

Future of Transportation in Palestine: What Needs to be Done?

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Abstract— The roads and transportation sector in Palestine has been facing many challenges, mainly due to the prolonged Israeli occupation, which hindered it from playing its intended role in socio-economic development and in providing reliable mobility and accessibly services in a safe and efficient manner. In response to that, the general development framework of the comprehensive multimodal transportation plan for Palestine is presented, with the identification of its vision, goals, objectives, and key strategies. This has formed the basis to present what needs to be done in the key fields that include traffic safety, sustainable transportation, and smart transportation. The paper outlines the urgent need to develop a sustainable transportation system that improves mobility and safety, and utilize the new intelligent transportation technologies in traffic management and control. The paper concludes by highlighting the necessity to have a robust institutional framework and stakeholder collaboration in order to achieve the intended outcome towards a successful national strategy in developing the sector with proper funding mechanisms and policy guidance.

I. INTRODUCTION

The road and transportation sector plays a vital role in providing the foundations for economic and social development for communities and countries. Road and transportation networks provide the ability to move people and goods from one place to another within the country and with the outside world in an effective, quick, and safe manner.

The extent of the growth and influence of the road and transportation sector is considered as an indicator of the progress of nations. The development of countries has always been linked with the provision of proper mobility and accessibility through reliable road and transportation systems.

In Palestine, similar to other countries, this sector plays a pivotal role in providing the basis for transporting people and goods. However, there are unique obstacles that challenge such role, which are mainly associated with the prolonged Israeli occupation and continued aggressions. These include, at specific, the recent brutal devastation of the road infrastructure, among the other infrastructure sectors and all other aspects of life in Gaza Strip as well as in parts the West Bank. Moreover, Palestine needs a robust road and transportation sector that would serve as the cornerstone in establishing a sovereign state, in control of its land, waters and airspace, as well as its international gateways, and an integrated country, connecting the two separate parts of the West Bank and Gaza Strip in order to have a viable and contiguous Palestinian State on the ground.

Considering the above, there is a need to plan for a proper transportation system, that would facilitate identifying both remedial and developmental interventions, addressing the consequences of the Israeli occupation on the components of the road and transportation sector on one hand, and seeking to

pave the road towards a sector that facilitates socio-economic development on the other. This will ensure the basic role which the road and transportation sector will play in the future of Palestine.

After 58 years of occupation and 32 years of signing the Oslo agreement, the Palestinian National Authority (PNA) is inheriting a disjoined and lagging road infrastructure that needs to be developed, rehabilitated, or reconstructed. Gaza Strip, specifically, not only suffered from not being connected to the West Bank and to the World for about 19 years, but also currently has a totally damaged road infrastructure following the Israeli aggression and total destruction of all the aspects of life since October 7, 2023, as well as in the previous aggressions on the strip.

The paper aims to identify key issues concerning the future of transportation in Palestine, considering a comprehensive approach on one hand, but also defining specific areas of interest, which require detailed plans and implementable actions, highlighting what needs to be done in the key fields of traffic safety, sustainable transportation, and smart transportation.

The development framework for the transportation system in Palestine is presented first. This is followed by presenting recent efforts towards developing the road and transportation sector, addressing each of the three specific major fields of traffic safety, sustainable transportation, and smart transportation. The paper ends with conclusions and recommendations.

II. DEVELOPMENT FRAMEWORK FOR THE TRANSPORTATION SYSTEM IN PALESTINE

The development framework for the transportation system in Palestine, including identifying the vision, goals, objectives, and main strategies. This framework is defined taking into account the outcome of the strategic assessment of the sector based on the findings of the Roads and Transportation Master Plan (RTMP) for the West Bank and Gaza Strip (2016), which was approved by the Council of Ministers in 2018. This is addition to the sectoral strategic plans prepared by the Palestinian Government, including the Sectoral Strategy for Transportation 2017-2022 (Ministry of Transportation, 2017), the Strategic Framework for Intelligent Transport Systems 2019-2029 (Ministry of Transportation, 2019), the Sectoral Strategy for Transportation 2021-2023 (Ministry of Transportation, 2021), and the Sectoral Plan for Roads and Transportation, which is part of the National Spatial Plan (The Palestinian Government, 2023). Highlights of the plans and sectoral strategies are presented hereafter.

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A. Roads and Transportation Master Plan

The RTMP was prepared in 2016, which was funded by the European Commission through the European Investment Bank. It targeted the year 2045, but divides the period until 2045 into five developmental stages. The RTMP report and related annexes is considered as a key step towards a comprehensive vision for addressing the deficiencies and weaknesses in the Palestinian transportation sector and developing the various components of the sector in order to meet the needs of Palestinians and satisfy the economic and development needs. It covers infrastructure development, operational, legal, regulatory, and financial aspects. In addition to the road transportation, the plan included plans for railway transportation, air transportation, sea transportation, public transportation and logistics. The comprehensive multimodal plan for 2045 is presented in Figure 1.

B. Transportation Sectoral Strategic Assessment

The main findings of the strategic assessment, identified in the Sectoral Strategy for Transportation 2017-2022, the Sectoral Strategy for Transportation 2021-2023, and the Sectoral Plan for Roads and Transportation, are summarized. In all of these, the major issues on the national level that need to be addressed in the transportation system development framework in Palestine include the following:

- Damage of most of the road infrastructure in the entire Gaza Strip due to the Israeli authorities' destruction of the infrastructure during their brutal aggressions, especially since October 7, 2023, as well as in many parts of the West Bank.
- There is no connection between the West Bank and the Gaza Strip, between Gaza Strip and the world, and controlled connections between the Palestinian communities within the West Bank and with the outside by the Israeli authorities.
- Lack on non-road based transportation modes that can provide efficient movement of people and goods.
- Underdeveloped mass public transportation system.
- Lack of logistic facilities and properly developed freight transportation system.
- The constraints set by the Israeli authorities controlling roads and transportation.
- Lack of financial resources allocated to rehabilitate, manage, maintain, or develop roads and traffic safety aspects in Palestine, as most of the road network is in need for that.

C. Sector Development Framework

The sector development framework was prepared based on the key issues derived from the strategic assessment, which includes the vision, the goals and objectives, as well as the strategies. Consequently, the action plan was prepared.

• Vision

The document titled Palestine 2025, Palestine 2050, Envisioning Palestine (National Spatial Plan, 2015), identified the sector vision to be as follows:

“Advanced multimodal transportation system, linking the Palestinians together and with the world, and facilitating socio-economic development”

This vision is intended to represent the aspirations of the Palestinians considering the role of the road and transportation sector in connecting the two parts of the Palestinian State, linking the Palestinians together and with the world, leveraging the socio-economic development, and satisfying the population mobility and accessibility needs, and efficient movement of freight.

• Goals, Objectives, and Strategies

With consideration of the sector vision and the key issues derived from the strategic assessment as indicated above, the goals and objectives, as well as the strategies are derived. These had been grouped into seven categories, including roads, railways, air transportation, sea transportation, public transportation, border crossings and freight transportation, as well as institutional organization and legislation.

Details of these can be found in the above indicated plans and strategy documents, whether on the short- or long-term. The action plans, including the prioritized areas on intervention, whether in the form of developmental programs or projects, were also identified, mainly in the RTMP and subsequent Sector Strategies as referred to above.

D. The Strategic Framework for Intelligent Transportation Systems 2019-2029

The strategic framework for intelligent transportation systems was prepared by the National Intelligent Transport Committee, and approved by the Council of Ministers. It is a strategic framework that aims to adapt the intelligent transportation systems (ITS) and integrate them within the transportation systems in Palestine. This strategic framework represents the backbone of the next phase of transportation systems in Palestine as it encompasses the outlines and the major issues of most concern.

The plan presented a brief diagnostic of the status of transportation sector in Palestine. The plan identified that utilizing the advanced techniques of monitoring, data collection, control and telecommunication maximizes the benefits of using the ultimate capacity of transportation networks and smoothing the flow of traffic. This would reduce number of trips, mileage, accidents and environmental pollution, as well as improving the response to accidents and emergency cases.

The strategic framework includes the vision, the objectives, strategies, and action plans. These are briefly presented hereafter.

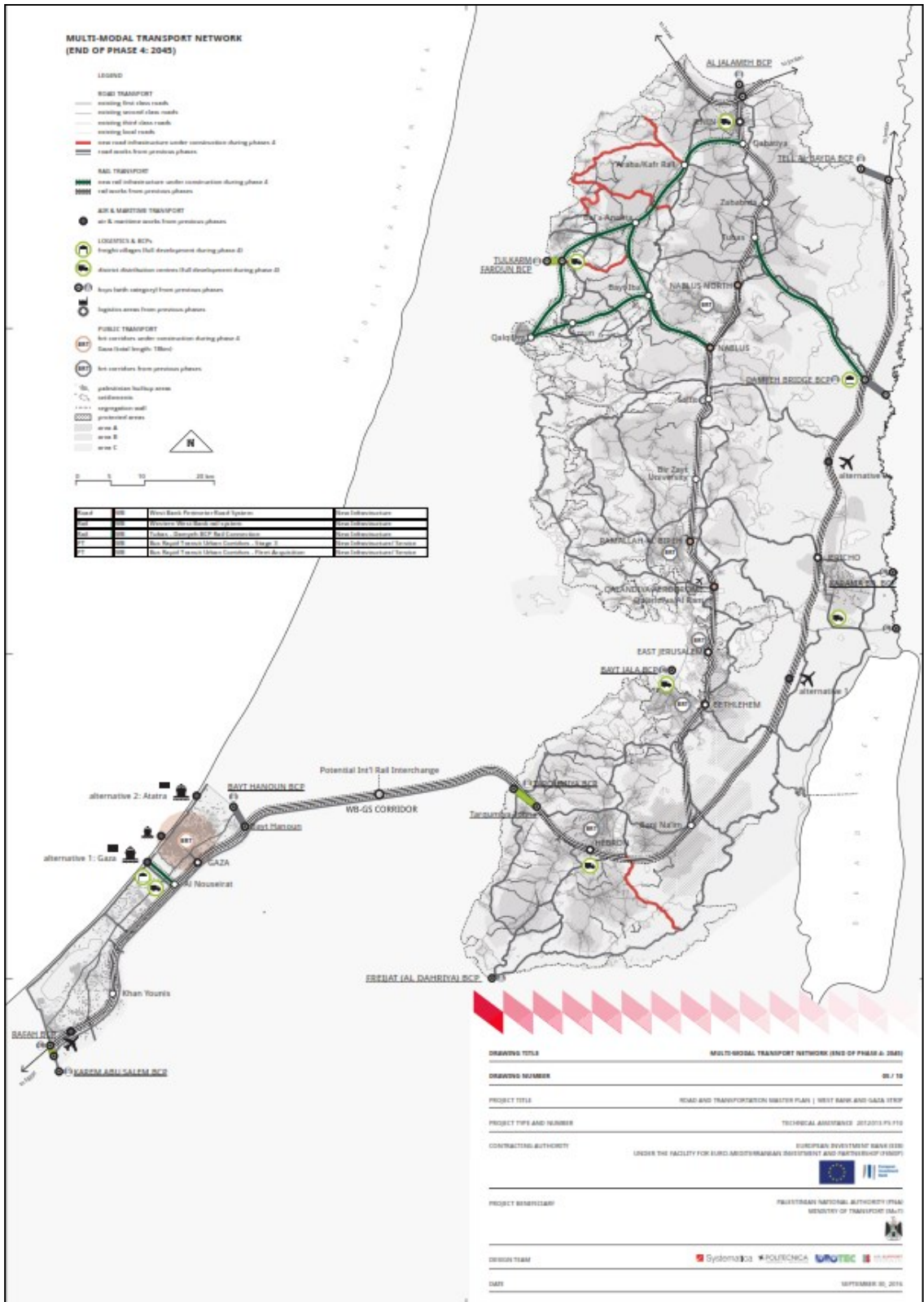


Figure 1. The 2045 Roads and Transportation Master Plan

- **Vision**

- **“Intelligent transportation system, efficient and sustainable”**

A roadmap to establish the ITS in Palestine was established to attain the identified strategies and objectives. An implementation plan was also proposed as a phased plan that addresses the issues, objectives, list of required projects and priority interventions. It is divided into three phases: short term plan of 5 years, intermediate and long-term plans of 3 years for each.

Furthermore, a set of performance indicators is created. The document confirmed the need to prepare the technical studies which are required in the implementation of each project. The institutional bodies and legislations are prerequisites in the implementation of this strategic framework.

The plan presents the Action Plan for the different components of ITS including:

- Pre-requests of laws, regulations, policies, and Deployment of Databases for ITS
- Communication
- Traffic Management
- Public Transportation
- Traveler Information
- Commercial Vehicle Operation
- Pedestrian Supporting Systems
- Road and Vehicle Safety Systems

III. TRAFFIC SAFETY

During the period of 25 years starting slightly after the establishment of the PNA (1997-2021), there had been in general a rise in the number of traffic crashes and casualties in Palestine. Abu-Eisheh et al. (2017) had presented the state of road safety over a longer period, which had covered road safety from 1970 to 2015. Furthermore, Hassouna, et al. (2020) established that a general increasing trend of road crashes in Palestine is observed over the years. Furthermore, a forecasting model was developed, which expected that crashes would continue to increase in the future. Consequently, there will be a vital need to improve traffic safety conditions and develop a national traffic safety program in Palestine.

According to official statistics presented by the Palestinian Central Bureau of Statistics (PCBS) for different years, there

were 4,715 crashes in the West Bank in 1997 but this number tripled to 14,104 over 25 years, at an average rate of 8.2% annually. As Figure 2 shows, the total number of casualties in the West Bank almost doubled from 5,933 in 1997 to 11,043 in 2021 at an average rate of at an average rate of 5.4% annually.

Fatalities resulting from road crashes in the West Bank increased from 103 in 1997 to 133 in 2021. However, the death rate per 100,000 dropped from 5.8 in 1997 to 4.3 in 2021. Detailed analysis of crashes, injuries and fatalities, was conducted as parts of the efforts in preparing the Road Safety Strategy for 2023-2030 (Palestinian National Institute of Public Health, 2023).

The preparation of the first national strategic plan for traffic safety in Palestine, Road Safety Strategy for 2023-2030, came in recognition of the Palestinian government of the importance of coordinating national efforts with a clear vision towards to meet the challenges arising from the consequences of the steadily increasing traffic crashes numbers. These include considerable loss of lives, injuries, property damages, as well as social and economic impact at the national level.

The plan aims to reduce the rates of deaths and serious injuries to reach rates that can be considered acceptable, in line with the decision of the United Nations General Assembly in 2020 to declare the period 2021-2030 as the second decade of action for road safety at the global level. The decision set an ambitious target of preventing at least half of road traffic deaths and injuries by 2030. This is in harmony with the sixth objective of the third sustainable development goal, which aims at decreasing traffic road fatalities and injuries by 50% by 2030.

The Palestinian National Institute of Public Health, with support from the World Health Organization (WHO), took the initiative, in cooperation with all relevant stakeholders, to arrange for launching the Traffic Safety Decade of Action and preparing a politically supported national strategy for road safety in Palestine.

The national strategy for road safety presents the vision, goal and objectives, strategies, as well as an action plan that includes the roles and responsibilities of the relevant stakeholders and the expected costs, along with the implementation timeframe. The Palestinian government was supposed to approve the plan since 2023 and work towards its implementation.

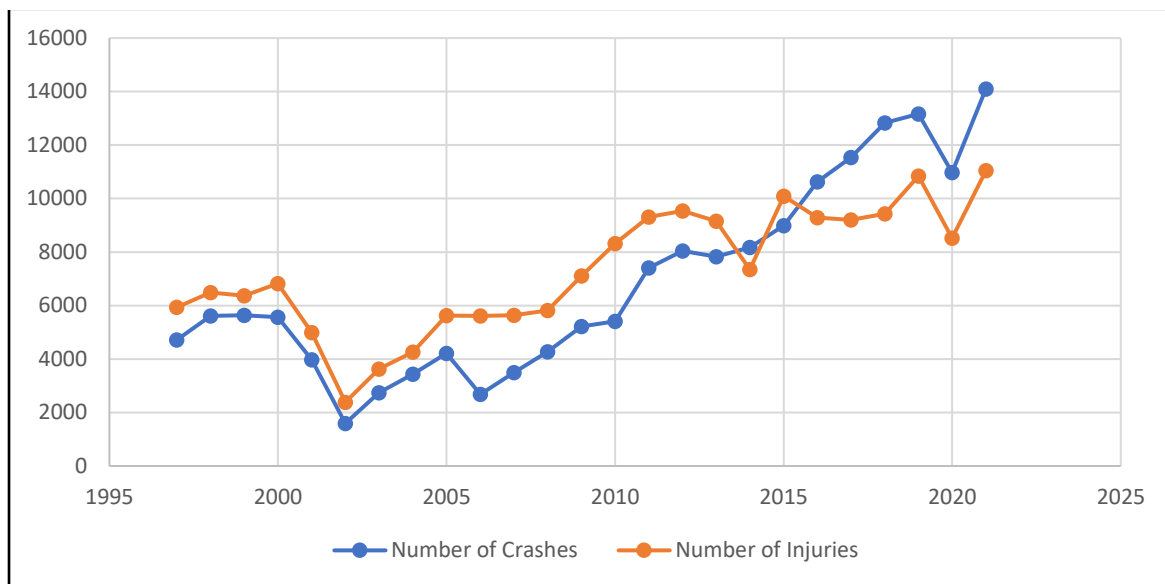


Figure 2: Traffic crashes and injuries in the West Bank during 1997-2021

The plan has the vision of safe and sustainable mobility, with the main goal reduce the deaths and serious injuries resulting from road crashes per 100,000 inhabitants by 40% by 2030. It identified the key issues in six areas; laws and legislations, vehicles, road users, road engineering, traffic engineering and urban planning, road safety management, control and audit, and emergency and post-crash response.

The key strategy objectives include:

- Upgraded legal system and legislation necessary to enhance traffic safety and to deter perpetrators of dangerous traffic violations and crimes.
- Raised level of the capacity of drivers and competency of applicants to obtain driving licenses.
- Increased traffic awareness among road users including drivers, passengers and pedestrians.
- Controlled spread of illegal vehicles to reduce traffic crashes.
- Increased mobility using mass public transportation, ride-sharing, and active transportation (including bicycles, etc.), and limited use of private cars.
- Improved quality of the outputs of the road planning processes.
- Linked planning and design of road and transportation facilities and improvement of road safety with sustainability and climate change concerns.
- Developed safe road network through the preparation and execution of proper design for all road elements ensuring safety of all users, with due attention to proper operation, maintenance and management of the road network.
- Raised level of compliance with Traffic Law and road safety legislation.

- Developed smart transportation systems to enhance control over drivers, monitor traffic violations, and tighten penalties for perpetrators.

- Improved quality of information on traffic crashes and using these to improve traffic safety.

- Increased coordination among partner institutions in the field of road safety.

- Increased financial allocations to the road and transportation sector in general, and road safety at specific.

- Raised level of readiness to respond when traffic crashes occur.

- Improved public awareness is responding to traffic crashes.

- Improved coverage of ambulances and emergency and civil defense centers, and provision of adequately equipped ambulances to deal with road crashes.

- Enhanced provision of the necessary health care for road crash victims.

- Enhanced and rapid response to repair crash sites.

With consideration of the identified strategies, an action plan was prepared in consultation will all the partners. It included 41 actions distributed over the 2023-2030 period, with a total cost of 135 million USD, where 44% of the total cost is proposed to be from government sources and the rest from other partners or donors.

IV. SUSTAINABLE TRANSPORTATION

Sustainability is defined as meeting the needs of the present without compromising the ability of future generations to meet their own needs. This includes a Triple Bottom Line (TBL):

Environmental Sustainability, Social Sustainability, Economic Sustainability. It is an interconnected and holistic approach.

A. Transportation and Sustainability

Transportation as a major sector contributing to carbon emissions, air pollution, energy consumption, and land use changes. In addition to carbon dioxide (CO₂), transportation also emits other harmful pollutants, such as nitrogen oxides (NO_x), particulate matter (PM), and volatile organic compounds (VOC), which can have serious health effects, especially for vulnerable populations, such as children, elderly, and low-income communities. There is also an important role of sustainable transportation in achieving global sustainability goals (SDGs). Some of the key sustainability challenges in the transportation sector include greenhouse gas emissions (GHG), air quality, energy efficiency, and urban sprawl.

Therefore, the key concepts of a sustainable transportation include:

- **Low-Carbon Mobility:** Minimizing the carbon footprint of transportation systems.
 - **Eco-Efficiency:** Reducing resource consumption per unit of service.
 - **Equitable Access:** Ensuring fair access to transportation for all demographics.
 - **Resilience:** Adapting transportation infrastructure to climate change impacts.
 - **Multimodal Transport:** Integrating various modes of transport (e.g., walking, cycling, public transit, electric vehicles).
- As such, the elements of a sustainable transportation system should include, among others:
- **Energy Efficiency:** Using less energy for the same transportation service.
 - **Emission Reduction:** Lowering harmful emissions (CO₂, NO_x, particulate matter).
 - **Affordability:** Making transportation options affordable to all segments of society.
 - **Health and Well-being:** Encouraging active transportation modes like walking and cycling to improve health.
 - **Smart Infrastructure:** Incorporating technology for better traffic management and reduced congestion.

B. Tools and Frameworks for Sustainable Transportation

The tools and framework for a sustainable transportation system includes, among others:

- **Sustainable Urban Mobility Plans (SUMP):** Integrated planning framework for cities to develop sustainable transportation.
- **Life Cycle Assessment (LCA):** Assessing environmental impacts of transportation systems throughout their life cycle (construction, operation, disposal).

- **Transport Emissions Evaluation Models:** Tools to estimate and reduce emissions from transportation systems.

- **Smart Mobility Technologies:** Use of data analytics, IoT, and AI to optimize transportation efficiency (e.g., traffic management systems, autonomous vehicles).

Globally, there are numerous sustainable mobility initiatives, samples of which include:

- **Non-Motorized Infrastructure:** Creation of cycling lanes and pedestrian-friendly zones, as well as the use of micro-mobility vehicles.
- **Public Transport Initiatives:** Expansion of metro or bus rapid transit (BRT) systems.
- **Electrification:** Transition to electric buses and charging infrastructure.
- **Congestion Pricing:** Implementation of tolls to reduce traffic in urban centers.

C. Challenges in Achieving Sustainable Transportation

However, sustainable mobility faces some universal challenges. These include:

- **Funding and Investment:** Due to the high initial capital costs for sustainable infrastructure.
- **Public and Political Resistance:** due to the need in changing behaviors and policies.
- **Technological Barriers:** Development and deployment of low-emission technologies.
- **Urban Sprawl,** which increases distances between urban centers and transportation hubs.
- **Equity Concerns:** a challenge to ensure that all socio-economic groups benefit from sustainable transport options.

It is; therefore, important to recognize that achieving sustainable transportation requires integrated approaches across all levels of governance. There is also a need for innovation in policy, technology, and urban design.

D. Mobility and Sustainability

Mobility is the ability to move, to move from one place to another. Mobility involves roads, bicycle, public transport, rail, air transport, sea transport, micro-mobility, etc. In this regard, it is essential to recognize that there several strengths and limitations for each mobility mode.

The rapid and unplanned growth in urban centers, the growing private vehicle fleet mainly due to urban sprawl and income growth, as well the lack of proper planning of transport systems have led to increasing deterioration of mobility and environmental problems. This is a global issue. The attainment of a sustainable mobility requires an integration between all means of transportation.

Cities are looking for a better balance in space for non-motorized transport, public transport and residential space at the expense of space for stationary and moving cars. This saves space in the city and relieves congested areas, but requires more urban public transport capacity and more space outside

the city where it is possible to transfer from car to public transport or bicycle.

Mobility is not a static concept but rather a dynamic and evolving one. The emergence of new technologies, such as electric and autonomous vehicles, shared mobility services, and mobility as a service (MaaS), are transforming the way we think about transportation and mobility. These innovations promise to reduce the environmental impact of transportation, increase efficiency and convenience, and provide more accessible and inclusive mobility options. However, they also raise new challenges and uncertainties, such as cybersecurity, data privacy, regulatory frameworks, and social acceptance.

In summary, the choice and design of mobility types can have significant implications for climate resilience, affecting not only the mitigation of GHG emissions but also the adaptation to the impacts of climate change, such as sea-level rise, floods, heatwaves, and droughts. However, there are benefits and limitations of each mode. Therefore, it is crucial to consider the multiple dimensions of mobility in the context of climate resilience, and to adopt a holistic and participatory approach that takes into account the diverse needs, aspirations, and perspectives of all stakeholders. Understanding and managing mobility requires a holistic, creative and multidisciplinary approach that takes into account the needs and aspirations of different stakeholders, the trade-offs and synergies between different modes of transport, and the long-term sustainability and resilience of our transport systems.

E. Creating A Realistic Sustainable Mobility Vision for Palestine

Creating a realistic vision of sustainable mobility for Palestinian municipalities involves designing transportation systems that are environmentally responsible, economically viable, and socially inclusive. Given the unique challenges of



- **Reducing roadside parking:** To free up space on the road for other uses such as cycling lanes, bus lanes, and wider sidewalks. This can also reduce the risk of accidents caused by cars parked in dangerous locations.

- **Implementing green infrastructure:** such as trees, plants, and green roofs can help to mitigate the **urban heat**

political instability, limited resources, and infrastructural constraints in Palestinian territories, the need for innovative solutions is paramount.

A sustainable mobility framework must prioritize public transportation, pedestrian-friendly spaces, cycling infrastructure, and the use of clean energy to reduce dependency on fossil fuels. It also requires collaboration with local communities, government agencies, and international partners to address immediate transportation needs while fostering long-term resilience and sustainability in urban planning.

1) Improving of existing roads in densely populated and built-up areas. This is a challenging task, as there is limited space in Palestinian urban areas for expansion and disruption to traffic flow, which can cause significant inconvenience to commuters. In the Palestinian context, here are some possible strategies:

- **Implementing Traffic Systems Management (TSM):** improving intersection traffic control (signs, signals, or channelization), optimizing traffic flow using computer modeling software, etc.

- **Implementing Intelligent Transport Systems (ITS):** It can provide real-time information to commuters; improve the efficiency and reduce the travel time. The Intelligent Transport Strategic Framework for Palestine 2019-229 has been prepared and approved by the Palestinian Cabinet in 2021/2022; therefore, should be adopted and implemented gradually.

- **Reducing the number of private cars:** Encouraging the use of public transport, cycling, and walking can help reduce the number of private cars on the road. This can be achieved through measures such as providing safe and convenient cycling and pedestrian infrastructure, improving public transport services, and implementing car-free zones in certain areas.

island effect, reduce air pollution, and improve the aesthetics of the area. Green infrastructure can also help to absorb storm-water runoff and reduce the risk of flooding. There are some examples in Palestinian cities - on limited scale. Sometimes, the challenge is in the limited available space (right-of-way).



• **Upgrading road infrastructure:** such as resurfacing, repairing potholes, and adding lighting, can improve road safety, reduce accidents, enhance the experience of road users, and improve their satisfaction with the transport system.

2) **Micro-mobility:** It refers to the use of (electric) bicycles, e-scooters, e-steps and other short-distance vehicles. There is a growing interest worldwide in micro-mobility and its envisioned as either an alternate means car dominant transport or an integrated means to public transportation. Micro-mobility is therefore ultimately about flexibility and sustainability.

Forms of micro-mobility include (Electric) bicycles, also called e-bikes; (Electric) scooters, also called e-scooters; e-steps; Speed pedelecs, also known as speedbikes; Light Electric Vehicles (LEVs), light electric vehicles with three or four wheels.

In the Palestinian areas, the use of some forms of micro-mobility (e-bike, e-scooter, LEVs, etc.) have been increasing in recent years; this has been observed through urban streets. However, they are not properly regulated or enforced. Furthermore, urban planning has not addressed the needs of such a mobility type.

Although it is challenging considering the existing built up areas and limited available space; however, urban/transport planners are required to create innovative solutions to adapt to their growing trends. This could be planned/designed in specific area; not necessarily at the city level, and it is integrated with the option of reducing reliance on private cars; such as creating car free zones.

3) **Transit Oriented Development (TOD):** It means integrated urban places, designed to bring together people, activities, buildings and public spaces, with easy walking and cycling. Excellent public transport to the rest of the city is a prerequisite. This means inclusive access to opportunities and resources across the city for all, through the most efficient and healthy combinations of mobility modes.

TOD is a long-term process. People can get to an interchange; accessibility (BRT), or car (multi-modality). The result will be the lowest financial and environmental costs, and with the greatest resilience to disruptive events. TOD is thus a necessary basis for long-term sustainability, equity, livability and accessibility in cities. This requires a local/regional task at a higher scale level. Proper process management is essential.

In Palestine, with the exploration of various public transportation master plans, a TOD concept becomes an integrated approach to such plans. Such a concept has recently been explored in the “Comprehensive Public Transport Master Plan for Ramallah and Al-Bireh Urban Area” project, and partially explored in the Bethlehem Mobility Study, as well. This will create a new atmosphere around urban centers and public transport stations, and would change the negative image surrounding public transportation and encourage its use.

4) **Parking:** Parking in urban centers can be a major challenge due to the limited space and high demand for parking spots. In many cities, parking is often seen as a necessary evil, as it can take up valuable land and contribute to traffic congestion and air pollution. In (most) city centres, including Palestine, there is limited space for car parking, at a charge. The public space should remain attractive for residents, visitors, pedestrians and shoppers.

The provision of comfortable and low-priced parking might be seen as a way to encourage using private cars. To address

these issues, urban planners and policymakers have implemented various parking principles in urban areas. Parking principles in the urban area might include: balanced approach, zoning, shared use, pricing, sustainability, prioritizing active transportation, prioritizing accessibility, off-street parking, etc.

Palestinian government/municipalities must develop and adopt a “Parking Policy” and “Parking Management Plan”. Overall, effective parking policies and infrastructure can contribute to a more sustainable and livable urban environment, reducing congestion and encouraging active transportation while also meeting the needs of drivers.

5) **Curb Side Management:** refers to the planning and management of the physical space located along the curb of urban streets, including sidewalks, bike lanes, and parking areas. It involves the allocation of this space to different uses, such as loading and unloading of goods, drop-off and pick-up of passengers, street vending, and parking.

Effective curb side management is essential for ensuring safe and efficient movement of people and goods in urban areas. However, it is a complex task, as different users have competing demands for the limited curb side space available.

Strategies to manage curb side space would include time-limited parking, permit-based parking, metered parking, and the use of smart technology to monitor and manage parking demand. It also includes dynamic curb side management, which involves the real-time adjustment of curb side uses based on current demand and traffic conditions.

Effective curb side management can help reduce congestion, improve traffic flow, and enhance safety for all users, while also providing opportunities for economic development and enhancing the livability of urban areas.

V. SMART TRANSPORTATION

Historically, transportation systems were dominated by **capital-intensive infrastructure projects** (heavy reliance on physical assets like roads, bridges, railways, ports, and airports). These systems required Huge upfront investments, often by governments, long planning horizons, limited flexibility once built, and centralized management and limited user interaction.

With advances in **digital technology**, the transportation sector began integrating communication and information tools, leading to an **Intelligent Transportation Systems (ITS)**, with various applications such as real-time traffic management, signal control optimization, electronic toll collection, dynamic route guidance, etc. This has further developed to using advanced **Communication Technologies**, with applications such as Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) systems, GPS navigation and real-time tracking, mobile applications for ride-hailing and public transit, etc.

Recently, a new paradigm of communication- and information-based transportation system has evolved. Transportation has now become increasingly **software-defined and data-driven**. Examples include **Mobility as a Service (MaaS)** (integrates public and private transport into seamless digital platforms (e.g., Uber, Moovit)), **Data analytics & AI** (predictive maintenance, route optimization,

demand forecasting), **Cloud platforms & IoT** (Real-time monitoring of vehicles and infrastructure), and **Decentralized access** (users interact with transportation systems via smartphones, not just physical infrastructure).

Table 1: Shift in Focus of the Transportation Systems

From Capital-Intensive	To ICT-Based
Building more roads	Managing demand intelligently
Public investment	Public-private digital platforms
Fixed infrastructure	Adaptive, responsive systems
Centralized planning	User-centric design

Smart transportation, also known as Intelligent Transportation Systems (ITS), definition is smart modes (vehicles) driving on smart highways (facilities) to make drivers (systems) smarter. ITS is the application of computers, communications and sensor technology to surface transportation.

The ITS classical functional areas vary; it includes, among others:

- **ATMS:** Advanced Traffic Management Systems
- **ATIS:** Advanced Traveler Information Systems
- **AVCS:** Advanced Vehicle Control Systems
- **CVO:** Commercial Vehicle Operation
- **APTS:** Advanced Public Transportation Systems
- **ARTS:** Advanced Rural Transportation Systems
- Security Systems
- More recently, **Autonomous Vehicle**

Some of these functional areas are integrated with each other. Here are some example applications of these systems.

With the advancement in technology, the application of different types of ITS becomes feasible world-wide, including Palestine. **The ITS Framework for Palestine 2019-2029** has been prepared and approved by the Palestinian Cabinet in 2021/2022; therefore, should be adopted and implemented gradually.

Various ITS strategies can be used to optimize traffic flow, reduce congestion, guide trips, improve public transportation services, etc. Technology is available and affordable. Here are few samples of these applications.

Advanced Vehicle Control Systems (AVCS): to assist drivers in various tasks, to provide automatic warning, and automatic control of vehicles. Examples include intelligent cruise control, lane sensing & lateral control, automatic vehicle control, collision avoidance, etc.

One of the main obstacles towards a higher level of using ITS in Palestine is the Israeli occupation and its control over the advanced use of telecommunication and internet.

VI. CONCLUSIONS AND RECOMMENDATIONS

Like many other facets of life, Palestine's transportation system faces complex and enduring obstacles, most of which are caused by the military and political limitations imposed by the Israeli occupation. Over the years, a number of high-quality studies and initiatives covering national master plans, urban area-specific strategies, public transportation systems, and a framework for intelligent transportation solutions have been developed in spite of these challenges. Although external factors have frequently stalled their implementation, the planning process must continue. When feasible, these plans should be carried out gradually in order to create the foundation for long-term gains.

A fundamental change toward sustainability, resilience, and innovation is essential for Palestine's transportation system's future. Although a number of strategic initiatives have been introduced in recent years, challenges related to infrastructure, policy coordination, funding, and urban planning remain significant. This paper has outlined the urgent need to develop a comprehensive and sustainable transportation system that promotes environmental concerns, improves mobility and safety, and supports economic growth.

A multifaceted strategy is recommended in order to develop such a system, including strengthening public transport, improving non-motorized infrastructure, integrating renewable energy sources, and ensuring accessibility and inclusivity. Incorporating smart transportation solutions, like data-driven planning, intelligent traffic and safety management, and advanced vehicle control, among others, carries a good potential. These solutions can help the industry overcome present challenges and constraints and prepare for the future.

A well-coordinated national strategy backed by robust institutional frameworks and stakeholder collaboration is necessary for Palestine to achieve this goal. Adopting new technologies is only one step in the future; another is fostering an innovative, sustainable, and long-term planning culture. Palestine can create the framework for a cutting-edge transportation system that serves its citizens' needs and promotes overall development with the correct funding and policy guidance.

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