



Innovative Sustainable Strategies to Mobility and Urban Transport Problems in Benghazi

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Abstract

Nowadays, sustainable transport strategies and plans that involve different modes and options of travel have been considered as the suitable tools for tackling urban traffic and transport problems in cities with high population densities. In Libya, the mobility and traffic conditions in the urban areas experience number of problems, due the rapid increase in urbanization and the lack of public transportation means, which have led to an increase in the number of automobiles ownership per household. Libyan transportation authority stated that the road traffic has crucial negative impact on society's health and safety, considered that a major cause of death and injury in large Libyan cities, particularly, in Tripoli and Benghazi. In these cities, the car-based transport mode is predominated and most commuters are dependent on private travel mode to move from home to work or other destinations. While reviewing successful cities experiences that implemented comprehensive sustainable transport plans proved having access to a variety of transport modes and options can help households and road-users to reduce transport costs, improve transport safety, reduce pollution and providing easy and safe access to work, services and opportunities. Furthermore, public transport, includes buses; metro, light rail; and other modes, is one essential aspect of the overall system. This paper ascertains the remaining situation of transport and mobility in Benghazi, which is the second city in Libya, and hosts several important companies and institutions. Also, it is an important economy center and the most populous center in the Cyrenaica region. This study develops a plan for sustainable transport strategies that can be applied in or around the urban area of Benghazi to reduce transport

problems, and this plan could be used as an indicator for achieving healthy and high quality of life in Benghazi community.

Keywords

Transport problems • Traffic conditions • Sustainable strategies • Variety of transport modes • Accessibility • Mobility

1 Introduction

Today's studies stated that the terms "quality of life" and "livability" are used as essential demand in environmental and land-use planning, particularly, in planning for economic development and infrastructure, where the main part of this infrastructure is the urban transport system. In Libya, the mobility and traffic conditions in the urban areas experience number of problems, and the rapid urbanization and motorization and also the increase in car ownership per household make the problems more difficult. Libyan transport authorities state that the road traffic has crucial negative impacts in social, health and safety, and they assort it as a major source of death and injury in large Libyan cities, particularly, in Tripoli and Benghazi. Where, in these cities, the car-based transport mode is predominated and most commuters are dependent on private travel mode to move from home to work or other destinations. Furthermore, in large Libyan cities, traffic congestion causes additional costs for society in terms of travel delays, longer journey times, road safety and environmental pollution (Safour, 2011).

According to the authority of Traffic and Licenses, Libya is one of the countries that have the highest percentage of deaths by accidents, and the following figure illustrates samples of the increase in the car numbers and accidents, where Fig. 1a shows the estimations of the gradually increase in car numbers in Libya from 1995 to 2025, and

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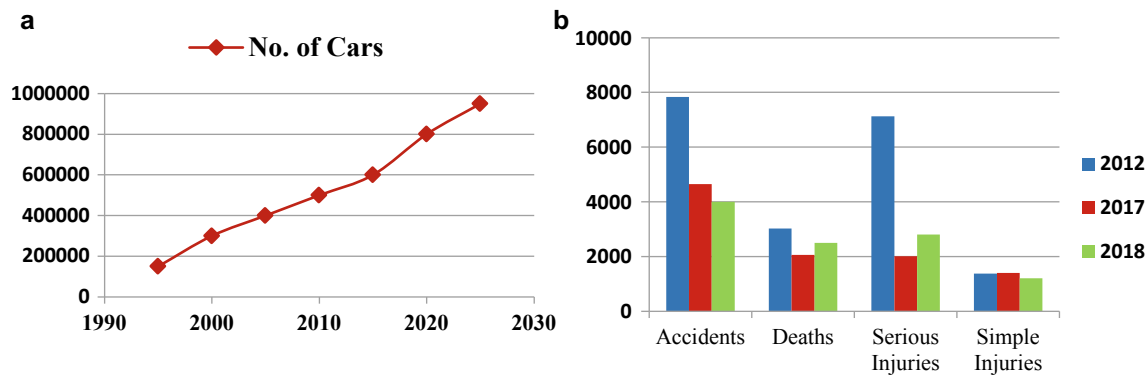


Fig. 1 a The increase in car numbers in Libya from 1995 to 2025 (Safour, 2011). b The traffic accidents and deaths in Libya in years 2012, 2017 and 2018

Fig. 1b illustrates the traffic accidents and deaths in Libya during the years 2012, 2017 and 2018.

On the other hand, the urban sustainable transport strategies have been considered a suitable tool for tackling urban transport and traffic problems. Moreover, to meet the Goals of the UN Sustainable Development agenda, in particular no. 11, sustainable transport strategies are needed to create a better livable environment for the benefit of users and transport policymakers. The study aims to set key issues that can be used as a plan for the reconstruction of the urban transport system in Benghazi through a sustainable urban development plan. This study shall be a part of comprehensive study that based on extrapolating the agenda of sustainable urban planning that identified by the United Nations. This next section explains the meaning of sustainable transport and the benefits of sustainable approaches.

2 The Urban Sustainable Transport Strategies

To meet the goal no. 11 from the United Nations Agenda (2015) “by 2030, ensure access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons”, also, to get a better quality of movement and travel, urban sustainable transport strategies that involve different modes and options of travel means have been considered as the optimal approach to solve urban traffic and transport problems in cities with high densities.

Sustainable transport is defined as an urban system that is intended to meet daily needs through a mechanism of accessibility and mobility in multiple ways, and high efficiency to achieve the social, environmental and economic goals of current generations in a manner that develops and maintains non-energy sources and to meet the needs of

subsequent generations (USDOT, 2010). In simple terms, sustainable transport refers to the mobility within cities with low environmental impact and includes non-mechanical transport patterns such as walking, cycling, mass mechanical and environmentally friendly transport means such as green vehicles and car sharing (Abbas & Imarn, 2016).

The studies illustrated that transport sector has a serious environmental impacts, and it is responsible for approximately 23% of global CO₂ emission. It also has a number of other effects such as noise and pollution (IEA, 2011). Because of that *sustainability in urban transport* becomes increasingly important target.

2.1 Sustainable Transport Objectives

The main objective of the sustainable transport is *reducing the demand for transport* by decreasing the number of trips and the length of traveled distance. The urban planning and design sector can help in reducing the distances between places and people by increase the density of the spaces, and as a result, people travel less to obtain goods and services. Furthermore, the reduction in the transport demand will cut down the use of scarce resources and adverse impact on the environment and economy.

2.2 The Benefits of Sustainable Transport Strategies

Studies stated that sustainable transport strategies could be a powerful tools in reducing traffic congestion, improving the environment in the city, so they can offer benefits in terms of managing the traffic on the roads by reducing the delays and increasing traveling car speeds, encouraging road-users to use other alternatives, decreasing car numbers at peak periods, making journey times more reliable. It can offer benefits in terms of reducing pollution and emissions.

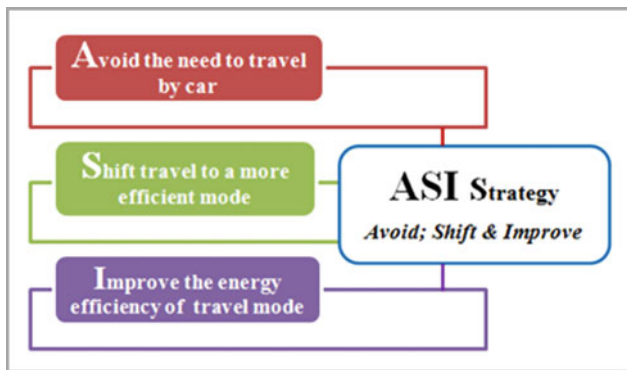


Fig. 2 Three pillars of an integrated urban transport policy

2.3 Principles of Successful Sustainable Solutions

Reviewing successful cities experiences indicated that the implementation of comprehensive sustainable transport plans and proved to be the only successful solution for urban sustainable transport strategies which is a combination of the following three principles:

- avoiding the need to travel by car; to avoid or decrease the travel by car, some issues are needed to be recognized, such as integrate the better urban design and transport policies, like car park charging and road pricing.
- shifting travel to a more efficient mode; Ishii (2013) mentioned that to reduce the greenhouse gas emissions there numbers of action can be done, such as implementing strong and optimized public transport, integrating transit with efficient land use, encourage people to use mini-cars and electric two-wheelers or non-motorized transport (NMT) like walking and cycling.
- improving the energy efficiency of travel mode, where improving vehicle energy efficiency could be reduced by up to 50% by 2030.

These strategies are called the “(ASI) Avoid, Shift and Improve” strategy (Mezghzani, 2011). The successful examples pointed that having access to the variety of transport modes and options can help road-users to reduce transport costs, improve transport safety, reduce pollution and providing easy and safe access to work, services and opportunities. Figure 2 summarizes the three pillars of an integrated urban and sustainable transport policy.

3 Case Study Area, Benghazi City

Benghazi, which is the second city and the capital of East of Libya, hosts several important companies and institutions. The city had faced a very hard time during the war which

started on May 2014 till July 2017. During this time, many areas of the city were massively destroyed such as the central business district (CBD) which is the main sector of Benghazi which includes the historical area and most services buildings (Safour & Elmazeg, 2018). Moreover, as a result of the war, Benghazi traffic conditions faced many problems. Another point is the rapid increase in car ownership for household in Libya makes the problems more difficult, and today, these problems become more severe and need urgent efforts to treat.

The master plan of Benghazi covers an area around 31,000 ha, and the gross residential area is about 700 ha. The gross residential density of Benghazi is about 100 inh./ha (Third generation studies, 2009), and according to the General Authority for Information (2012), the population of Benghazi is 700,000 inhabitants with a growth rate 2.117%. Figure 3a, shows the land-use plan of Benghazi which includes the distribution of the different uses.

Figure 3b shows the classifications of roads in Benghazi according to the second-generation plan, and road network was generally well designed. However, traffic jam and poorly maintained roads are some of the transport problems in this city; also the increase in vehicles ownership has caused a number of problems in the CBD of the city. The road network in the city of Benghazi has been classified into four main categories according to the location of road, traffic volume and the road layout. The first category includes the three radial roads, designed as expressway arterials and prominent in the proposed traffic system of Benghazi. The second category includes the coastal highway and the six ring roads. Most of these roads consist of two lanes without any frontage. These roads are border residential districts and connect the radial roads. The third category includes the collector roads. This category receives the greatest traffic flow in the network as they carry traffic to the city center and the residential areas. Therefore, this category of road is busy with private and light good’s vehicles most of the day and with commercial vehicles coming from the harbor in the morning time. Figure 4 illustrates the situation of different roads in Benghazi.

The public road network and bridges have been utilized for a long time since their construction without any proper maintenance, conservation or developmental work being undertaken. This absence of periodic maintenance and the absence of funds have caused real problems including substantial damage to the components of this network and to the road traffic equipment which are necessary for the safety of road-users (Safour, 2011). Today, the roads of Benghazi are in a bad state, and immediate action is needed such establishing a proper strategies and maintenance. The next section will enumerate some basic issues concerning the transport sector in the case study area, Benghazi city.

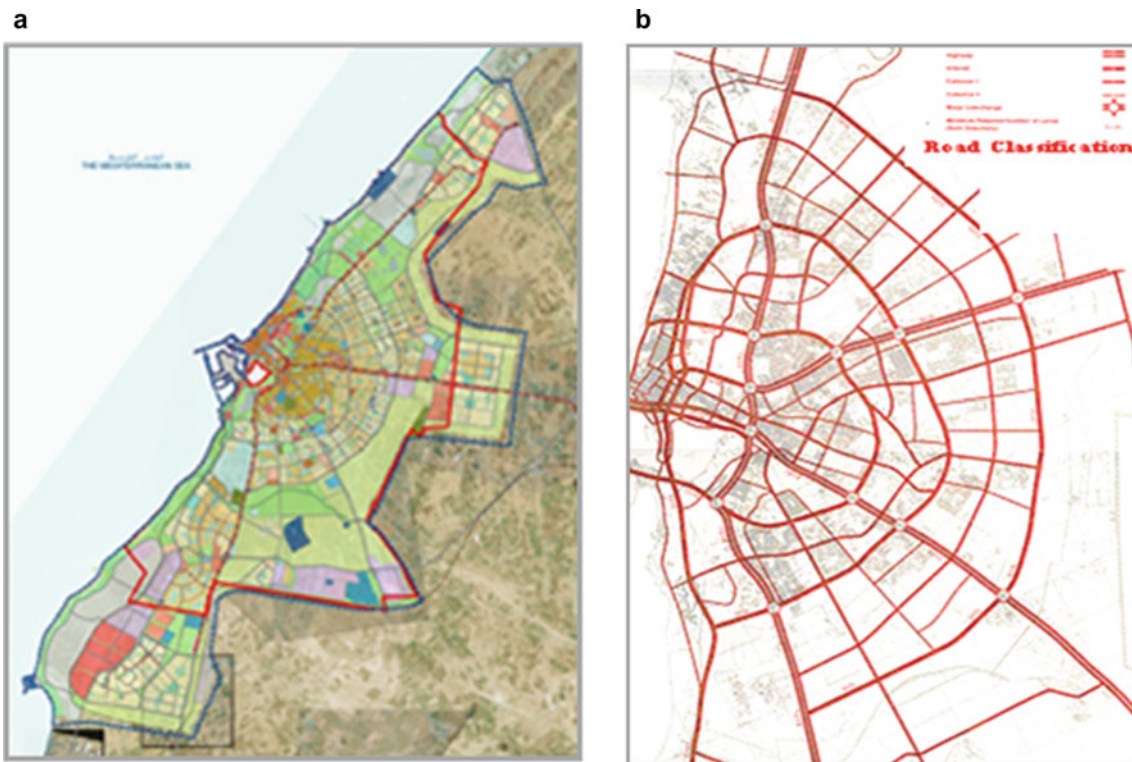


Fig. 3 a Land-use plan of Benghazi (TGS, 2009). b The classifications of roads in Benghazi (DOX-LIB, 1989)



Fig. 4 Situation of roads in Benghazi

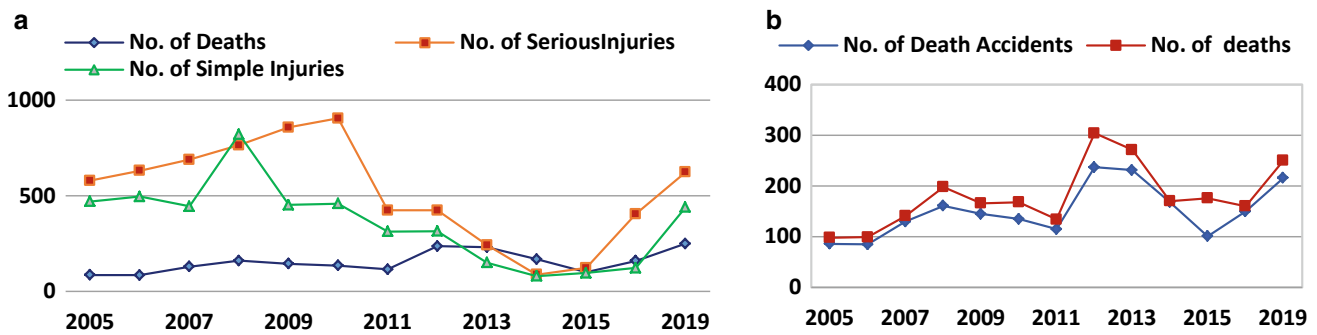


Fig. 5 a Number of accidents injuries in Benghazi from 2005 to 2019. b The increase in the numbers of deaths accidents in Benghazi from 2005 to 2019

3.1 Why Sustainable Transport Strategies Are Needed in Benghazi Now?

The traditional solution to solving traffic problems such as congestion is constructing new roads. However, the new road construction not only takes up a huge amount of time and money but also causes environmental damage. In Benghazi, the Municipality of Benghazi (MOB) has developed several solutions to reduce traffic problems, such as congestion in the CBD. For instance, changing the level of the roads and increasing the traffic signs. Additionally, in the last decade the MOB has used a new transport policy to reduce the problems of congestion by applying a charging policy for car parking in the CBD area. This policy was aimed at urging people to use other transport modes instead of their cars. However, despite these attempts the problems of congestion are still increasing. The government argues that existing solutions which have been applied are not enough and they are seeking for establishing new strategy that can help to reduce these problems. Another important issue is that Benghazi city has the highest percentage of deaths due to automobile accidents in Libya, and Fig. 5a and b illustrates the number of accidents and injuries in Benghazi from 2005 to 2019 and the traffic accidents and deaths toll in Benghazi during the period from 2005 to 2019, where the highest percentage of accidents and deaths occurred during the year 2012.

3.2 Challenges in the Transport Sector in Benghazi

According to estimations of the International Energy Agency in 2011, the transport sector produced emissions of 6.5 gigatonnes of CO₂, or 23% of world energy-related CO₂ emissions and road transport accounts for about 75% of the CO₂ emissions in the sector. While the increasing

of this sector's emissions is strongly due to the increasing of car numbers (IEA, 2011). Figure 6a shows the global CO₂ emissions from fuel combustion in transport sector. In Benghazi, the car-based transport mode is predominated, and most commuters are dependent on private travel mode to move from home to work or other destinations. Furthermore, the traffic congestion causes additional costs for the society in terms of travel delays, longer journey times, road safety and environmental pollution, and Fig. 6b presents the main challenges in the transport sector in Benghazi.

4 Benghazi Proposal Plans and Opportunities for the Future

According to Safour (2011), the Libyan national plan 2005–2030 has a number of objectives such as completing the constructions of the roads network, improving the traffic movement system, implementing light train, metro and railway network, also using number of policies that ensure the efficiency and safety of traffic management. The government is seeking for establishing a new policy that could be effective in reduction of traffic problems and avoiding the amplifying of traffic problems in future.

In Benghazi, the transport decision-makers have also argued that existing solutions that have been applied such as changing the level of roads and increasing the traffic signs are not enough because of the difficulties in changing roads levels or increasing the capacity of road lanes. The new strategy should be linked with the urban planning strategies and transport strategies and plans. To meet these needs, there are some options such as the redistribution of important service locations, improving existing local centers and creating other local centers, such as transit-oriented centers, TOD, instead of centralizing the majority of services in the CBD.

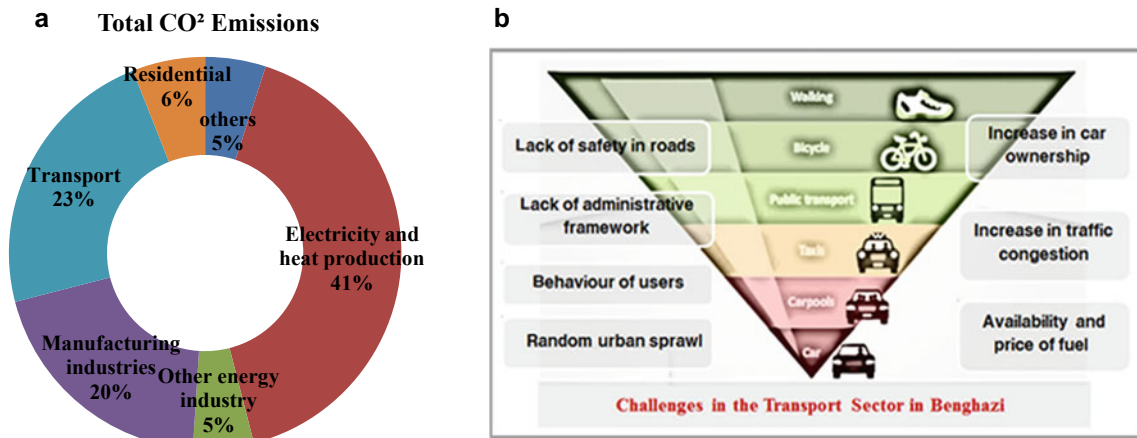


Fig. 6 a Global CO₂ emissions from fuel combustion (IEA, 2011). b Challenges in the transport sector in Benghazi

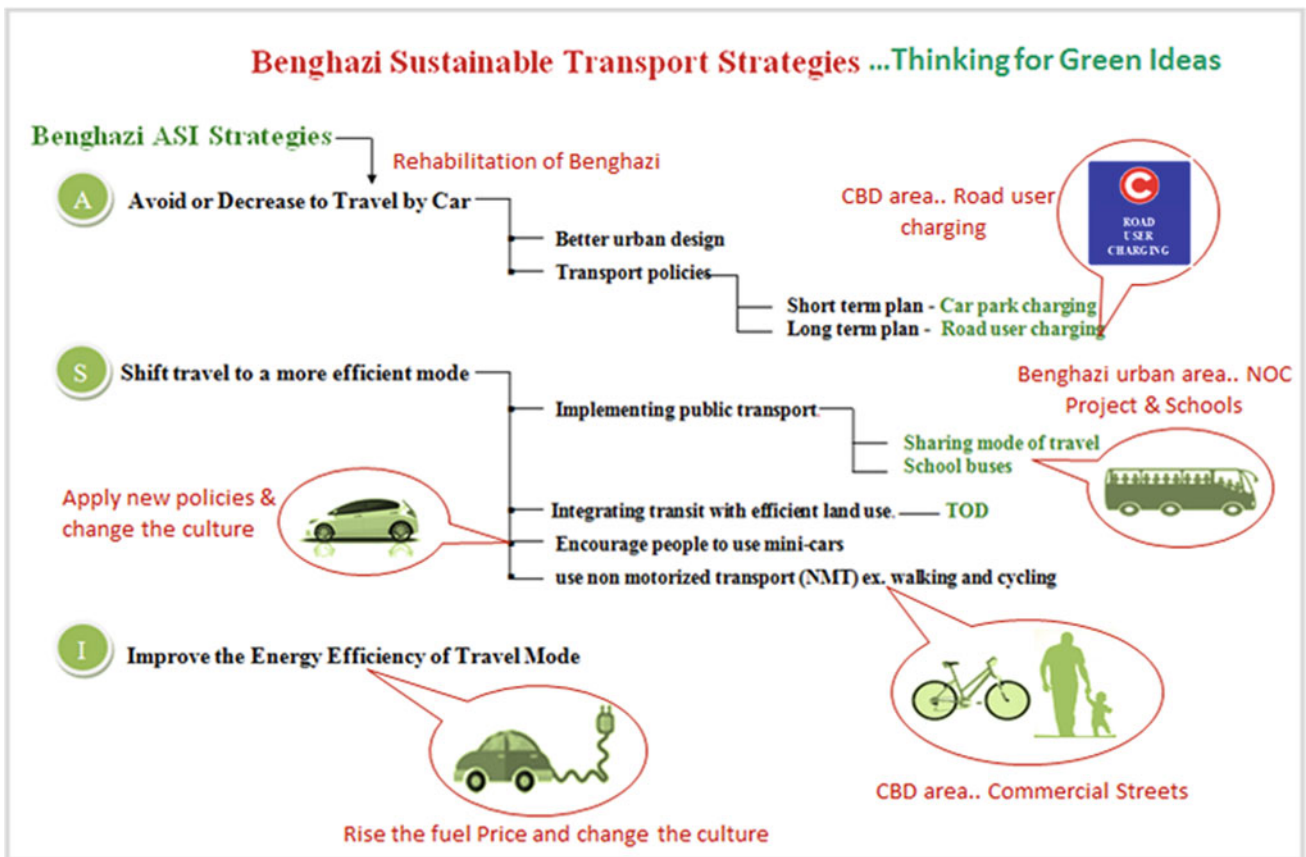


Fig. 7 Suggestion strategies for ASI principles and opportunities for the future of Benghazi

This study suggests number of strategies concerning the sustainable thinking for Benghazi transport system which explains in Fig. 7 by illustrating the thinking for green ideas and the ASI principles and opportunities for the future of Benghazi.

The following part will cover numbers of questions that concern the demand policies and plans that can be applied in Benghazi and the answers that justifies the purposes of these policies.



Fig. 8 Congestion of roads in the CBD area of Benghazi during different peak periods

4.1 Why Road-User Charging Scheme is Needed in Benghazi?

Currently, road-user charging (RUC) policy is considered to be an appropriate policy for managing urban traffic and transport problems. For instance, In Benghazi city, to meet the needs of the transport sector for implementing a good transport strategy that can be used to reduce the congestion in the CBD area and to decrease other existing transport problems, RUC can be implemented as a suitable tool to solve such these problems. Figure 8 shows the congestion in some roads of the CBD in Benghazi during different peak periods.

Safour (2011) mentioned that all over the world, there are a number of road-user charging schemes which have been implemented in order to reduce traffic congestion in the CBD of the city, such as in Singapore, London, Durham and Dubai. Other cities have applied road-user charging schemes to obtain revenue for new infrastructure funds, for instance, in Oslo, Bergen and Trondheim. However, it is essential to state that all of these schemes have achieved a reduction in traffic crossing the charging area in the range of 7–25%.

In addition, a field-based road-user charging experiment in Benghazi was conducted in 2008 with the road users in the central business district (CBD) indicated that RUC policy can have a positive impact in reducing traffic congestion with a reduction in car trips crossing the restricted areas during the peak period by around 35.5%. Because of the reasons stated above, RUC can be applied in, or around,

urban areas in Benghazi in order to reduce traffic congestion and other transport problems (Safour & Egbu, 2013).

4.2 Why Public Transport System is Important in Benghazi?

Improve the public transport system by increasing the number of public transport modes and lines and raising the number of buses also encouraging people to use public transport can help in reducing the number of private cars on the roads, organizing the traffic and reducing the negative environmental impacts in Benghazi.

The calculations of the International Road Transport Union (IRU, 2010) concluded that, in Curitiba, “in Brazil, the bus is capable to carry as many passengers as 30 cars, where a car usually carries to work about 1.7–1.8 passengers, while a double (blocked) bus can carry about 200 passengers in rush hours. In terms of the occupied area on the road (dynamic clearance) a blocked bus is equal to 4 cars which carry 7 passengers. A bus, however, can carry 200 passengers. This implies that the priority should be given to public rather than personal passenger transport because, in this case, traffic, accident rate and harmful environmental effect would be reduced and the problems of urban public transport and their solution trends”.

As a result of the above investigations, the authorities of transport in Benghazi should have plans to develop the existing bus network and increase the lines of this network, and

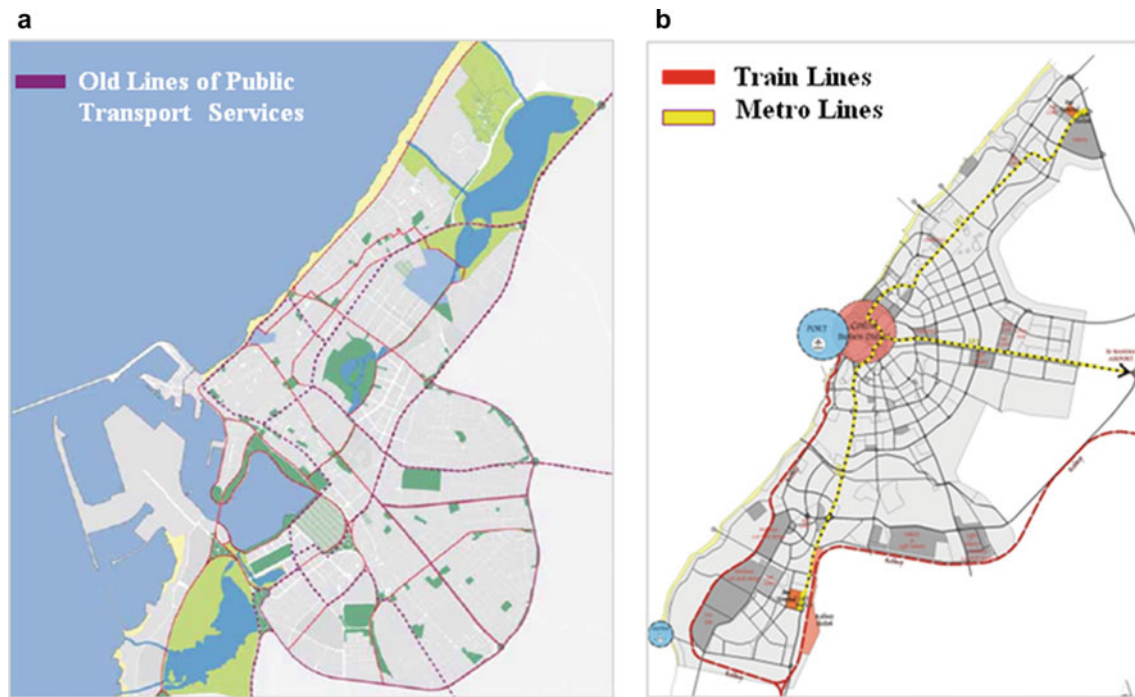


Fig. 9 **a** Old public transport lines (buses) that suggested for tram network (HPCU, 2010). **b** The proposal of light rail and train network in Benghazi (HPCU, 2010)

furthermore, implement a number of public transport projects aiming to improve the life and road conditions as well public transport services. Figure 9a shows the old lines of public transport network in Benghazi, and Fig. 9b offers the proposed light rail and train networks for Benghazi.

4.3 Why Walkable Streets in Benghazi Are Important and How Can We Achieve Them?

To achieve walkable streets in Benghazi, numbers of scenarios have to be implement, in particular the CBD area, which is the main part of Benghazi that includes the historical area, the most service buildings and the main commercial and traditional center and the main problems are congestion, and traffic jam during the morning. Using a policy such as RUC can help the decision-makers in Benghazi to adapt or convert many streets in the CBD to walk streets and establish another street to serve the area by car service lines. For instance, in Benghazi, because of its size (metropolitan city), shape of the city central CBD location (in the middle of the shape), the road network (ring roads), the cordon-based charging system can be considered as the best type for this city.

In a cordon-based charging scheme, drivers who enter the CBD during the restricted time can choose to pay the toll and continue with their current travel pattern, or they can choose another alternative for their travel behavior, such as crossing

the cordon before the restricted period; crossing the cordon after the restricted period; changing their destination for certain activities; driving and parking outside the cordon and continuing by another mode; or traveling using public transport. The cordon should delineated around the central area which is around the harbor and has the highest density of residences, shops, offices and most of the public services buildings, and as a result has the busiest roads in the city, especially during peak periods such as in the morning (Safour, 2012).

To sum up, walkable and pedestrian streets for the main and busiest streets, as Gamal St., Omar El Mokhtar St., and Omer Ben Ass St. became crucial demand to ensure livability in the CBD.

4.4 Modal Share and Shuttle Service

For some places or projects which have special conditions, there are various scenarios that can be applied or designed according to the conditions of the place. One of these scenarios is modal share and shuttle service; the modal share and shuttle service has been developed to serve the National Oil Company (2019) business center project in Benghazi near the CBD.

Because of the limitation of the site area and the location of the center, as well the number of the road users and limited space for car parking, also, to keep the site free for

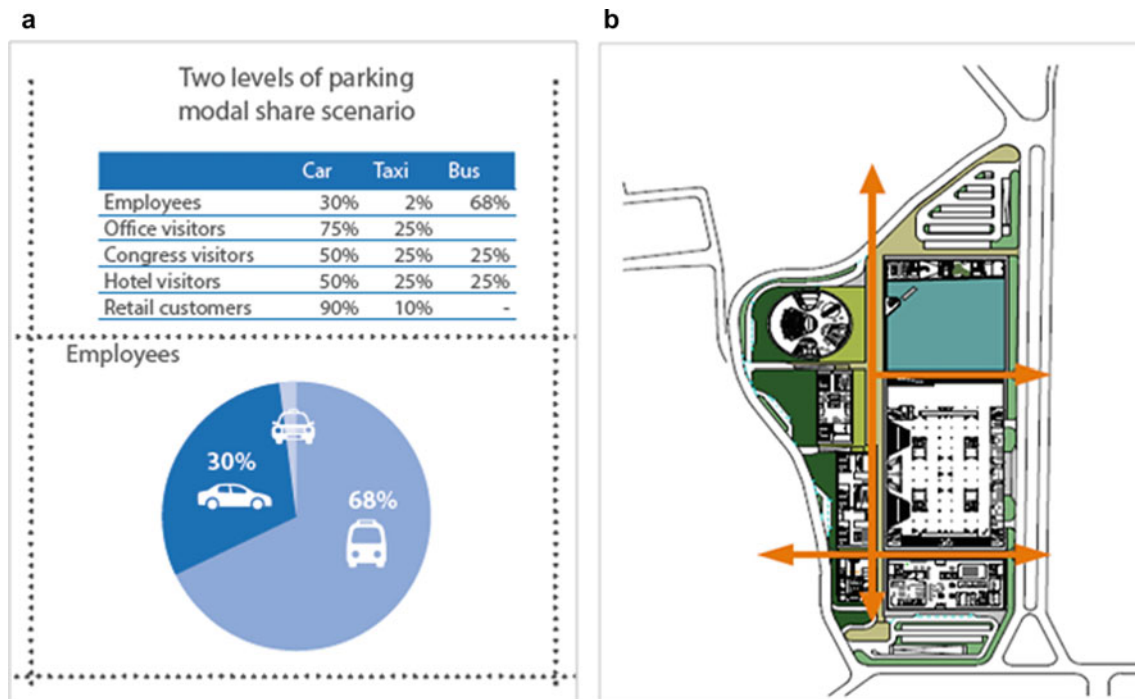


Fig. 10 a Percent of car users and shuttles (NOC, 2019). b The site of the NOC project (NOC, 2019)

pedestrian and green the company has introduced employees' shuttle buses, where about 68% of employees' trips are carried out by shuttle and parking is provided for 30% of employees, the car parking place has designed to occupy the underground at levels -1 and -2. This scenario is inspired by Istanbul best practices, where employers are expected to either give their employees a free transit subscription, or to offer a private shuttle service that brings about 70% of employees (all general employees) to work every day. Figure 10a shows the percent of the users and the mode of travel for commuter trips, and Fig. 10b presents the site of the NOC project and the main axes of the green pedestrian (NOC, 2019).

4.5 Transit-Oriented Development Approach—TOD

For the cities with high densities, the transit-oriented development (TOD) is considered as a suitable approach to transfer the movement from the traditional automobile or road-based model to create attractive, livable and sustainable urban environments. TOD can be defined as the planning approach that incorporates a high density, mixed use type of development with a walkable radius around any transit node. TOD aims to allocate housing and commercial development close to transit infrastructure that involves various modes of trips to be use instead of automobile trips (Hamand &

Petker, 2015). In Benghazi, the new proposal master plan has numbers of sub-centers that aim to reduce the travel to CBD for services trips and to allocate the services buildings close to the residential areas.

Transport authorities should prepare a comprehensive transport plan that involves different transport strategies that integrated with the land-use plan. According to master plan of Benghazi, the sub-centers of the city are the ideal places to implement TOD approach that involves walkable, mixed-use communities around rail stations.

Figure 11 shows different solution that would be applied depends on the existing conditions and proposal plans of Benghazi as well the opportunities for the future of Benghazi. TOD is one of the optimal strategies that needed to develop the transport sector in a city such Benghazi.

5 Conclusion

To conclude, as this paper ascertains the remain situation of transport and mobility in Benghazi, which is the second city in Libya, and hosts several important companies and institutions. The study develops a plan of sustainable transport strategies that can be applied in or around the urban area of Benghazi to reduce transport problems, and this plan could be used as an indicator for achieving healthy and high quality of life in Benghazi community. The plan covers numbers of issues concern the demand policies such as the set of ASI

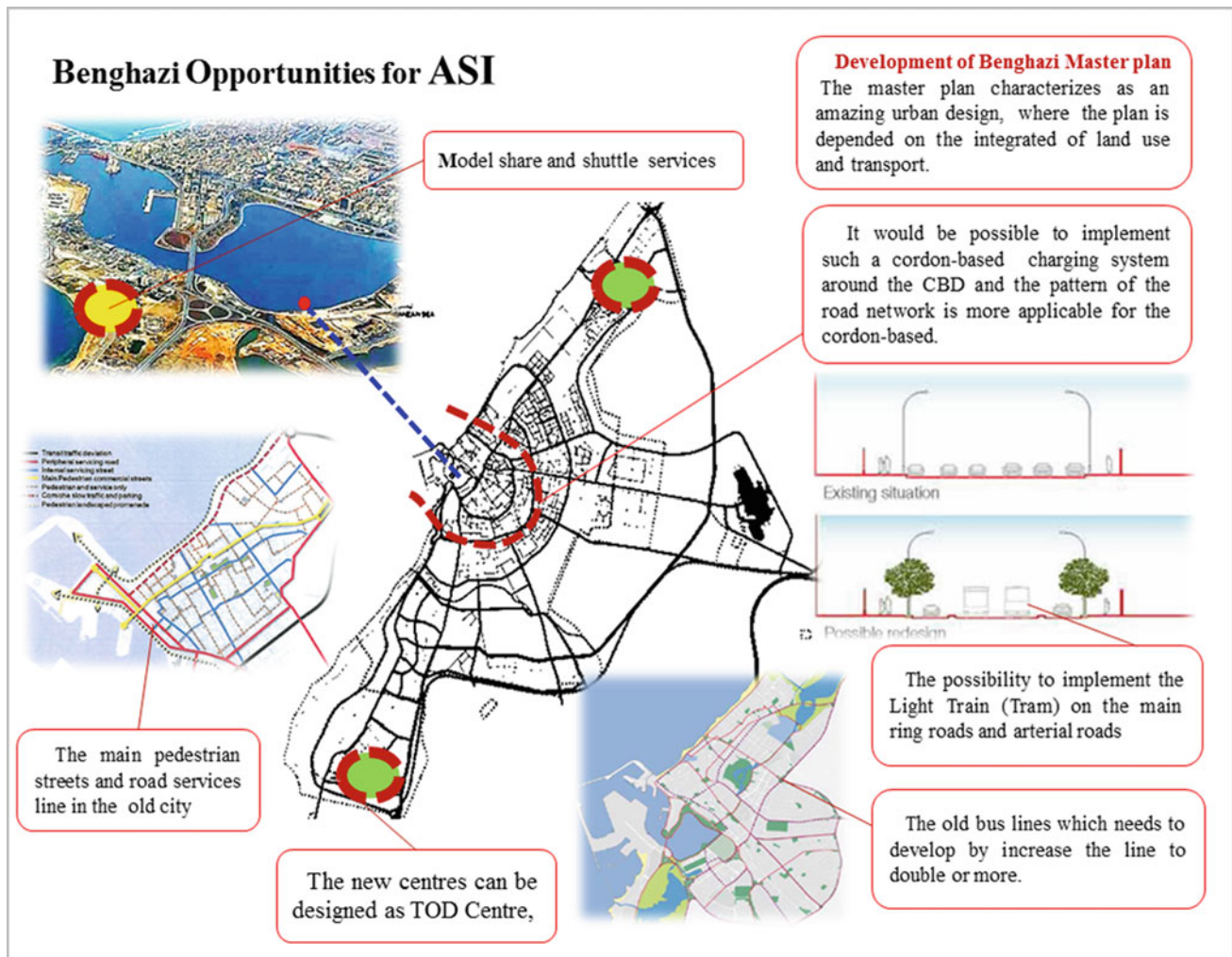


Fig. 11 Opportunities and strategies for the future of Benghazi

strategies. These strategies are called the Avoid, Shift and Improve, where the successful examples of ASI proved that having strategies such as ASI that allow access to the variety of transport modes and options can help road-users cutting down transport costs, improve transport safety, reduce pollution and providing easy and safe access to work, services and opportunities. Furthermore, public transport includes buses; metro, light rail; and other modes, is one essential aspect of the overall system. Another ideal strategy is transit-oriented development (TOD) that aims to allocate housing and commercial development close to transit infrastructure which involves various modes of trips to be used instead of automobile trips. According to the master plan of Benghazi, the sub-centers of the city are the perfect places to implement TOD approach that involves walkable and mixed-use communities around rail stations. Other different solutions that would be applied depends on the existing conditions and proposal plan of Benghazi as well the opportunities for the future of Benghazi (ECOU, 2010).

To implement sustainable transport strategies successfully from the beginning the transport policymakers could use this green plan as indicator to identify the main issues, requirements and needs of the sustainable transport strategies before the process of rehabilitation of Benghazi begins, and this plan will be the first step in the implementation sustainable transport strategies in Libya.

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