

## RESEARCH ARTICLE

## DEVELOPING THE TRANSPORTATION SYSTEM IN LIBYA

Halima Mostafa, Alashkm Keshim

Department civil engineering, higher institute of science and technology, zawiya, Libya.

\*Corresponding Author Email: [Monm.hamad@yahoo.co.uk](mailto:Monm.hamad@yahoo.co.uk)

This is an open access article distributed under the Creative Commons Attribution License CC BY 4.0, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

## ARTICLE DETAILS

## Article History:

Received 23 September 2024  
Revised 18 October 2024  
Accepted 11 November 2024  
Available online 13 November 2024

## ABSTRACT

Traffic congestion in cities due to population growth and building density necessitates providing appropriate infrastructure, particularly transportation and logistics systems, to address the population's needs. This includes introducing various means of transportation, such as pedestrian and cycling environments, light rail, metro, rapid buses, and public transport buses. High-level road projects should be integrated with city planning, and modern technology, such as smart applications, should be adopted for better accessibility and participation. However, there is a lack of clear vision for the development of transportation systems, whether public or private, which should be made possible through sustainable planning and design standards. Research is crucial in diagnosing obstacles, evaluating contemporary developments, and maximizing potential by applying international standards and approved studies in this field.

## KEYWORDS

development, transportation, roads, friendly system

### 1. INTRODUCTION

Traffic congestion affects cities all around the world, causing delays and inconveniences for both locals and visitors. Because of the growing population and denser building in metropolitan areas, there are more cars on the road, which contributes to the congestion. Providing sufficient transport and logistics infrastructure that satisfies citizen requirements and helps to alleviate traffic congestion is a challenge for cities (Button and Hensher, 2018). As a result, several strategies are put out to enhance urban transportation networks. These strategies include creating new modes of transportation like cycling and walking as well as public transit like buses, metro, and light rail. Additionally, integrating city plans with transport plans is necessary to address a number of issues in the sector of public transport. Implementing cutting-edge road projects and building them to the highest standards, offering dedicated parking spots, and making public transit easier to access are all necessary to ensure the success of modernizing transportation networks. Consequently, this subject is among the most significant problems that cities are currently facing, and studies and research in this area are crucial for determining the challenges that the existing transport systems are experiencing, assessing them, and creating solutions that adhere to international standards (Khisty and Khisty, 2004; Institute of Transportation Engineers, 2010). The purpose of this introduction is to emphasize the value of research in this area and the ways in which it might enhance urban quality of life and ease visitor and resident mobility (McCarthy, 2011; Tumlin, 2012).

Libya's transport status is a significant problem that requires growth and attention due to its obstacles. Achieving comprehensive development, improving urban-rural connection, and fostering commerce and mobility all depend on effective and sustainable transportation. Libya is facing significant transportation-related issues due to a number of causes (Alhodairi, 2012). One of these elements is the degradation of logistics centers, bridges, and road infrastructure, which has a detrimental impact on vehicle speed and safety. Additionally, the nation lacks effective and dependable public transit, which makes it difficult to reach possibilities for work, education, and essential services. Libya also has political and security issues that have an impact on the transport industry (Elmansouri et al., 2020). The nation's political upheaval and wars had an impact on the

smooth running of logistical networks and transportation. Developing comprehensive solutions to enhance Libya's transport status is important to address these challenges (Abuhamoud and Rahmat, 2010). In order to offer effective and dependable public transit, work must be done to maintain and upgrade the road infrastructure. To encourage investment in the development of infrastructure and the transport sector, collaboration between the public and private sectors has to be enhanced. In order to enhance traffic management and deliver transportation services more effectively and smoothly, efforts should be directed towards expanding the use of technology in the transportation industry, such as mobile applications and geographic information systems. The advancement and amelioration of Libya's transport infrastructure may bolster economic growth and elevate the standard of living for its populace. This calls for sustainable investments in the transport sector as well as collaboration and coordination between the public, business, and local community sectors (Ismail and Elmloshi, 2011).

### 2. URBAN TRANSPORTATION

A society's ability to develop economically depends on its transport system (Abuhamoud et al., 2011). A country or area cannot maximize the utilization of its natural resources or the productivity of its population without adequate transportation. Many urban issues, including traffic, severe air pollution, urban sprawl, and unsuitable land development with low urban density, are brought on by urban growth globally (Imbayah et al., 2023). Over the last few decades, Libya's economy has expanded, but the country's transport infrastructure has struggled because of a sharp rise in travel demand. However, the infrastructures have a number of issues. (Elmnifi et al., 2019). Illustrates, the population density is quite low when compared to the populations of other nations, where a tiny population is dispersed over a large territory with severe weather. The number of urban regions has increased significantly due to the population's fast rise. In the last thirty years; it has expanded by 50% (Figure 1).

For the previous three years, the predicted average annual growth rate was 1.2%. According to projected data from the Libyan Census Bureau in 2018, it was anticipated to be 6.47 million people (Elmnifi et al., 2024). For

## Quick Response Code



## Access this article online

Website:  
[www.jtin.com.my](http://www.jtin.com.my)

DOI:  
10.26480/jtin.01.2024.42.48

the past 50 years; Libya's urban population has been overpopulating. World Bank indicators reported urban population in 2016 at 78.75%; the same report shows that the urban population growth rate was at 1.18%. The majority of urban population concentrates along the coast where the major cities are located, including the capital Tripoli. Every year, more people relocate to major cities where the infrastructure is much better, and services are available. Comprehensive data on the global urban population is available from the United Nations Population Division.

Libya's urban population has grown significantly over the past 40 years, from 40% to 80% (Almsetati et al., 2011). As a result, there is a glaring shortage of public transit across the nation. Inadequate attempts have been made to enhance services and create a reliable transport system. A few bus routes run erratically, transporting passengers from the north to the south and from the east to the west. Plans and initiatives throughout the previous years have centered on moving

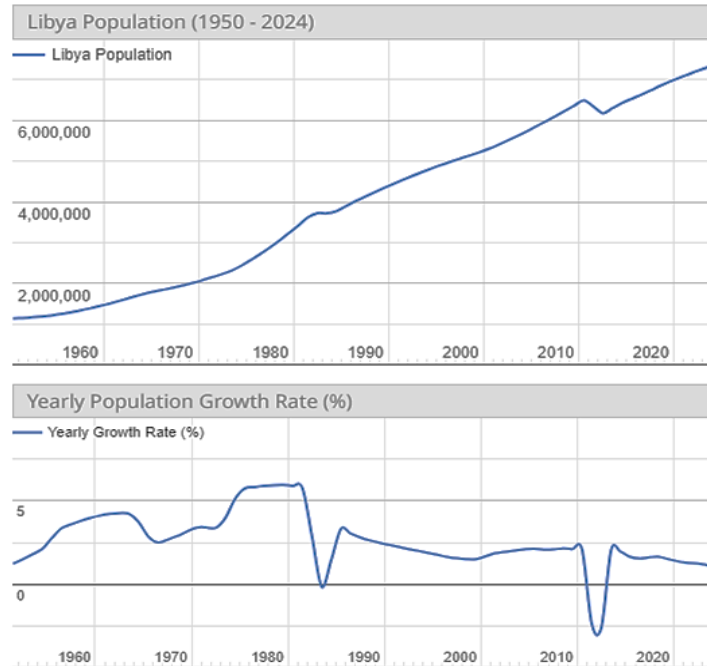


Figure 1: Urban population growth in Libya.

Fewer vehicles by disregarding public transport and constructing more highways. An effective transport system aims to move as many people as possible at a reasonable cost while offering passengers enjoyable and safe travels. However, shared taxis are the sole means of transportation available to those without vehicles. The majority of them rely only on taxis to get around metropolitan areas. The Libyan Census Bureau reports that public taxis have grown by about 60% during the past six years. Over the same period, the number of taxis increased by over 10% yearly (Sign, 2005). The nation's essential infrastructure—old, dilapidated railroads and roads—is seriously harmed. The majority of the small, narrow roads built during the early years of independence were unpaved. World Bank

data state that 47,590 kilometers of roads were paved by 2014. The Libyan Coastal Highway is an important route that runs down the coast of Libya, connecting the east and west. The highway spans over 1800 km between the borders of Egypt and Tunisia. Government figures from 2010 (Bureau of Figures and Census, 2015) show that the road network is made up of 18,386 km of minor roads (farm roads and sub-roads) and 15,143 km of interconnected main highways. The number of automobiles has risen significantly, and maintenance has been ignored in recent years, which has caused the roads to deteriorate quickly. The country's primary roadways are seen in Figure 2.

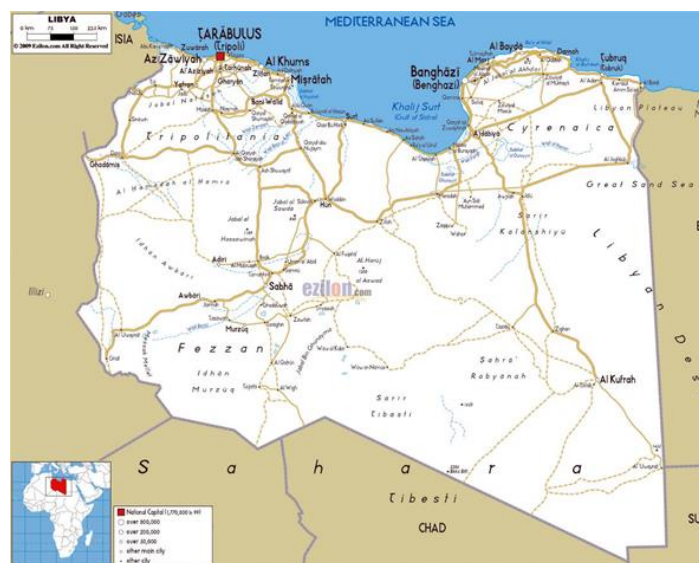


Figure 2: Major roads and airports in Libya.

In addition, the majority of the nation's roadways have several difficulties. There are not many bridges and unrestricted freeway access in most metropolitan areas. The highway has just eight grade-separated crossings, or interchanges (Bureau of Statistics and Census, 2015). Vehicles entering and leaving the road cause traffic delays and accidents. Other problems

that exacerbate the transportation system include subpar roadside amenities including rest stops, park and ride lots, and pedestrian facilities. In addition, lane lines need to be redone, signs are broken or missing, and the roads are dirty. Pre-timed signals are used to regulate intersections; these should be changed and replaced with more recent controls that can

react to both vehicles and people. In Libya, traffic congestion is not so much a problem as a means of resolving other issues. Two further significant issues associated with congestion are accidents and the scarcity of parking spots in metropolitan areas. The coastal region, with its dense population and industrial activity, presents a significant pollution risk due to the disposal of hazardous waste and the release of dangerous gases.

### 3. INTEGRATED TRANSPORT SYSTEMS

Transportation systems operating within cities, especially those following the Transport-Oriented Development (TOD) system are very diverse. There are many means used in all public transport systems within cities and urban centers. These systems require integrated streets or dedicated lanes to isolate the movement of a particular system, in addition to bridges and tunnels specifically designed to accommodate these systems, ensuring their compatibility with them. This infrastructure aims to provide ease and comfort in transportation, which affects citizens' choices in transportation methods, as their choices depend on the efficiency of land use, urban density, and population density in specific areas (Abuhamoud et al., 2011).

#### 3.1 Integration of land use planning and transportation systems

The thoughtful distribution of land uses facilitates mobility patterns. The demand for transportation revolves around the need for individuals to reach specific locations, hence the importance of integrating land use planning with transportation planning to achieve this goal. This integration ensures the accuracy of urban planning, helps achieve the goals of integrated planning, and reduces negative impacts on the environment. In addition, this approach contributes to ensuring the required activities by addressing land use planning and separating different activities to reduce negative impacts between them. Many world capitals have adopted this principle since the beginning of the twentieth century, where integrated road networks were designed to serve specific areas while minimizing negative impacts and ensuring high levels of mobility using vehicle-based mass transit (Abuhamoud et al., 2011).

#### 3.2 Air Transport

Air transport is one of the most efficient means of transport, especially over long distances. In Libya, it is used to travel between major cities that have runways and airstrips. Air transport facilitates the movement of passengers and goods across the country and reduces the negative effects of traditional transport systems such as congestion and pollution. Safety and security, passenger services, and airspace are among the most important key performance indicators that decision makers in the Libyan airport sector should take into account. Currently, 13 airlines operate in Libya. In 2011, air traffic in Libya decreased by more than one million passengers compared to 2010; this decrease is attributed to the revolution that the country witnessed in 2011. International air traffic rates increased over a period of six years, while domestic traffic rates remained almost constant, with the highest traffic levels in 2006 and 2007. Figure 3 shows the domestic traffic during 2005–2023 period (Almselati et al., 2011).

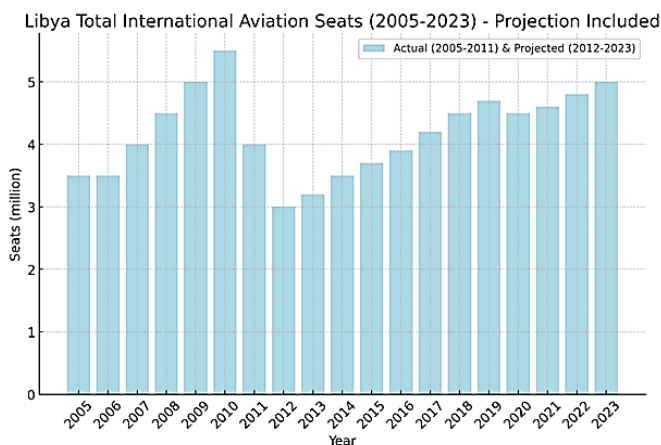


Figure 3: shows the domestic traffic during 2005–2023 period.

#### 3.3 The mode of transportation via train

Libya lacks trains of any type, despite the fact that railroads offer a great deal of potential for transportation both inside and between cities and towns given the country's topography. Due to the geographical dispersion of Libyan cities, long-distance travel routes are necessary. The presence of railways within and between cities, whether for freight or passengers, may

reduce accidents as well as other adverse effects of transportation, such as traffic, pollution, etc.

### 3.4 Public Transportation

As the population increases, the need for transportation also increases, leading to an increase in the number of vehicles and the emergence of congestion, in addition to other negative consequences such as pollution and safety risks. As we see in most developed countries, this problem can be addressed through public transportation systems. Although the design of these systems is complex and requires many inputs to determine the optimal combination, if done correctly, it can meet the needs of the present and the future. When talking about public transportation, there are two types of shipments: passengers and goods (Verma and Ramanayya, 2014). The larger the population, the greater the need for these public services. Moreover, public transportation is an effective means of reducing the negative effects of transportation, especially since transportation is one of the main causes of air pollution. These services provide an ideal opportunity to solve these problems. Regarding public transportation in Libya, unfortunately, there are no systems, whether planned or improvised. Research indicates that public transportation is the main solution to the problem of increasing congestion in Libya. Transportation is divided into two main categories: public transportation and private transportation:

#### 3.4.1 Public transportation

Each mode of public transportation has several characteristics that make it the most efficient in certain locations within the city. Therefore, the research will address the patterns of public transportation and analyze its prominent planning characteristics in urban areas.

##### 3.4.1.1 Buses

Buses are a flexible mode of transportation that can adapt to changing travel patterns. They can be used to cover main trips, as well as arrival and departure trips, and feeder trips to other modes of transportation such as light rail, metro, and rapid transit buses. Due to their operating costs, they can serve areas with high and low density, providing people with closer access to their homes and destinations compared to other public transportation modes. The distance between bus stops is usually (0.25-0.5) km, which leads to a high concentration of passengers. Bus systems with priority such as dedicated lanes or high-density buses are able to transport similar volumes at lower costs compared to rail, as demonstrated by the Bus Rapid Transit (BRT) system. For example, in the Integrated Transport Plan (2030) of the Emirate of Abu Dhabi, buses were used to transport citizens to their homes that other public transport systems (train, metro, and tram) do not reach (Singh, 2012).

It is worth noting that Sydney city center currently relies on more than 1000 buses to meet travel needs, and yet it suffers from congestion. Therefore, public transport bus stops should be provided every (0.25 - 0.5) km. In Libyan cities, buses do not adhere to specific stations, often do not arrive at specific times within main areas, and lack dedicated routes, which leads to them overlapping with private cars and being affected by traffic congestion. This negatively affected the effectiveness of public buses in providing access within a regular schedule. From a social and economic perspective, bus passengers generally benefit from cheap fares, and most passengers using buses often belong to low-income groups, compared to users of other public transport such as heavy rail and private transport. In general, low-density cities with multiple commercial areas and buildings with a height of 2 to 5 floors cannot be served by large-capacity transportation systems. Therefore, these cities need transportation systems capable of transporting (15,000 to 25,000) passengers (in each direction per hour) with dedicated lanes, and do not require changing the nature of the city. This can be achieved through modern bus and coach rapid transit systems. Figure (4) shows bus systems (including rapid and modern buses) in cities and their types and routes (flexible, specific, and completely isolated).

Buses can operate on the same routes as private cars, or be given priority by allocating a specific route, and this route may be completely isolated from private car routes, depending on the number of passengers to be transported. Specific streets are also designated for pedestrians and public transport, often depending on the efficiency of the street. In general, buses can transport medium numbers of passengers (15,000 - 25,000) in each direction when dedicated bus routes are available. It is preferable to use them in areas where buildings are high (2-5 floors), and they are also used as buses to feed other means of transportation such as metro, light rail (LRT) and bus rapid transit (BRT). Currently, Libya lacks these systems, according to current studies, as expectations indicate an increase

in traffic in the future. Therefore, there is an urgent need to identify special routes for rapid transit, which will be a necessary solution in the heart of large cities to transport passengers and feed other public transportation systems (Onokala and Olajide, 2020).



**Figure 4:** Shows bus systems including rapid and modern buses.

### 3.4.1.2 Bus Rapid Transit (BRT)

BRT is flexible and high-performance, which means it provides a fast means of transportation that combines a variety of operational elements and systems, creating a permanent integrated system that leaves a positive impression in the memory of citizens thanks to its quality and unique characteristics. Latin America is considered among the best systems that use the BRT system, as it is characterized by high speed, large capacity, and quality of service that competes with all other means of transportation, although the best systems in terms of quality are the metro and light rail networks. BRT has a large transport capacity compared to private cars and small and medium buses. To implement the BRT system, special lanes must be provided within the street, in addition to stops at distances of every 1 km. The costs of building these systems are also lower than the costs of building light rail and the metro. BRT can be used to easily connect distant areas, making it an important part of integrated transportation systems in Libyan cities, as it connects several areas within the appropriate main roads and streets. The capacity of buses ranges from 30 to 270 passengers, thanks to developments in technology and the specific capacity of buses. The volume of traffic depends on the need for a certain capacity to meet the transportation requirements of the city. Figure (5) shows bus models and their capacities.



**Figure 5:** BRT bus models.

### 3.4.1.3 Heavy rail and metro

Heavy rail and metro are the backbone of the transport system in large cities, providing an efficient means of moving large numbers of people efficiently in city centers. However, this type of transport is not the ideal solution for commuting on low-density local streets. In suburban residential areas, buses play a greater role in facilitating traffic than bus services on main streets where railways are present. Travels by heavy rail and metro usually perform better, for several reasons, including the relative simplicity of the network due to the absence of emergency stops (isolated track and special stations). Journeys to city centers are relatively faster due to their separation from surface traffic (where the metro usually operates underground), which helps avoid congestion. Heavy rail requires significant capital investment and is particularly suitable for densely populated areas. Modern urban expansion creates an obstacle for fixed-route transport systems, as low-density areas extend farther and reduce the passenger volume that is compatible with the metro capacity.

In major capital cities, railways and metros share common features, namely their ability to transport large numbers of people in urban areas, and they are electrically powered, making them environmentally friendly. Metros also provide a high service frequency compared to other systems, with fixed arrival and departure times. The distance between stations ranges from 1-2 km. It was estimated that the costs of building a metro are much higher than those of other public transport systems, with heavy rail construction costs estimated to be about five times higher than light rail

(LRT) and about ten times higher than dedicated buses. With the increasing population density in city centers, there is an urgent need to introduce transport systems capable of transporting more than 40,000 people per hour in each direction. This can usually be achieved through suspended or underground railway systems. The metro system is considered the most efficient and capable of accommodating a large number of passengers in city centers (more than 40,000 passengers per hour in each direction), as it operates smoothly without interference from other transport systems, making it suitable for areas with high population density (more than 5 floors) (Onokala and Olajide, 2020).

## 3.5 Trams and light rail

Light rail is best suited for inner-city areas, with stops between 0.75 and 1.5 km (0.96 and 0.99 miles). Light rail systems tend to run along the street (a dedicated and isolated track), meaning they share space with individual modes of transport such as cars, bicycles and pedestrians. Although bottlenecks can occur between the LRT system and cars and bicycles, which can hamper the performance of light rail services, this can be overcome by isolation, and there is often mixed traffic (where streets are cut off). Light rail (LRT) is an urban passenger transport system, with independent lanes defined on the route, with stops spaced 0.75 to 1.5 km (0.96 to 0.99 miles) apart. It is often used in cities with wide or dedicated streets (providing a dedicated track). Light rail can be elevated on poles in cases of population congestion, allowing other modes to move underneath. However, if the stations are not able to accommodate the number of passengers during peak hours, the underground metro system is relied upon.

## 3.6 Private transport

### 3.6.1 Walking

Walking is the main means of transportation, as the vast majority of trips are completed or started by walking. This type of transport requires a more advanced infrastructure compared to other modes of transport. It can be noted that distances of up to 2 km (about 20 minutes) are suitable for walking, making it competitive with public transport. The usual walking speed for a healthy adult is estimated at about 6 km/h, or 1.67 m/s. However, walking ability is affected in some groups, and the speed is reduced for people with average physical fitness, as well as by adverse weather conditions such as high temperatures or rain, in addition to the impact of luggage (such as shopping or mobile devices). Although a person may be able to maintain a constant walking speed (6 km/h) for 20 minutes, this speed decreases to (5 km/h) after 30 minutes, and to (4 km/h) after an hour. For planning purposes, the average walking speed (3 km/h) is adopted as a standard for short distances of less than half a kilometer (400 meters to 800 meters).

#### 3.6.1.1 Challenges facing walking

- Having a distant destination that is difficult to reach.
- Lack of designated pedestrian paths, or not directing the path to the desired destination.
- Fear of being robbed or assaulted, and fear of stray animals.
- Bad weather conditions (lack of places to protect from weather conditions), and poor opportunities to cross streets safely.
- Areas with fast traffic and congestion, and poor lighting system.
- Unattractive and noisy environments and the presence of bicycles on pedestrian paths.
- Carrying heavy items such as shopping, which poses a challenge for the elderly, the sick, and children.

It is worth noting that most Libyan cities currently suffer from all of these obstacles. Therefore, solutions to these challenges must be developed in the city's neighborhoods, taking into account its long history, extensive activities, and strategic location in crowded cities. We emphasize the need to promote the concept of walking in city centers for shopping purposes and access to work places, which helps reduce the pressure on the increasing traffic congestion.

## 3.7 Bicycle Facilities

### 3.7.1 Benefits of Cycling

Cycling, like walking, is an environmentally friendly, means of transportation and provides significant health benefits. However, we note that there are difficulties that cyclists face compared to other means of

transportation, which has led many citizens to stop using this means. In addition, bicycle accidents, risks, and bicycle theft have increased.

### 3.7.2 Improving cyclist safety

These challenges can be addressed by improving cyclist safety through:

- Improving the security situation.
- Regulating traffic routes.

In most developed countries, the elderly travel by bicycle for a distance of up to 12 kilometers per week, due to the lower operating cost of transportation per kilometer compared to small cars.

### 3.7.3 Integrating cycling with public transportation

One of the conditions for enhancing the integration between cycling and public transportation is providing appropriate facilities. Increasing the number of bicycles at intersections, such as bicycle washing and storage stations, can encourage the use of this means if these services are available.

## 4. TRANSPORT INFRASTRUCTURE IN LIBYA

This section aims to provide an overview of the road infrastructure in Libya in its current state by reviewing three relevant aspects: engineering, paving, and traffic. Road surfaces in Libya are entirely constructed using flexible pavement, and most of them are old. Therefore, existing roads cannot meet current demands. In addition, the suspension of all infrastructure projects after the 2011 revolution, in addition to the deterioration of the structural condition and the lack of maintenance and repair works, made the paving inadequate. In the beginning of 2020, successive governments implemented road projects in some municipalities.

### 4.1 Road Engineering

Road transport is the oldest and most widely used means of transport for the transportation of goods (Stojic, 2018). In general, with the exception

of some requirements such as acceleration and deceleration paths, the engineering design of Libyan road surfaces conforms to specifications in terms of width and layout, especially at the time they were built. However, some safety aspects, such as traffic signs such as speed limits, directional signs, and paving signs, as well as other features such as reflectors and side barriers (curb stones), are lacking, as some of them have eroded and others have disappeared. Furthermore, due to unauthorized construction activities and violation of the right of way by some shop owners who use the adjacent roads as places for marketing and advertising, and the use of the roads as parking lots by some drivers, the actual width of these roads is less than their original width. Other factors, such as sand sliding, contribute to the aggravation of this problem.

### 4.2 Pavement Condition

The current condition of most flexible pavement parts shows that they do not meet even the minimum service level and this condition is deteriorating day-by-day (figure 6). The failure of these parts is mainly attributed to the following:

- Inappropriate design and implementation.
- Use of insufficient materials.
- Lack of appropriate maintenance and repair activities.

The geographical distribution of the country requires the use of different asphalt mixtures, as the southern regions are characterized by special climatic conditions that require different asphalt mixtures than those used in the north. Failure to meet these requirements has resulted in short-lived pavement surfaces. Moreover, local companies lack the required expertise in flexible pavement design and implementation, as well as inspection, maintenance and repair activities. Because of the slow response, surface cracks and potholes have appeared over time, which represent major structural problems and safety risks. More importantly, random underground activities such as installing and repairing water and electricity pipes and randomly cutting pavement surfaces cause interruptions and irreparable damage.



Figure 6: Pavement Condition in Libya.

### 4.3 Traffic situation

The traffic system in Libya consists mainly of private cars and minibuses, followed by small trucks, with a small proportion of medium and large trucks travelling mainly on intercity roads. Medium and large trucks, as well as private cars and minibuses, are concentrated on coastal and intercity highways connecting the east, west and south, forming a major traffic network. Although the phenomenon of traffic congestion is only present in the capital Tripoli, congestion is evident in other city centers, where public services and private businesses are located. In other sections of the internal transport networks, bottlenecks are formed either because the original designs did not accommodate future developments or because of encroachments from neighboring facilities and businesses. Moreover, traffic volumes in most urban areas are not very high compared to other countries, and the location of congestion sites is often a temporary phenomenon, especially during peak times. Therefore, traffic volumes in most cities are not considered the main cause of traffic congestion. In addition, the proliferation of buildings and facilities that do not provide decent entrances, exits, and parking spaces for their users along traffic routes has contributed to this problem. In addition, most drivers lack

respect for driving etiquette and regulations, and use outdated traffic control systems, such as timed traffic signals that are powered by conventional energy and are affected by power outages.



Figure 7: The high traffic congestion of some Libyan cities Benghazi and Tripoli.

## 5. POLLUTION

### 5.1 Air pollution

Air pollution, in particular, is closely related to smoke and fume emissions. Simply put, air pollution is defined as the presence of unwanted and hazardous substances in the atmosphere. Increased urbanization and industrialization have significantly contributed to the aggravation of air pollution (Nassar et al., 2017). In addition, air pollution has become a pressing issue due to its negative impact on health, biodiversity and ecosystems, making it a modern dilemma.

### 5.2 Transportation as a major cause of pollution

Transportation is a major cause of air pollution, and with the increase in the number of motor vehicles and their emissions, the effects of this pollution are seen in urban areas. Urbanization requires sophisticated environmental management, due to its complex elements and population density, and maintaining records of the associated factors and numbers can help in taking corrective actions and determining future decisions (Nassar et al., 2017).

### 5.3 The situation in Libya

In Libya, the lack of public transportation and the unregulated acquisition of vehicles have led to an annual increase in the number of cars imported into the country. Moreover, a higher percentage of these vehicles are old models, which means that they are often in poor condition, whether in terms of body, engine or both. These old imported vehicles have contributed significantly to air pollution in Libya. According to a study, the transportation sector is followed by the electricity industry (33.9%) with a share of 30.7% of pollutant emissions, with an annual volume of 18,732,000 tons (Nassar et al., 2017). The data shows that Libya ranks 53rd out of 225 in CO<sub>2</sub> emissions, with a contribution of 0.22%. In addition, Libya ranks 41st in CO<sub>2</sub> emissions per capita (Nassar et al., 2017). These statistics represent a major local and global threat, and are enough to make the Libyan authorities start a comprehensive review of the transportation sector.

### 5.4 Future Challenges

The above figures are alarming. Moreover, these quantities are increasing non-linearly every year, as the imported vehicles are mostly old models. The problem is not limited to the age of existing vehicles, but their physical condition and engine performance also deteriorate, leading to increased exhaust emissions over time. Moreover, health services in Libya are provided in a basic and modest manner, which increases the impact of air pollution. Continued practices by local industries and the transportation sector towards the emissions problem could lead to disastrous social, economic and environmental consequences in the near future.

### 5.5 Safety

Road accidents are a major issue related to road safety, as they unexpectedly and sometimes unavoidably lead to fatal and non-fatal injuries, in addition to material damage (Nassar et al., 2017). Libya suffers from a high rate of fatalities resulting from accidents, amounting to 26.3 per 100,000 inhabitants, with an overall average of about 2,500 deaths per year. The World Health Organization (WHO) Road Safety Report 2017 confirmed that road accidents have become one of the main causes of death among children and young people aged 5 to 29 years, surpassing many diseases. According to the annual statistics issued by the Ministry of Interior, the number of deaths due to road accidents has increased to 49,500 over the past twenty years. Death figures in traffic records refer to deaths immediately following accidents, and there is no accurate documentation of deaths resulting from injuries. Excessive speed is the main cause of accidents, with 2,442 and 2,338 deaths recorded in 2016 and 2017 respectively, representing 48% and 45% of the total deaths resulting from accidents in those two years. Figure 9 shows the locations of these accidents during those two years (Traffic and Licensing Directorate, 2019).

## 6. CONCLUSION

Transportation systems vary in each location within the city based on their uses (industrial, residential, commercial) and others, and they are integrated with each other to operate in a comfortable and convenient manner. Transportation systems vary in capacity, cost and location within the city (such as buses that accommodate 6,000 people per hour, rapid transit buses that accommodate between 6,000 and 11,000 people per hour, and light rail that accommodates 6,000 people per hour), with a specific type being adopted depending on population density and

infrastructure. Public transportation buses are known for their flexibility in operating within central areas and low-density areas, stopping every (0.25 - 0.5) km, and are characterized by their reasonable prices for all citizens, in addition to the cost of their establishment compared to other transportation systems (such as metro and trains). Buses are sufficient for areas with buildings between (2-5) floors and work best in integration with the metro (to transport people to metro stations and trains), and can run on the road with private cars or have priority on a specific route. Bus Rapid Transit (BRT) has its unique characteristics and speed, and to perform its activities accurately, it is necessary to provide special lanes for it, and BRT buses can accommodate twice the number if they have two cabins, and they need special stops approximately every (1) km.

The metro is considered the backbone of transportation in large cities and central areas, and it is the fastest due to its isolated path (usually underground), and it stops only at stations, and it has a large capacity that transports more than (40,000) passengers per hour in each direction. It also has a fixed schedule for movement between stations, but it is considered expensive compared to other transportation systems and is used in areas with high density (more than 5 floors). Trams and light rail are important in cities, with stations ranging from (0.75 - 1.5) km, and have a dedicated track, but they divide the street into two parts if they operate on a track on the ground. Walking for a distance of (2) km or (20) minutes is acceptable for pedestrians, and for planning purposes, (4 km/hour) is considered a typical case, and public facilities should be provided at intervals of (400 - 800) meters. An encouraging and safe environment should be provided for pedestrians, as walking is the best means of transportation in terms of environmental impact, health and economy. Developing a sustainable, integrated and environmentally friendly transportation strategy is an important foundation and a suitable basis for future generations, and it is necessary to develop appropriate plans to ensure that each public transportation system operates individually and with high accuracy, in addition to enhancing the effectiveness of these systems when working in integration with other public transportation systems.

## REFERENCES

- Abuhamoud, M.A.A., and Rahmat, R.A.O., 2010. Influencing modal shift to public transport for sustainable urban development in Tripoli (Libya). In 2010 The 2nd International Conference on Computer and Automation Engineering (ICCAE) (Vol. 4, pp. 72-75). IEEE.
- Abuhamoud, M.A.A., Rahmat, R.A.O.K., and Ismail, A., 2011. Modeling of transport mode in Libya: A binary logit model for government transportation encouragement. *Australian Journal of Basic and Applied Sciences*, 5 (5), Pp. 1291-1296.
- Alhodairi, A.M., 2012. Is Public Transport System in Libya Sustainable?. In *Proceedings of 1st Conference on Sustainable Planning for the Reconstruction of Libya*. Benghazi, Libya (pp. 1-11).
- Almselati, A.S.I., Rahmat, R.A.O.K., and Jaafar, O., 2011. An overview of urban transport in Malaysia. *Social Sci.*, 6 (1), Pp. 24-33.
- Button, K.J., and Hensher, D.A. (Eds.), 2018. *Urban Transport and Land Use*. Edward Elgar Publishing.
- Elmansouri, O., Almhrroog, A., and Badi, I., 2020. Urban transportation in Libya: An overview. *Transportation research interdisciplinary perspectives*, 8, Pp. 100161.
- Elmnifi, M., Almakhtar, M., Vambol, S., Sydorenko, V., and Mykhailov, V., 2024. Agricultural waste in Libya as a resource for biochar and methane production: An analytical study. *Ecological Questions*, 35 (2), Pp. 1-20.
- Elmnifi, M., Alshilmany, M., and Abdraba, M., 2019. Potential of municipal solid waste in Libya for energy utilization. *globe*, 11, Pp. 13.
- Imbayah, I., Ahmed, A.A., Alsharif, A., Khaleel, M.M., and Alarga, A., 2023. A Review of the Possibility Integrating the Solar System into the Libyan Railway Transportation. *African Journal of Advanced Pure and Applied Sciences (AJAPAS)*, Pp. 171-180.
- Institute of Transportation Engineers. 2010. *Transportation Planning Handbook (3rd ed.)*. Wiley.
- Ismail, A., and Elmloshi, A.E., 2011. Existing transportation scenario in Tripoli, Libya. *Australian Journal of Basic and Applied Sciences*, 5 (9), Pp. 1288-1295.

- Khisty, C.J., and Khisty, B.C., 2004. *Transportation Engineering: An Introduction*. Prentice Hall.
- McCarthy, P., 2011. *Transportation Economics: Theory and Practice*. Wiley.
- Nassar, Y., Aissa, K., Alsadi, S., 2017. Air pollution sources in Libya. *J. Ecol. Environ. Sci.* 6 (1), Pp. 63–79.
- Onokala, P.C., and Olajide, C.J., 2020. Problems and challenges facing the Nigerian transportation system which affect their contribution to the economic development of the country in the 21st century. *Transportation Research Procedia*, 48, Pp. 2945-2962.
- Onokala, P.C., and Olajide, C.J., 2020. Problems and challenges facing the Nigerian transportation system which affect their contribution to the economic development of the country in the 21st century. *Transportation Research Procedia*, 48, Pp. 2945-2962.
- Singh, S.K., 2005. Review of urban transportation in India. *Journal of public transportation*, 8 (1), Pp. 79-97.
- Singh, S.K., 2012. Urban transport in India: issues, challenges, and the way forward. *European Transport/Trasporti Europei Issue*, 52.
- Stojčić, M., 2018. Application of ANFIS model in road traffic and transportation: a literature review from 1993 to 2018. *Oper. Res. Eng. Sci. Theory Appl.* 1 (1), Pp. 40–61.
- Traffic and Licensing Directorate, 2019. *The Traffic Statistics Report*, Libya.
- Tumlin, J., 2012. *Sustainable Transportation Planning: Tools for Creating Vibrant, Healthy, and Resilient Communities*. Wiley.
- Verma, A., and Ramanayya, T.V., 2014. *Public transport planning and management in developing countries*. CRC press.

