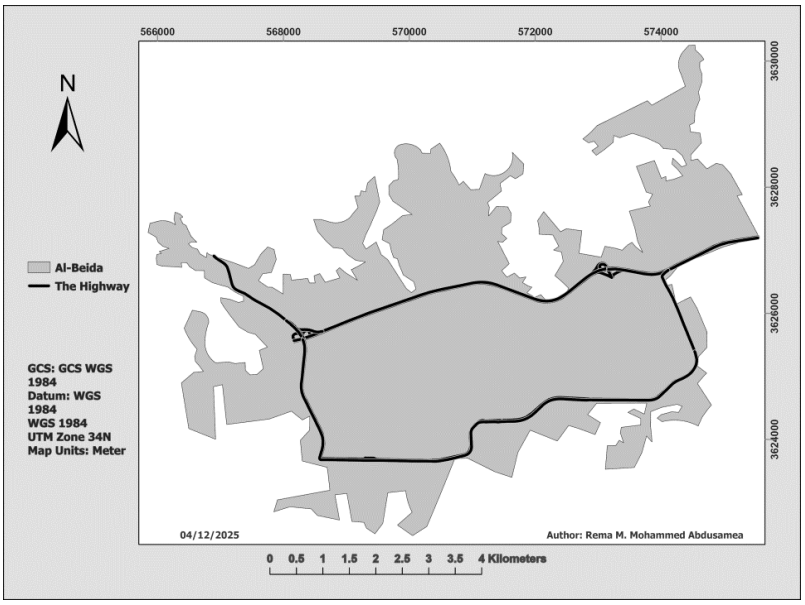
Figure 5: Shows the extension of Al-Mustashfa street.

Al-Mustashfa Street can be reached from several side roads lead to Al-Orouba Street. These roads are small branches that connect all main roads and highways together, eventually formed the city's road network (Fig- 3 above). The highway in the study area is in the form of an episode (Fig- 7), It divided into north part (known as The New Highway) and south part (known as The Old Highway); the north is paved, while the south is unpaved. Now in 2025 the government have been started to pave the southern part (fig- 6).

Source: Photos taken by the author (2025)

Figure 6: Shows the southern part of the highway (The Old Highway after paving).

The northern branch is located between an area called Wrdama in the east, and an intersection known as "Sidi Rafeh" in the west of the city. Sidi Rafeh intersection leads to the old campus of Omar Al-Mukhtar University in the west, while the directly opposite branch leads to the industrial area, while the east branch leads to the heart of the city.



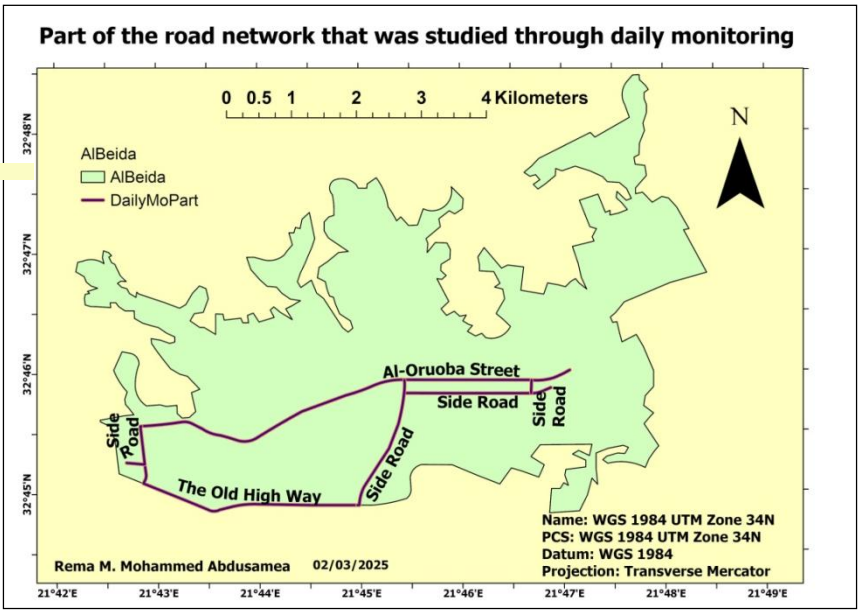
Source: Designed by the author using ArcGIS Pro V.3.0.0 (2025).

Figure 7: Show the highway, it is surrounding most of the city.

Methods and Methodology

The city of Al-Beida was chosen to be the study area due to the many problems it has. The study includes continuous monitoring of main and side roads during the day and at different times to record observations. The field study took more than seven years to collect accurate and complete information. Monitoring phase was started in May 2017 before writing and continued during its

writing until the last hours of the completion of this study in order to identify and record all variables. The process of collecting information was carried out in two methods. First one is the quick monitoring. It was applied automatically to a specific part of the road network as a result of daily use of this part (Fig- 8). It is the part extending from front of the Industrial Institute in Al-Beida Al-Jadeeda area to the old campus of Omar Al-Mukhtar University. Second method is an accurate. It was used to examine some active points in the road network (Fig-9 & Fig-10).



Source: Designed by the author using ArcGIS Pro V.3.0.0 (2025).

Figure 8: Shows part of the study area network that was studied through daily monitoring.

The first method gave a large amount of information, while the second method included more accurate and comprehensive information. Some of the papers that studied same problems have been reviewed in order to identify the causes of these problems and to stand on the solutions that have been proposed. Moreover, Google Earth Pro was also used to map some of the most important road intersections in the city of Al-Beida to shed more light on the problem and imbalance in the city's road network. In addition, some of the Geographic Information Systems apps were used: ArcGIS Pro V.3.0.0, QGIS V. 3.26.3, and Arc desktop (V. 10.3 & V. 10.7) to design maps and display the current situation in the city to make a better design that includes solutions to some functional and organisational problems in the network.

Monitoring Results

As a result of daily monitoring, many problems were observed in part of Al-Orouba Street, the part that connects the western gate of the city with the eastern gate of it. There is increase in the number of cars as a result of the increase in the population in the study area during the last years. In addition to that the roads are narrow, they do not accommodate this increase. There is no specific section of the road for parking. The increase in the number of cars on the roads is because of the non-guided and illegal car ownership. The roads cannot assimilate this massive

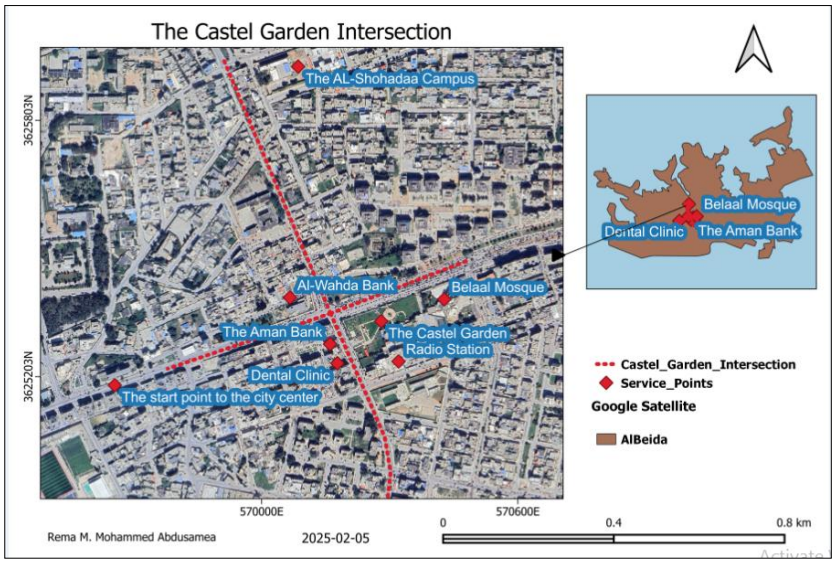
and increasing inflation in the number of cars. In addition, the drivers exceed the legal speed on the roads. Many drivers under legal age and occupy roads unnecessarily.

Moreover, most intersections lack the roundabout islands, and all the city's roads lack white pedestrian lines. It was also noted that the public transportation network is very weak; there are no specific places for bus stops, nor are there specific times for their arrival or active stations to wait.

On the other hand, the results of the intensive monitoring for some of the basic intersections showed this; There is a major defect in the road network at the intersections. There are no roundabouts at most of the intersections. The presence of roundabout islands at the intersections is very effective if we compare it with those that lack the islands. It was noted that there is a significant traffic disorder at these intersections, which often suspends traffic for 10 to 15 minutes, or more, especially at the rush hour. This makes many people arrive late for work and school. This phenomenon increases on holidays and religious occasions. In addition, the traffic police are sometimes absent in many of these intersections.

The Chosen Intersections

First intersection: It is a crossroads near a park so-called Castle Garden. This intersection is a connection point between a street leading to the heart of the city in the west and a street leading to Omar Al-Mukhtar University- Al-Shohadaa Campus in the north. Al= The, Shohadaa= Martyrs. This intersection leads to many facilities and public services; banks, clinics, mosques…etc. (Fig- 9).



Source: Designed by the author using QGIS V 3.26.3 (2025)

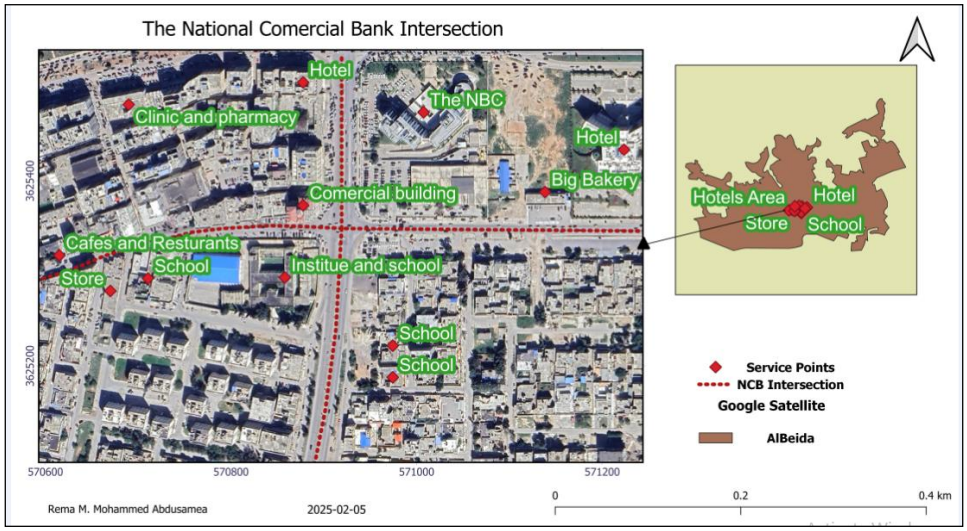
Figure 9: The first intersection that was examined through this study. It lacks to a roundabout island.

This intersection was chosen because it is close to many service points and is a gateway to the heart of the city. During regular monitoring, a great and repeated disturbance was observed in this intersection, whether in cases of traffic jams or not. Due to the presence of many banks near this intersection, many bank customers use the corners of this intersection as parking lots, which affects negatively traffic.

Moreover, the absence of an island at this crossroads makes the direction of driving overlapping and unspecified. All these violations make driving through this intersection very dangerous. At best, they repeatedly lead to obstruction of traffic and thus delay arrival for work and school, as it may lead to traffic accidents that may be serious. The lack of deterrent laws and penalties makes it worse. It was also noticed that walking and driving through this crossroads are almost impossible in the absence of traffic police because of this overlap in directions. In addition, the drivers who drive quickly through this intersection increase the possibilities for traffic accidents. Cars remain in the middle of this intersection from 5 to 10 minutes, depending on the absence or presence of the traffic police officers.

Regulating traffic at this intersection is very difficult due to the lack of an island and thus interference in road directions.

Second Intersection: This intersection is behind the administration of the National Commercial Bank (NCB) see Fig- 10 in following. This crossroad was chosen because it is one of the most dangerous intersections in the study area; it lacks a roundabout island, the distance between the platforms is wide, there are no traffic lights anywhere near it, and there is no traffic police at any time of year at the intersection's branches. Although there are many service points near this intersection, such as schools, institutes, hotels, commercial buildings, stores, restaurants and cafes, this important intersection is without any security or safety laws. Although there is an increase in the flow of cars in this part of the road network, there are no pedestrian lines or walking bridges to save the people lives when they cross the roads.



Source: Designed by the author using QGIS V 3.26.3 (2025).

Figure 10: Shows the intersection location and some of the service points.

The breadth of this intersection is the most dangerous factor. The distance ranges between 14 and 17 metres (according to an accurate measurement using the ArcMap V. 10.8 tools). The pedestrians are at risk of traffic accidents every time they cross this road intersection's branches, especially when crossing with children. Moreover, the overlap at this intersection is higher than the first intersection.

Structural and functional problems

The Road Network

The road network in the city of Al-Beida is not subject to periodic maintenance operations, and if that happens, it is not identical to the required standards (because most of them are temporary and ineffective). The roads also suffer from many structural problems that include design (road design/asphalt layer design) (Fig- 11).

Source: Pictures filmed by the researcher (2025)

Figure 11: Shows the situation of the asphalt in one of the side roads (roads within residential areas).

Many drivers often use roads badly; they drive over the separators between the roads to move from side to side. This behaviour against the road safety rules and laws, and this increases traffic accidents. At best, it leads to traffic disorder. The main reason for increasing this violation is the lack of deterrent laws. In addition, the natural sidewalks between both sides of the roads are not surrounded by a fence, and if surrounded by a fence, they are not subject to periodic maintenance if damaged.

On the other hand, the roads lack many important safety specifications, whether on the highway, main roads or the roads within residential areas. For example, there are no pedestrian lines on any of the roads at all. Also, the presence of traffic police officers is limited to specific points all year, while there are other important locations that lack the presence of the traffic police at any time of the year. In addition, traffic light laws are not applied in an actual way even though they are at

most danger intersections. Many drivers ignore the red light, while some of them wait for it, but they go beyond the line of vision of traffic lights; thus, they do not notice as soon as the colour of the light changes. The open and closure times of traffic lights are calculated on all roads and intersections inside and around the network, so any delay has its effect on the entire network. Consequently, drivers who are waiting after the traffic lights' sightline only move after hearing the cars' trumpets behind them, and this hinders and delays traffic.

The government started paving and repairing main roads and highways at the end of 2024 and is still continuing until the last moments of writing this paper. Repairs are underway until Jan 2026.

The Transport Network

Transportation in the city is limited to private cars and public transport. The public transport includes minibuses and taxis, which, in fact, are private cars that are not licensed by a state institution to act as taxis. The use of public transport has many problems because it is not regulated and managed by a government authority. It is the transport drivers themselves who decide on the cost and route. Bus drivers chose a specific route, it is through Al-Ouroba Street and some branches (Figure 12). There are many roads and streets that are not served by any of the public transport. Citizens are forced to take long walks. When someone needs to go to a site outside this bus route, he/ she must pay additional fees. This current path is ineffective and does not cover the city fairly (Fig- 12).

Source: Google Earth Pro (2023)

Figure 12: Shows the specified bus route according to the desire of the buses' owners.

In addition, there is no specific bus stop for the minibuses, and they do not carry specific symbols or numbers; therefore, if one of the passengers forgot something inside, they cannot have it back. There are no specific bus stations to wait for the buses. Therefore, passengers can go down at any point, even in the middle of the road. Public transport owners do not follow a specific law, so passengers may wait for more than 10 minutes before riding or get a ride as soon as they stand on the roadside. This is due to the lack of a bus time schedule. Moreover, bus drivers refrain from transporting passengers to their destination in case of traffic congestion even if it is on the route

that they specified (fig-12). Bus prices are subject to the owners; they change the fees as they want.

On the other hand, taxis are private cars without a specific shape or paint colour. Drivers decide at any time to use their cars as taxis; they can transport any passenger from the road. Some used to use their cars as taxis all the time, and they use any intersection corners to park. This location is not suitable to stop in.

Main Causes behind Road Problems and Transportation

1. The lack of a deterrent and strict law on violations due to the dominance of traditions in this aspect.
2. Illegal driving licenses; Most drivers are younger than the legal age for a license, while others have a purchased license.
3. There are no traffic police or even traffic lights in many intersections and roads.
4. Although there are radar cameras at some important intersections, they are not used to edit violations.
5. Drivers go beyond each other without respecting traffic lights or for fear of carrying out strict penalties against them.
6. Public transportation does not follow an organised government agency.
7. Failure to provide real stations for public transportation in all centres and neighbourhoods of the city.
8. The bus path is determined by its owner, passengers get out from the bus wherever the owner decide.

Geographic Information Systems as an ideal solution for such problems

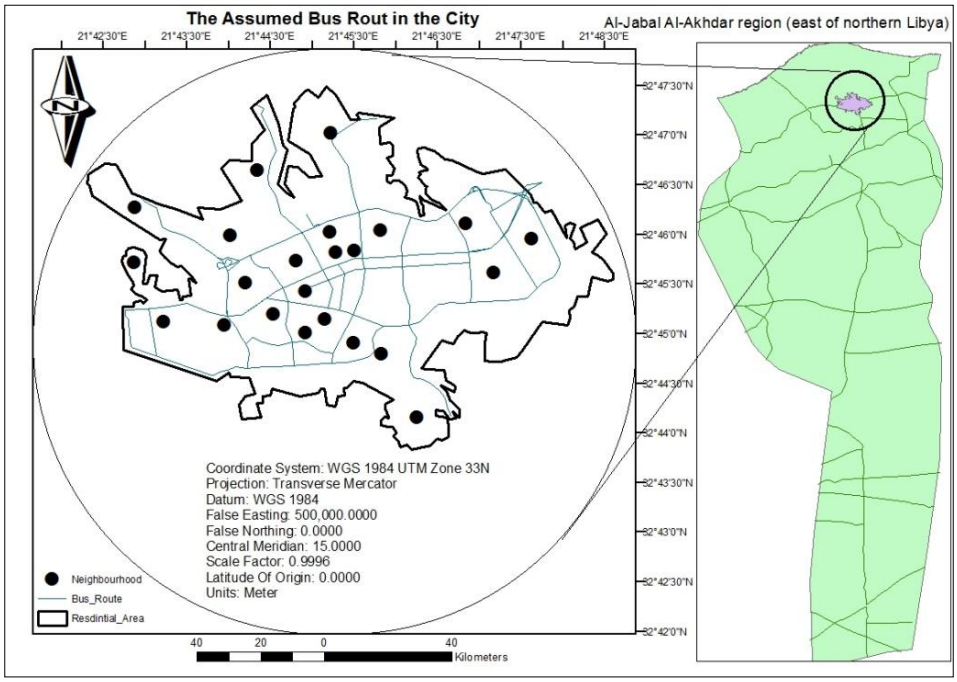
The planning and analysis of the urban transport system is an important activity to enhance the active movement of people and goods (Shaheen *et al*., 2022), as well as to develop societies (Black, 2003). According to (Paul *et al*., 2004) and (Shaheen *et al*., 2022) such problems related to the face of the Earth must be solved using the Geographic Information Systems capabilities (GIS). It also helps to understand how to treat problems and whether dealing with spatial problems is different from other problems. It is important to focus on describing the entities, then emphasizing their location (coordinates and spatial reference) before starting any analysis using Geographic Information Systems. Description and spatial reference for entities are important to solve a specific problem related to the total form of the region. Must combine both of them. Geographical information systems repair many old problems related to the Earth by combining general scientific knowledge and specific information; As a result, it gives real value to both.

In conclusion, the effective use of geographic information systems (GIS) in all sectors, especially in the development of transportation and road infrastructure, is crucial. According to Al-Qarni (2012), GIS activation is one of the most important elements of improving long roads and increasing the effectiveness of their planning, design, monitoring, and repair. Enhancing traffic safety and security in the long road care sector can be better achieved by utilising GIS. One of the GIS characteristics is its ability to analyse networks; when activating this technology, it will be easier to detect and fix any malfunction anywhere on the road network. Thus, specialists can go

directly to the problem location of any road network. In the study area, it is difficult to determine the cause of any problem or its location due to the lack of use of GIS in the planning or construction sectors. It is effective in maintaining the road network on a regular basis. GIS application must be supplied with a database on the roads (traffic history), including the maximum speed and traffic density at various times, particularly during rush hour, as well as the distance and height of each segment of the network. Utilising GIS can effectively calculate the necessary intervals for routine maintenance, ensuring consistent security and safety.

Suggested Solutions Based on GIS

First of all, all buses should be owned and managed by a government agency, such as the traffic police department. Buses must follow a clear schedule that outlines their routes and stops. Public transport must be accessible everywhere in the city, not just in specific locations (Fig-11 previously). The current bus route is limited to Al-Orouba Street and only serves a few neighbourhoods, neglecting many others in the city. Fortunately, the study area's road design is a network, so it is easy to design new routes for the public transportation. There is a proposed bus route, as shown in Fig-12.

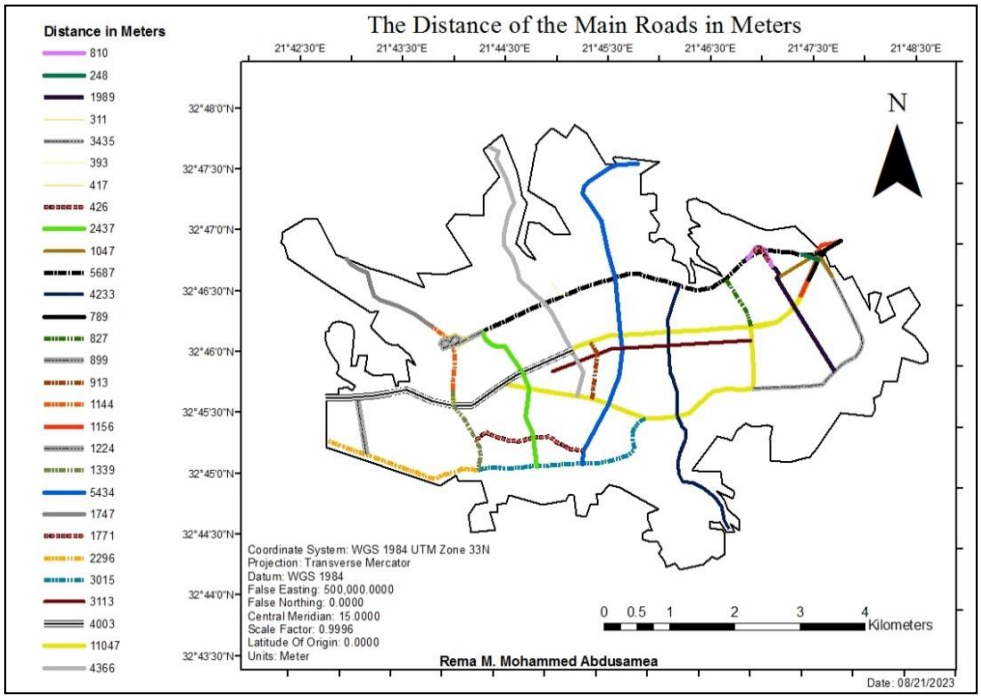


Source: designed by the author using ArcGIS V. 10.7 (2023)

Figure 12: Show the neighbourhoods locations and the suggested scheme for bus paths

Using one of the applications for geographic information systems, the new bus route was proposed along with the best locations for bus stations. This proposed scheme aims to support every neighbourhood within the study area (refer to Fig. 12), ensuring that all residents effectively benefit from the public transport. By implementing this scheme, we will enhance comfort and ensure easy access to daily destinations, making life smoother for everyone. Choosing appropriate locations for boarding and disembarking stations and ensuring fair

distribution across the city is a critical aspect. When proposing locations for bus stops, two important factors were taken into account: distance and efficiency. The comfortable walking distance varies from person to person and increases with fitness level, starting at 200 metres. In addition, an efficient transport system is necessary; the shorter the distance between stations, the slower the passenger movement, which can make public transport less attractive. To determine the total number of stops for each branch, it is essential to have the length measurements of each main road branch (see Fig- 13).



Source: designed by the author using ArcGIS desktop V. 10.7 (2023).

Figure 13: Shows the length of each branch of the main road network.

The length of each part was calculated individually using the ArcMap V. 10.7 tools (Fig. 13) above. The roads have been divided according to the nature of the area and the distribution of service points and neighbourhoods around each one. Each branch is assigned a distinctive colour, which is also recommended for buses that serve that route. To differentiate buses of the same colour, numbers and/or letters can be added, or a unique logo can be designed specifically for each branch.

Proposal for bus station locations can now be introduced more clearly and easily depend on Fig. 13. For instance, the blue branch connecting the northern with the southern part of the city is about 5,434 metres long. This branch supposed to include about 15 bus stations with a spacing of 350 m apart. Two out of them are shared stations (the red points on Fig. 14).

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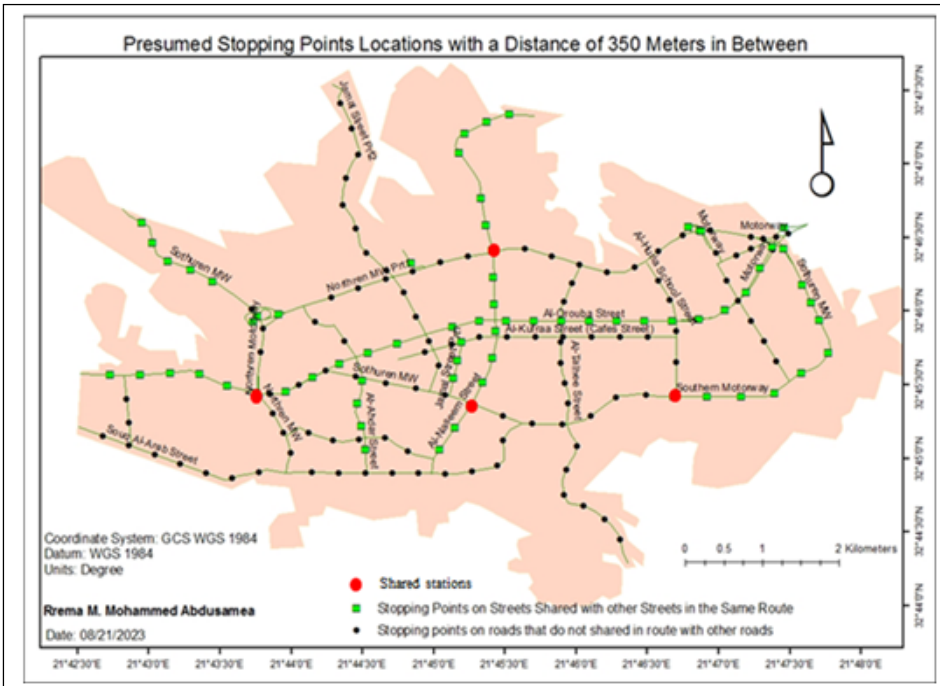

Source: designed by the author using ArcGIS V. 10.7 (2023)

Fig- 14: The proposed sites of bus stations with a distance 350 meters in between. The black points refer to the stations on roads that do not contain joint stations with another route, while the green squares refer to stations on the roads that include shared stations or close station to another on different route. The red points refer to four the shared stations; in the north, in the west, in the middle, and in the east.

Source: designed by the author using ArcGIS desktop V. 10.7 (2023).

Figure 14: The shared stations and two types of bus stops

These two stations serve different branches; part of the yellow route and the long dashed black route (see Fig-13). The northern shared station is located at the intersection with the northern part of the highway while the southern one in the middle intersected with the southern part of the highway (Fig- 13). Therefore, the required destination for people who wait in these two stations varies. Four buses will stop at each one of them. The blue branch will be operated by two blue buses (A21 and A22) see table-1 in following. Two additional buses will work in two opposite directions along the routes that share stations with the blue branch (Table- 1).

Table-1 in following shows an example to clarify the assumed colours and symbols of the six buses which supposed to stop at the north shared station (Figure 14). These colours were chosen depending on each branch colour.

Table 1: A proposal for bus features that are supposed to stop at the north shared station in accordance with the supposed partitions in Figure 13 and bus stations sites in Figure 14.

The Bus Colour and Code	A 21		A 22	
The Bus Route	It goes to the **northren part of the blue** route…fig 13		It goes to the **southren part of the blue** route…fig 13	
The Bus Colour and Code	C 52	C 53	J 101	J 102
The Bus Route	It goes to the **eastren part of the dotted black** route…fig 13	It goes to the **westren part of the dotted black** route…fig 13	It goes to the **eastren part of the yellow** route…fig 13	It goes to the **westren part of the yellow** route…fig 13

Source: designed by the auther just to clarify the asumed scheme (the codes and the numbers not to use on real, can be studed later)

This applies to all shared stations in the study area. According to the supposed scheme there must be four shared stations.

On the other hand, there are adjacent stations serve different routes, each with different buses that transport passengers to different destinations. The distance between them is less than 350 meters.

To increase the effectiveness of this system and avoid wasting time, buses should stop for only 2 minutes at each stop unless one or more passengers are waiting, or one passenger needs to get off. In addition, a bus schedule map should be placed at the station to indicate the different routes and which buses can be boarded.

According to (Burrough and Rachel, 1998) GIS and/or database operations have been used to derive and to redistribute spaces. The distributions can be derived or modified based on the locations of the points that share the spaces. This can be achieved more simply by signing the distribution of points relative to the spaces according to what coincides with them. The most quantitative method of signing distributions involves increments between points in order to achieve a continuous spatial change. Augmentation techniques (surface trend analysis, key functions) have been used regularly.

Conclusion

The road and public transport network in the city of Al-Beida is insufficient and needs to be redesigned, both functionally and structurally. There are no pedestrian lines or bridges at all in

the study area. Roundabouts are not available at all intersections. Some important routes without traffic lights. The city lacks real public transport. It is a set of buses and cars that belong to their owners and are subject to the laws that they set. Public transport does not serve all neighbourhoods. Many neighbourhoods are not provided with public transport. Due to the need to develop radical solutions to some problems from this network, geographic information systems use a technology that has proven its effectiveness in such studies and its ability to analyse networks and help develop designs in the form of maps to finally display what is proposed and present the picture that would be if it were applied to the ground. The importance of this technology is emphasized in raising the efficiency of these networks and speeding them up, in addition to facilitating the regular maintenance of roads within the city and on long-distance routes through the provision of official services

Recommendations

1. Dealing with road and transport networks through an updated database that is added to GIS software from the establishment phase.
2. Use pedestrian lines on the roads to save the lives of pedestrians.
3. Build pedestrian bridges at many points to facilitate their movements from side to side on the streets.
4. Must distribute police cars, ambulances, and their service centres throughout the city to facilitate rescue operations and respond to emergency calls quickly.
5. Placement and activation of radar cameras on all major roads and highways.
6. Create roundabout islands at every intersection in the city to regulate traffic.
7. Providing GIS applications with databases related to important services such as emergencies, to help determine the shortest route between two points in terms of distance and the time required to cover that distance, which in turn reduces losses caused by accidents, fires, etc.
8. Use the GIS to identify the appropriate points to place any of the service points along the road and to sign these points relative to the total area of the road.
9. Activating the GIS in all the service facilities, such as fire, security, health, public works, buildings, water, engineering, public service facilities such as mail and home delivery services, and more.

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