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Strategic Planning for Sustainable Transportation in Developing Countries: The Role of Vehicles

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Abstract

The transportation sector in developing countries plays an important role in their socio-economic development. However, there are challenges that face the sector, including the increasing traffic congestion due to the high growth rates of vehicle ownership and the resulting impacts.

Strategic planning approach is utilized to achieve sustainability in the transportation sector in the developing countries. The aim of this research is to explore the proper measures that would be capable of dealing with the identified key factors, mainly as related to the vehicles negative impacts on the environment, and to formulate a strategic framework for sustainable transportation system in the developing countries. Palestine is taken as the case study, that could be considered as an example of developing countries, representing lower-middle income countries with moderate annual car growth rate.

After performing quantitative and qualitative analysis based on field surveys, statistical data, and interviews, SWOT analysis is conducted, considering the internal status and the external environment. Based on such analysis, the proposed framework for strategic planning towards achieving a sustainable transportation system is formulated. The framework has identified the vision, goals and objectives, and strategies and actions.

The output of this study would lay the foundation to debate and adopt the framework in partnership with other stakeholders. Key strategies are defined considering the Shift-Avoid-Improve approach, along with the supportive administrative and legal tools. Such strategies include actions related to the application of energy efficient technologies, promotion of adopting cars with hybrid and electric engines, and support using new fuel alternatives.

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1. Introduction

The sustainability of the transportation system is critical in developed and developing countries alike. Despite that the transportation sector accounts for no more than 10% of the world's gross domestic product, it accounts disproportionately for about 64% of global oil consumption and 27% of all energy use 22%, and contributes to 23% of the world's energy-related CO₂ emissions (World Bank, 2017a). A sustainable transportation system may work as a catalyst in the development process. Sustainability in transportation is very important as a sustainable transportation system is not limited to minimizing the traffic congestion and improving air quality only, but it also helps to reduce poverty and brings economic prosperity (UNESCAP, 2012). Sustainable transportation expresses a system that promotes equity within and between successive generations, that is safe, consistent with human and ecosystem, affordable, operates fairly and efficiently, offers choice of transportation mode, limits emissions, uses renewable resources, and minimizes impact on the use of land.

This research aims to identify the key factors concerning the role of vehicles with respect to sustainable transportation in the developing countries, taking Palestine as a case study. It also aims to formulate a policy-oriented approach of a national strategic planning framework for sustainable transportation, proposing relevant strategies and recommendations to adopt and start implementing the proposed framework. The strategic planning framework is that set of constituents that include formulated vision, mission, goals and objectives, as well as a set of broad strategies, that can together express a strategic approach to the issue under consideration; sustainable transportation.

The research is motivated by the very rapid increasing trend in car ownership and the resulting mounting increase in the number of cars in the developing countries during the past few decades, and the associated negative consequences of the social, economic, as well as environmental aspects. Therefore, planning strategically to deal with such consequences especially in these countries is needed. Relevant issues in this regard, as related to the role of vehicles at specific, are addressed in this paper.

The number of motor vehicles in the world has been increasing steadily with time. Davis and Williams (2018) estimated the worldwide average annual car growth rate of 3.0% for the period from 1990 to 2015. The respective annual growth average rate was found to be 1.8% for a selected group of developed countries, while it is about five times higher, reaching 8.6%, for a selected group of developing countries. The modernization of life style and increasing per capita income in the developing countries are drastically driving the observed increase in the demand for owning cars, whereas in the developed countries the motorization levels are already high and are approaching or already reached saturation levels.

The rapid motorization growth in developing countries is taking place in the absence or lack of measures to ensure safety and environmental consequences. A major challenge is facing the developing countries in balancing between accommodating the desire for personal mobility and mitigating the heavy economic, environmental, and social costs of motorization (Sperling and Claussen, 2004). Without proper strategies and measures, the greenhouse gases (GHG) emissions from transportation in these countries will be increasing very rapidly.

In the developing countries, the economic and social development is the top priority and the issues of climate change mitigation, sustainability and sustainable transportation are of less importance. Therefore, the key challenge for developing countries is to identify strategies that address high-priority socio-economic developmental issues while also reducing the environmental and social cost of owning and using vehicles. Despite these challenges, there are many opportunities for improvement. The governments in the developing countries should take decisions on the infrastructure, vehicles and fuel technologies, and transportation mode mix that would significantly affect GHG emissions (Sperling and Salon, 2002). The developing countries can learn from the experiences of developed countries in integrating land use and transportation plans, encouraging more efficient forms of vehicle ownership and use, and accelerating the introduction of environmentally sensible vehicle technologies and fuels.

This article presents a quick overview on sustainability of the transportation sector in developing countries, in addition to introducing the case study of Palestine, including analysis of vehicles related issues within the transportation system and the recent prepared Roads and Transportation Master Plan. This is followed by an illustration of the methodology followed for the development of a strategic framework, considering the implementation and analysis of the surveys and interviews. Next, the strategic assessment for the transportation sector is briefly presented based on analysis of the collected information and the results of analysis. After this, the development of the framework for strategic planning for clean and sustainable transportation for the case study is

presented, defining the vision, goals, objectives, strategies, and actions. Finally, study conclusions and recommendations are highlighted.

2. Developing Countries' Attempts to Consider Sustainability of Transportation and Palestine Case Study

There have been plans or strategies in a number of developing countries, whether these are broad national or transportation specific strategies, which include components that are related to promoting sustainable transportation. However, there is need to have strategic plans considering the sustainability dimension of the transportation sector, with focus on the role of vehicles, as it plays a central role in achieving sustainability, which could stand alone or supplement such already prepared national developmental plans or transportation master plans.

In order to have a sample of a tailored strategic planning framework for sustainable transportation for a developing country, Palestine is considered in this research as the case study. It represents a lower-middle income developing country economy, as identified by the World Bank (2017b). It can be also a representative case that exhibits the commonly observed sharp increase in car ownership, as the case of the majority of the developing countries during the past few decades.

A number of studies and research articles had addressed sustainability in transportation systems planning. Jeon and Amekudzi (2005) presented key relevant and basic issues on what constitutes transportation sustainability and how to measure it. They indicated that transportation system sustainability is largely being defined through impacts of the system on the economy, environment, and general social well-being; and proposed to measure it considering system effectiveness and efficiency metrics, and the impacts of the system on the natural environment. Gwilliam and Shalizi (1996) illustrated how inappropriately designed transportation strategies can result in networks and services that harm the environment, ignore the changing needs of users, and exceed the capacity of public finances. Consequently, they suggested priorities relevant to policy reform and strategic planning to better address transportation systems sustainability. Monzón and Suárez (2010) proposed a methodology to assess the three dimensions of sustainability: economic, social, and environmental, which constitutes an interdisciplinary approach tightly linking network analysis, spatial geography, regional economic, and environmental issues. More recently, literature had addressed the impact of new trends in vehicles, such as autonomous vehicles and electric vehicles, on sustainable transportation (Schiller and Kenworthy, 2017).

Before presenting the case study of Palestine, three examples are briefly illustrated here, one from Asia (Jordan), another from Africa (Rwanda), and a third from Latin America (Jamaica).

2.1. Examples from developing countries

The Jordanian National Transport Strategy and Action Plan, published by the Jordanian Ministry of Transport (2014), had the overall objective to develop the transportation system in Jordan. The strategic vision was formulated as “to have a developed and sustainable transport sector, distinguished for competency, safety and environmental stability, enhancing the socio-economic development and making Jordan a regional hub for transport”. The National Transport Strategy proposed a set of integrated and complementary strategies as related to sustainable transportation, which include development and implementation of a renewed bus network and services, setting and enforcing minimum standards for vehicles in order to improve safety and quality standards, improving vehicle inspection procedures, lowering the operational vehicle age, as well strategies related to actions regarding controlling pollutant emissions and GHG relying upon state-of-the-art technologies with better performances and fuel efficiency, and promoting alternative fuels and vehicles (such as LPG, CNG, hybrids, electric vehicles) and the related infrastructure.

Rwanda Strategic Transport Master Plan was published by Rwanda Transport Development Agency (2012). This plan which provided guidance for the development of integrated medium- and long-term land transportation programs for the next 10 years had a strategic vision that was developed with pillars which are relevant to transportation sustainability that include, among others, the economic pillar, considering the development of the transportation system that supports sustainable economic activity. The plan objectives were to have a planning direction for transport issues to covers the organization of the transportation sector as well as the delivery of transportation infrastructure and services, taking a long-term view on the future transportation system and identifying programs and projects that secure the integrity of the current system as well as laying the foundation for the future system in a sustainable manner.

In 2006, the Government of Jamaica mandated the Planning Institute of Jamaica to lead the preparation of a comprehensive long-term National Development Plan (NDP) to place Jamaica in a position to achieve developed country status by 2030 (Planning Institute of Jamaica, 2009). The preparation of the plan considered a broad range of interconnected economic, social and environmental factors. The plan well considered the transportation issues and challenges facing Jamaica. It identified the vision for transportation in Jamaica, and determined the key goals, objectives and strategies for the sector. The Sector Plan for Transport was structured following SWOT strategic assessment methodology. One of the main Transport Sector Plan of Jamaica objectives includes achieving a sustainable road transportation system that serves the economic and social needs of the country. The development of a sustainable land transportation strategy for Jamaica included relevant strategies and actions, such as implementing a comprehensive policy, legislative, regulatory and institutional framework for sustainable transportation and environment friendly sector using more energy-efficient transportation modes, cleaner fuels and technologies, and developing sustainable transportation policies, with priorities directed to support public transportation.

The above indicated cases are summarizes in Table 1. These briefly presented examples, along with other reviewed cases, were considered as to demonstrate how sustainability is being taken into account while preparing transportation master plans or national developmental plans, including the transportation sector. The results of such reviewed examples and cases indicate the lack of having strategic plans that are dedicated towards achieving sustainable transportation.

Table 1. Summary of developing countries examples considering country-wide transportation sustainability strategies.

| Item | Jordan | Rwanda | Jamaica |
|---|--|---|---|
| <ul style="list-style-type: none"> • Sustainability strategies relation with national transportation or development plan | Part of national transport strategy and action plan | Part of strategic transport master plan | Part of long-term national development plan |
| <ul style="list-style-type: none"> • Entity in charge | Ministry of Transport | Transport Development Agency | Country Planning Institute |
| <ul style="list-style-type: none"> • Plan vision highlights | Achieved a developed and sustainable transport sector | Development of the transportation system that supports sustainable economic activity | No specific reference to transportation sustainability in the vision |
| <ul style="list-style-type: none"> • Plan objectives highlights | Pursue a multimodal approach and Protect the environment and reduce negative impacts | Establish a system to ensure sustainable financing of road maintenance | Achieving a sustainable road transportation system that serves the economic and social needs of the country |
| <ul style="list-style-type: none"> • Strategies inclusion of role of vehicles highlights | Setting and enforcing standards improving vehicle inspection procedures, lowering operational vehicle age, controlling pollutant emissions and GHG, better fuel efficiency, and promoted alternative fuels | Promoting the use of the most efficient vehicles in terms of environmental standards, and use of new vehicles in public transport | Using more energy-efficient transportation modes, and supporting vehicles that use cleaner fuels and technologies |

2.2. The case study of Palestine

Palestine is considered in this research as the case study. It has to be stated that despite the recent preparation of Road and Transportation Master Plan (RTMP) aiming to develop the sector as presented later in this section, which include a number of strategies that help in achieving sustainable transportation, these are not focused nor integrated within a comprehensive framework to achieve this goal (MOT, 2016a). In fact this was one of the motives to conduct this research, as developing a strategic framework aiming to achieve sustainable transportation could be considered as a supplement to the recently prepared RTMP.

A general background on the transportation system in Palestine and geo-politics is presented first on the relevant issues related to infrastructure, vehicles, administration, and regulations.

Based on the per capita Gross National Income, with a value 3,180 USD for 2016 Palestine is a lower-middle income country (falling within the specified range for such countries in this class of 1,006 to 3,955 USD) (World

Bank, 2017b). On the other hand, the average annual car growth rate for Palestine has reached 5.0% for the 1990 to 2015 period (PCBS, 2016a), which could be considered as representative of an average developing country.

Road based vehicles are the sole means of transportation in Palestine utilized for the movement of people and goods inside the territories and to/from abroad. In recent years, the road network has been modestly expanded in the attempt to accommodate the rapid increase in the number of vehicles. The transportation sector plays as well a key role in the development of the Palestinian economy through providing mobility, investment and employment opportunities, as well as serving other sectors. Palestine’s roads become more congested, especially in the centers of the cities. Therefore, the outlook for a sustainable transportation is extremely urgent and vital.

The transportation infrastructure was poor and underdeveloped, but after the establishment of the Palestinian National Authority (PNA) in 1994, many road rehabilitation and traffic management projects were executed with the support of the international community, and consequently development was noticed in this sector.

The West Bank topography is mountainous and has an area of 5,860 km² and it is bounded by Jordan (the Jordan River) and the Dead Sea from the east and by Israel from the other three directions. Gaza Strip is a coasted strip that has a total area of 360 km², with borders with Egypt from the southwest and Israel from the other directions. The West Bank and the Gaza Strip are separated by about 34 km. The map shown in Figure 1 illustrates the location of the two regions.

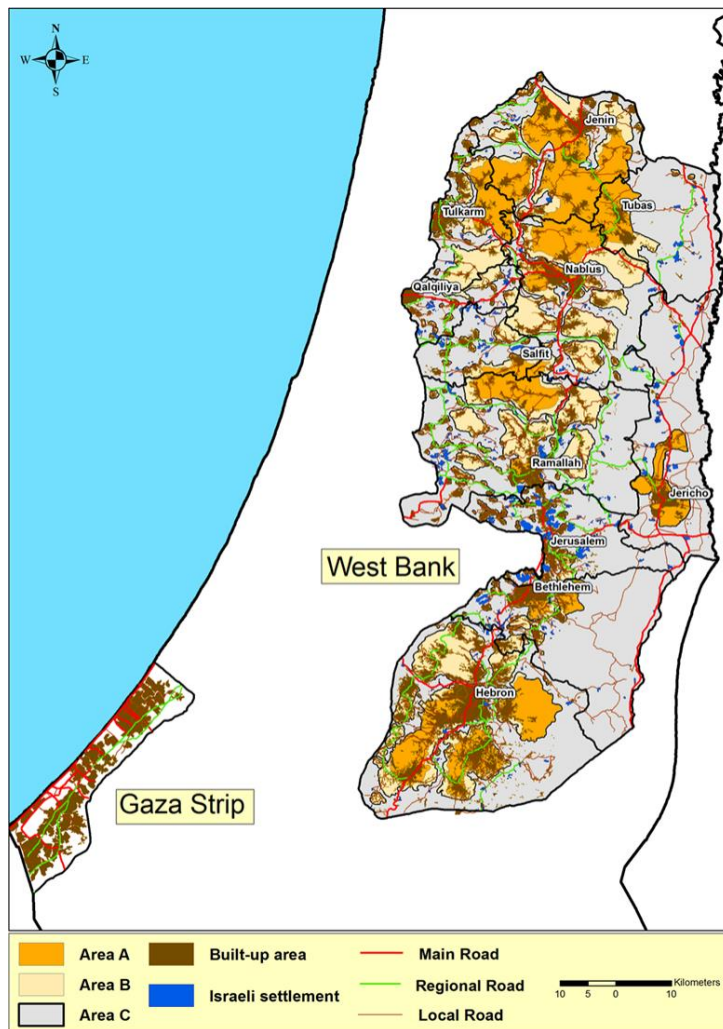


Fig. 1. Map of the West Bank and Gaza Strip.

By the end of 2017, about 4.78 million Palestinians were living in the Palestinian territories, of which 2.88 million in the West Bank and 1.89 million in Gaza Strip. The population is relatively young as nearly 47% are under the age of 17 years and only 5.2% are 60 years or older (PCBS, 2018).

Roads are classified into main, regional, and local roads, in addition to the bypass roads. The main roads link the major cities and connecting with the outside which are usually of two lanes and relatively with high traffic volume and speeds. The regional roads are the roads linking the nearby governorates of the West Bank and provide for intra-regional travel. The regional roads are two lane roads, and the traffic volumes are usually moderate with moderate speeds. The local roads provide access to the villages or connect the nearby villages, they carry lower traffic volumes and have lower speed, but they have the largest share among other class. They are usually two-lane and they include agricultural roads. The latter are sometimes unpaved roads and serve the agricultural areas.

The PCBS (2015) reported that the total length of the paved roads in the West Bank is 3,247 km, while in Gaza Strip, there is 297 km of paved roads. Table 2 shows the road lengths by class and region. According to the Ministry of Transport (MOT), 48% of the total roads and 56% of the local roads are deteriorated and in need for rehabilitation (MOT, 2015).

Table 2. Road network length by region and road class.

| Region | Main | Regional | Local | Total |
|------------|------|----------|-------|-------|
| West Bank | 657 | 1,127 | 1,463 | 3,247 |
| Gaza Strip | 76 | 122 | 99 | 297 |
| Total | 733 | 1,249 | 1,552 | 3,544 |

Source: PCBS, 2015.

Passenger transportation is divided into private and public transportation. Public transportation forms a basic component of the transportation system in the Palestinian territories. The public transportation modes are classified into buses, share-taxis, and taxis. The public transportation fleet is owned and operated by the private sector (individuals or firms). In addition, there is a limited illegal operation of private vehicles as shared-taxis or taxis.

The MOT is responsible for the vehicle inspection and licensing. It is also responsible for the regulation of freight and public transportation services. Every bus and shared-taxi is required to have a permit, which specifies the route on which it must operate. Almost no funds have been allocated by the PNA for the development of the public transportation facilities and no major developments in public transportation have been observed, as PNA has been focusing on physical infrastructure rather than on operations improvement and programs development (Abu-Eisheh et al., 2004). The statistics of the MOT (2016b) indicate that 38% of the vehicles are more than 10 years old (76% of those are private cars and 16% are commercial and trucks, while the rest are mainly public transportation vehicles). This indicates that there is high cost of the maintenance of these old vehicles which cause massive pollution.

When the West Bank and Gaza Strip were under Israeli occupation and until the establishment of the PNA in 1994, the Palestinians were buying their vehicles from Israeli dealerships or from the Israeli market of used vehicles. After 1994, the Palestinian private sector started direct imports from the international market, despite imposing some restrictions on that. The Palestinian vehicle import market developed from monopolistic to competitive supply structures.

The increase in the number of registered vehicles in the Palestine over the time period 1970-2015 is shown in Figure 2. It shows the general increasing trend in vehicle ownership over the period, during which many political and economical changes took place. In 2008, the ability of the Palestinian population for purchasing cars has been increased dramatically after an intensive campaign for the facilitation of bank loans to support purchasing cars. In 2016, the total registered vehicles in Palestine reached 294 thousand, including more than 26 thousand vehicles registered for first time. As was stated before, the average annual car growth rate for Palestine has reached 5.0% for the 1990 to 2015 period. However, the rate is increasing year after year, and reached 14.7% in 2016 (Abu-Eisheh et al., 2017).

The transportation sector has been a major source of revenue to the Palestinian authority. The sector contributed about 65 Million USD to the Palestinians treasury from vehicles registration fees and licenses of vehicles and drivers, in addition to the vehicles purchase tax revenue which reached 210 Million USD in 2016, representing 7.5% of all

purchase taxes on goods (MOT, 2016b). This is besides the fuel tax revenues, which reach 116% of the cost of the imported fuel, resulting in 679 million USD of revenues in 2016 (PCBS, 2017).

Before the PNA was established in 1994, all custom duties were collected by the Israeli authorities, but since 1994, vehicle customs and duties were set at up to 7%, while purchase tax reached 75%. All the cars would have additional 16% as an added value tax (VAT). Therefore, car prices in Palestine are considered among the highest in the region.

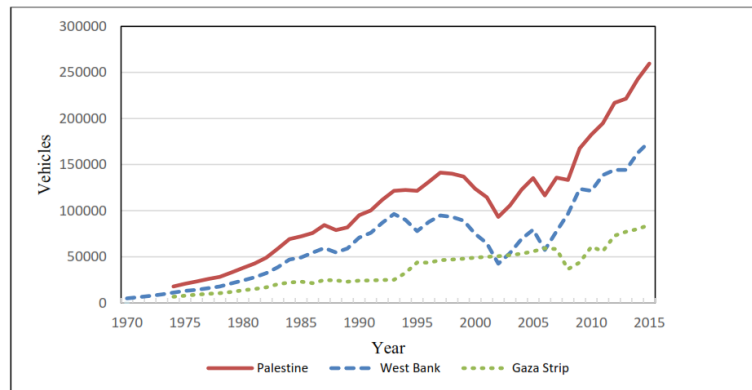


Fig. 2: Distribution of total registered vehicles in Palestine over the time period 1970-2015
Source: Abu-Eisheh et al., 2017.

In 2000, the PNA legislated the first and the only law in Palestine that is dedicated to traffic and transportation, which is Traffic Law No. 5. This law lacks some technical relevant aspects. The law does not also have any article that directly refers to environmental aspects, especially air pollution; however, Article 11 indicated that damaged vehicles or public vehicles older than 18 years from the date of manufacturing may not be registered. According to Article 15, inspection is required twice a year (instead on once a year) for the old vehicles, including public vehicles and buses, that are more than 10 years from the manufacturing date.

Until the MOT will prepare the revised traffic law and process it for the approval, the PNA had set and implemented a number of regulations during the past few years especially as related to vehicles licensing and importing. Starting in 2010, the customs were reduced for cars having engines below 2.0 liter to become 50% instead of 75% and kept as 75% for cars with engines greater than 2.0 liters, while the customs tax for environmental friendly vehicles were significantly reduced and became 10% for electric, 20% for Plug-in Hybrid Electric Vehicle (PHEV), and 30% for hybrid cars.

The international community led by the World Bank has been providing support to enhance the state of the infrastructure in the Palestinian territories. A strategy note was prepared by the World Bank (2007) in the intention to assist in directing the needed investment in the transportation sector wisely and in a way that ensures achieving sustainable development. However, no solid framework to achieve sustainable transportation was proposed.

In 2016, the MOT prepared the RTMP which was funded by the European Investment Bank to plan and develop the road and transportation sector, including the establishment of a corridor connecting the West Bank and Gaza Strip, which covers the period until 2045. The main objective of RTMP is to develop a vision for the future Palestinian transport sector and to leverage the potentials of transportation sector in contributing to the economic growth of the country and to respond to the increasing travel demand with a spatial, infrastructural, operational, legal, regulatory, and financial aspects. The RTMP was developed according to a phase-based strategy of four horizon years, and three different time-scenarios of short, medium and long terms were identified.

The RTMP includes all transportation modes, ranging from rail, road, air, maritime, freight, and public transportation. Demand for transportation considers multiple scenarios for demographic trends, consisting in varying rates in natural growth, the number of returning Palestinians and internal migration between Gaza Strip and West Bank. The RTMP objectives that could be related to sustainability included achieving a multimodal network leveraging the potentials of public transportation and non-road dependent modes of transportation, and proposing potential enhancements for the current institutional, legal and environmental protection instruments and setup. Despite

that the RTMP has set some strategies that help in achieving sustainable transportation, as presented below, these are not integrated within a comprehensive framework.

The RTMP consists of a series of actions, programs, priorities and projects. The most relevant strategies as related to the purpose of this research include development of the transportation infrastructure that considers, at specific, more attention to public transportation, including introducing new modes such as light rail, tramways, and BRT, and proposing policies for road network development in the context of sustainable urban development and land use. Other proposed strategies include improvement of road system interventions to allow a substantial amelioration of present road system through a number of actions such as those related to increasing the safety level on road network. In addition, strategies include strengthening the institutional and legal framework of the sector to be able to manage the implementation of the plan in areas such as promotion of environmental sustainable development regulations, sustainability of transportation services; and air and noise pollution.

3. Methodology

The methodology followed in this research considers SWOT analysis as the basis of the methodological approach for the development and formulation of the strategic planning framework to achieve sustainable transportation. The necessary data and information were obtained for the case study country specific indicators and statistical information, as well as through surveys and interviews. Therefore, qualitative/quantitative approaches were followed. Figure 3 illustrates the research methodology flowchart key features.

The mixed method of data collection was used. Creswell et al. (2003) defined the mixed method as a research approach using two methodologies in data collection; the qualitative and quantitative approaches. The former was related to the interviews with experts in the field of transportation, which aim to collect deep and detailed information about the sector to assist in the strategic assessment phase and to prepare the strategic planning framework for sustainable transportation in Palestine.

The quantitative approach is based on conducting a survey and analyzing the gathered information, and collection and analysis of relevant official statistical data. The survey required the design of a questionnaire, selecting the sample size and the distribution and analysis of a questionnaire which was handed to a sample of population, mainly car owners and drivers. The questionnaire contained questions related to the vehicles owners' perspective regarding their vehicles and transportation, and included obtaining information on their driving behaviors and patterns.

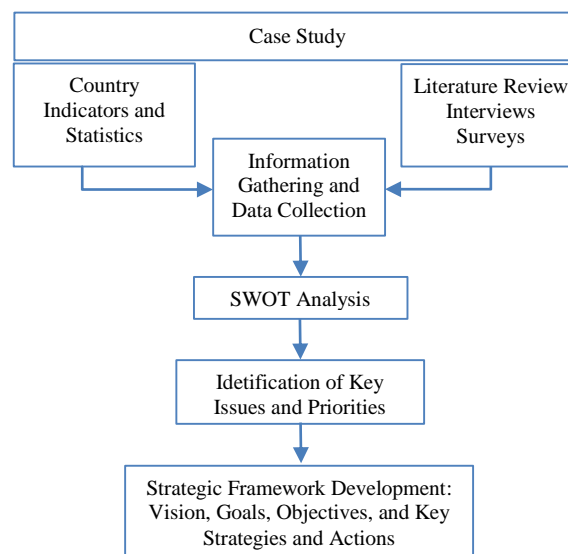


Fig. 3. Research methodology flowchart

After collection of the filled questionnaires, these were analyzed using the SPSS software. This allowed examining the correlation between the parameters. On the other hand, the methodology includes analysis of information from car registration reports and statistics obtained from the MOT and PCBS. The information collected from car registration reports and statistics were sorted and analyzed with respect to engine size and fuel type.

With consideration of the outcome of the analysis of the questionnaires and the interviews, SWOT strategic analysis approach was utilized in order to define the internal key factors (strengths and weaknesses), and external key factors (opportunities and threats), that could affect the sustainability of the transportation system, especially as related to vehicles, whether these fall in the political, environmental, social, legal, technological and economic domains.

The outcome of strategic analysis had assisted in the identification of the main influential relevant issues and in the prioritizing of these. This was conducted by the researchers benefiting from the outcome of the questionnaires analysis and the gained insight based on the interviews with experts in the field. Based on these identified key priority issues, the strategic framework could be developed.

Finally, the strategic framework for the achievement of a sustainable transportation system for the case study of Palestine was formulated. It included the re-formulated vision, the identified goals and objectives, as well as the corresponding strategies and proposed key actions. The time span of the framework was specified to be six years, corresponding with the national development agenda, which is being prepared for every six years. The resulting framework is envisaged to be a model that deserves to be considered when planning for sustainable transportation, especially considering the role of vehicles, in developing countries.

4. Results and Analysis

In this section, the results of the collected data and gathered information through the adopted survey and interview tools, beside the obtained statistical data, are presented hereafter, along with brief analysis.

4.1. Survey results and analysis

The main goal of the survey, conducted using a questionnaire, is to find, analyze and assess the role of vehicles and the opinions of the drivers as related to the sustainability of the transportation sector by obtaining data from a sample of the population. This facilitated the identification of the relations between relevant related variables, the analysis of the collected data statistically, and to draw general conclusions as related to the population with considerable accuracy.

The questionnaire was designed based on the potential key factors, as revealed from literature review, in order to gather relevant information. These include general socio-economic information on the respondents (such as their age, gender, household size, occupation and monthly income), their private car ownership related issues (such as make and year model of the car, fuel consumption, car price, taxes, registration fees, insurance fees, and car maintenance expenses), the knowledge, attitudes, and preferences of the respondents regarding transportation-related sustainability issues (such as the use of public transportation, and the relation between using cars traffic congestion, global warming, environmental pollution, methods of reducing fuel consumption).

The research population is specified to be the car owners and drivers. The study sample was chosen randomly and consists of 280 individuals. The confidence interval level is 95%, and the significance level set at 5%, the composition of the study sample varied in terms of governorate, place of residence, household size, occupation and monthly income. The statistical reliability was assessed which examines whether similar results are produced under consistent conditions.

The questionnaires were distributed in the vehicle inspection bureaus, MOT vehicle registration offices, and car showrooms. The survey was conducted during March to May 2017 through face-to-face approach. The collected filled surveys were examined for completeness and validity. Out of the 280 distributed questionnaires, 230 filled questionnaires were found to be valid, and therefore considered for analysis.

For achieving the study purpose, the data gathered from the valid questionnaires, were first input to the Statistical Package of Social Science (SPSS) software, and then were statistically processed.

The Cronbach's Alpha coefficient test was conducted to analyze the reliability of questionnaires. The results showed a coefficient of 0.87, and this result is considered to be acceptable for the study purposes. Next, descriptive

statistical analysis was conducted to find the frequencies and percentiles to describe the research data (sample size, mean, minimum, maximum, standard deviation, and variance) and to investigate correlations among variables.

A summary of some key results is highlighted here. As for the knowledge, behaviour, attitudes, and preferences of the respondents regarding transportation-related sustainability issues, 62% of the respondents indicated that they have eco-driving feature in their cars, but of these, 78% use such feature. About 58% of the respondents share their cars with others. On the other hand, about 70% support large-scale use of public transportation inside urban areas, but only 51% are willing to use it extensively instead of using the car. Regarding fuel consumption, 66% indicated that they monitor this periodically, while those who care to minimize their fuel consumption reached 84%. About 79% of the respondents indicated that the use of cars increases global warming, while 85% know that using efficient car results in less fuel consumption and less pollution?

The results of the analysis formed a valuable insight to the respondents' knowledge, opinions, and preferences as related to cars and issues concerning sustainability. These were used later in the SWOT analysis.

4.2. Interviews analysis

The interviews form a key constituent in information gathering. The interview questions were formulated to get opinion of the subject experts on the matters related to the research topic. The interviews protocol consists of nineteen questions, which were prepared and individually asked to the experts. They included questions on the current status and the expectation of future development for transportation sector especially as related to sustainability, and the challenges and obstacles faced in this regard, and their suggestions and recommendations to achieve sustainable transportation.

The interviews were conducted with 13 interviewees who are considered as representatives of the MOT (5), Ministry of Finance and Planning (3), Palestinian Energy Authority (1), academics (2), and industry experts (2). Each interview lasted for about 40-45 minutes. The interviews followed the semi-structured style. Thematic analysis was used to analyze the outcome of these interviews. This approach is a qualitative approach and its relevance comes from its flexibility that allowed the researcher to identify the importance of particular topics and to explore the research questions, thus allowing to focus on the relevant issues and get the expert opinions on analyzing the key issues and dealing with them (Clarke and Braun, 2014).

The thematic analysis of the outcomes of the interviews indicated that there is consensus that there must be policies and strategies to support having environment friendly vehicles, as there is currently no clear vision or enough fiscal incentives for owning cleaner vehicles. The interviewees also indicated that there will be certainly positive impacts on the transportation system once there are adopted supportive policies and implemented relevant strategies by reducing the overall expenditure on cars and the negative effects on the environment, but they expressed concerns on the limitations of the supply of electricity, as the vast majority of the electricity is imported from the Israeli sources, and as there are currently deficits in the satisfaction of the electric demand. They also stressed on the relevance of subsidizing public transportation by the government.

The major outcomes of the interviews were utilized in conducting SWOT analysis and in deriving the strategic framework to achieve sustainable transportation.

4.3. Statistical data analysis

In 2016, private cars formed 78% of the total registered vehicles, trucks formed 8%, other commercial vehicles formed 7%, taxis and buses formed 5%, and others (including trailers, motorcycles, etc.) formed 2%. The average number of vehicles in Palestine was 61 per 1000 persons in 2016 (PCBS, 2017). Despite the low level of ownership of vehicles, there is an increasingly high vehicle growth rate in Palestine, especially as related to cars, which reached an average annual rate of 5.0% for the past 25 years as indicated before.

Regarding vehicle age, the available statistics show that the share of licensed vehicles in the West Bank that have an age of 10 years or more is 40% (MOT, 2016). As for the fuel used, the relative distribution of licensed vehicles by fuel type (published only for the West Bank), shows that about 50% of the vehicles are fueled by diesel, while there are 49% of the vehicles fueled by petrol, while the rest is by other types; however, the consumption of diesel is much higher than that of petrol, with a ratio of 3:1, mainly due to the fact that all the public transportation vehicles (including

shared-taxis) and the commercial vehicles are fueled by diesel (MOT, 2016). Figure 4 illustrates the relative distribution of the vehicles by the year of production (referring to age) and fuel type. The presence of such high share of old vehicles indicates low vehicle efficiency, while the high share of diesel consumption, compared with that of petrol, indicates high negative impacts on the health and environment in terms of emitting more particulate matters and nitrogen oxides.

Road transportation accounts for about 45% of the overall energy consumed in the Palestine (PCBS, 2017). The transportation sector was responsible for the largest share of energy demand of any sector of the Palestinian economy in 2016, accounting for 32 thousand Tera joule. In terms of in physical units, statistics for 2016 shows that the sector consumed 624 million liter of diesel, 304 million liter of petrol, and 5.2 ton of LPG. The estimated cost of imports of oil products for the transportation sector was 1,265 million USD (PCBS, 2017). It had to be stated that the cost of energy, including that consumed in the transportation sector, is very high compared with the respective costs (in terms of unit prices) in the region and even worldwide.

The transportation sector was responsible for the largest share of energy-related CO₂ emissions, compared with any other sector of the economy, accounting for 35% (12.6 million ton of CO₂ Equivalent) (PCBS, 2016b). This indicates that the mean emissions per capita in Palestine are approximately 1.014 tons of CO₂ Equivalent, which is generally low compared with many other countries, but it is expected to significantly rise due to the high annual rate of increase of vehicle ownership.

The overall rise of emissions in Palestine is mainly due to the increasing population, economic activities, as well as vehicle ownership, and the related increase in transportation activity causing increasing energy consumption. Within the energy sector, the transport sector contributes to about three quarters of GHG emissions (73%) of all the energy sector emissions.

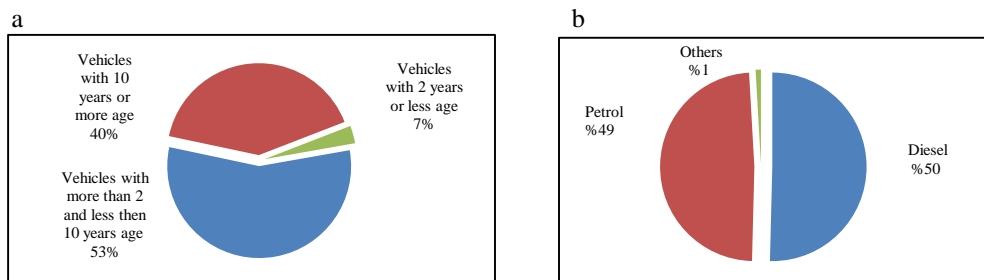


Fig. 4. (a) distribution of vehicle age; (b) distribution of vehicle fuel type.

In 2016, the number of reported deaths in Palestine was 10,940; with cancer as the second leading cause of death forming 14.0% of the total reported deaths, with a slight increase from 2015. The first cause of cancer deaths was lung cancer (MOH, 2017), and vehicles emissions and pollution could be of the main sources of those deaths due to the aged vehicles running on the roads causing increased rates of congestion and the associated pollution.

5. Strategic Assessment

5.1. Conducting SWOT analysis

The conducted SWOT analysis had resulted in identifying the strategic issues, which are a function of both the internal and external environments that affect the sustainability of road transportation, especially as related to vehicles. The analysis has showed that there are internal strengths which need to build on and opportunities that need to benefit the most from. On the other hand, the analysis shows that there are weaknesses that need to deal with, and also threats that need to minimize their impact on the sustainability of the transportation sector. Such analysis provides a good basis for successful strategy formulation.

SWOT analysis is conducted based on the following:

- Understanding international experience in strategic planning and best related implemented practices.
- Analysis of the current situation of the transportation sector in the country, especially as related to the role of vehicles.
- Analysis of the questionnaire results.
- Analysis of the outcome of the interviews.

Based on this, the strengths and weaknesses, in addition to the opportunities and threats, are identified. Strengths are identified as the main positive factors, which constitute the most powerful internal elements and provide support for the mission to be accomplished. Weaknesses constitute the main negative internal factors, which, if not overcome, will prevent the mission from being accomplished. Opportunities are the elements that can appear in the environment without any possibility of affecting their appearance, but it is possible to make use of them if correct action is taken in this direction. Threats are environmental factors that could not be affected, prevented or provoked, but if happen, they can affect the functioning of the system and make mission accomplishment difficult or impossible. The results of the conducted SWOT analysis are illustrated in Table 4.

5.2. Identification of key influential factors

Key issues that need to be addressed in the intent to have a sustainable transport sector have been identified through the conducted SWOT analysis. These issues have been classified under economic, system/organizational, technological/modal, behavioral, and legislative factors. Samples of these key influential factors are illustrated hereafter.

For economic and financial factors, it has to be indicated that very little financial resources have been allocated in recent years for financing the transportation sector, including public transportation, beyond the operations of the MOT and the basic maintenance and rehabilitation as well as operational expenses of the road infrastructure. However, there has been recently revised purchase tax system favoring clean vehicles, which reduces the governmental financial revenues. It is therefore essential that such preferential tax system is to be maintained for the success of the strategic direction towards sustainable transportation. The economic and financial issues need to be well addressed by the PNA.

System and organizational key factors include improper institutional capacity and the lack of definition of responsibilities and duties. One of the areas where this can be shown is that related to disarrayed public transportation. This sector is totally owned and operated by the private sector, with no proper support, control, or regulation.

Moreover, and despite that the transportation sector is one of the most income generating sectors contributing to the government revenues, limited attention have been given to the planning for systematic maintenance of the infrastructure. The dominating poor conditions of the road network are causing significant increase in vehicles operational and maintenance costs.

As for the technological/modal key factors, which are mainly related to the vehicles, there are external factors that affect the rapid global trend for advancement related to the production of affordable clean engines, which could be a good opportunity towards promoting vehicles with such engines in the developing countries. In addition, there are internal relevant factors such as the growing attention and competency to adopt the engines with traditional fuels towards being powered by LPG.

The transportation system users' behavioral factors have been identified based on the survey results. These form a key component in any clean sustainable transportation system, as behavioral changes and willingness to shift in mode use and to depend more on active transportation are basic issues in this regard, which are also related to proper education and awareness. Many of the respondents are willing to switch to sustainability practices once given the proper training. Many of the drivers are not aware of the proper behavior for efficient fuel-saving driving. There is a growing trend and preference to towards more use of the existing public transportation modes, if better organized and modernized, or to shift to use new public transportation modes which are being considered to be introduced in Palestine, such as the BRT and the tram/light rail alternative modes.

Finally, the legislative key factors include the potential for the completion of the revised Traffic Law and the new regulations and legislations under preparation, which are concerning sustainable transportation and the introduction of the vehicles technologies.

Table 4. Summary of the results of SWOT analysis regarding sustainability of the transportation sector in the case study of Palestine.

| Strengths | Weaknesses |
|--|---|
| <ul style="list-style-type: none"> • The current governmental support policies for clean vehicles through adoption of preferential tax system • The willingness to support and use reliable public transportation by the citizens • Stock of available transportation sector infrastructure, especially roads, that can be further developed and rehabilitated for the benefit of the sector • The high contribution of the transportation sector and vehicles importation to the government income from registration and license fees, purchase taxes, and customs • The availability of relatively good experience to develop the transportation sector by relevant ministries • The availability of recent studies and plans to promote public transportation and roads infrastructure • The growing interest of the national and local authorities to develop the infrastructure of the transportation sector and renew their fleet for efficient and economy vehicles | <ul style="list-style-type: none"> • The Traffic Law that regulates the transportation sector lacks consideration of sustainability issues • The transportation infrastructure is poor with considerable portions of deteriorating road network and infrastructure and limited control • Public transportation management and regulation are in disarray • There are no clear responsibilities and roles • Road traffic safety record is poor • Slow development and scattered activities by the MOT towards the sustainability of transportation sector • Insufficient institutional capacity building on the environmental aspects of transportation • The lack of attractiveness of mass transit in its present state • The continued implementation of improper and outdated policy instruments • No proper control against vehicles exceeding the permitted levels of pollutants • There is no public awareness programs on issues relevant to sustainable transportation and the role of vehicles in this regard • No regulations for the process of accommodating engines for the use of alternative fuels, such as LPG and CNG, which is being recently introduced in Palestine by informal workshops |
| Opportunities | Threats |
| <ul style="list-style-type: none"> • The international desire to support the emerging Palestinian State • There is a rapidly growing global trend towards production of new clean vehicles technologies • The global trend from donors to support and finance green and clean initiatives • The growing attention of foreign investors to invest in the Palestinian transportation system • The increasing investment trend towards alternative fuel technologies • New regulations and legislations, as well as the revised Traffic Law being prepared, concerning sustainable transportation and the introduction of the vehicles technologies • The Environment Quality Authority (EQA) in Palestine is promoting the preparation for the Environmental Impact Assessment studies to developmental projects • The establishment of new institutions and NGOs, such as the Association of Energy Engineers and the Higher Council of Green Buildings, that are concerned with protecting the environment • The willingness for improvement in the capacity of the relevant ministries and official institutions and the potential to consider environment and sustainability related issues and impacts | <ul style="list-style-type: none"> • No Palestinian control over the vehicles and spare parts imported via Israeli ports • The restrictions on the Palestinians private sector causing inability to import vehicles that are not imported before by Israeli dealers • The political situation negative effects on the donor's financial aid and on the economic growth • The dependence on the fluctuating external support and funding for economic growth which hinders proper planning • The relatively high monetary cost of implementing clean transportation policies and climate change adaptation actions • The expected resistance by a wide share of the population to change their life style for the environmental aspects, which would continue the trend of increasing car ownership and its related pollution to the environment |

6. Development of the Framework for Strategic Planning for Sustainable Transportation

The proposed framework for strategic planning for sustainable transportation in Palestine is briefly presented here. Based on the SWOT analysis and the identification on key relevant issues and priorities, the framework is developed. The strategic framework formulation implies developing the vision, as well as the goals and objectives, all based on the results of the strategic assessment, and then identifying the strategies, and proposing the actions which are to be adopted and implemented. Figure 5 illustrates these strategic framework components.

Before presenting the strategies and related actions, the vision, the goals, and the objectives are presented first. After that, a brief illustration is provided for the general framework, which is followed by a more detailed presentation of relevant strategies and actions for one of the fields, which is related to the role of vehicles/modes in achieving sustainability.

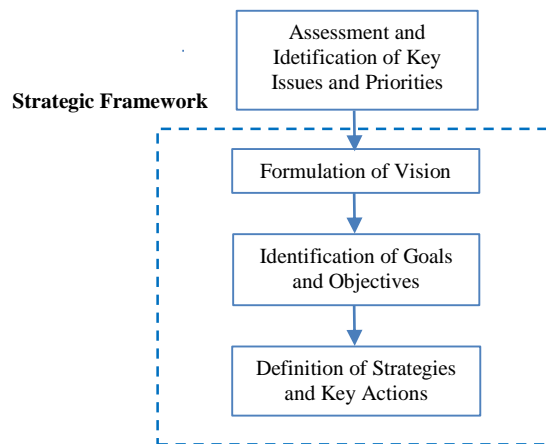


Fig. 5. The strategic framework components

6.1. Derivation of the vision

The development of the vision statement is the first step in the strategic planning formulation process. The vision is also used to describe the future overall aim. The currently formulated MOT’s vision states “Apply the excellence standards in transportation to regulate, develop, and provide the services with high quality to contribute to the development and sustainability of the Palestinian economy” (MOT, 2016a).

The MOT vision, although mentions sustainability in its formulation, it is incomplete and needs to be revised, as it is missing to include safety and the provision of multi-modal aspects of transportation. Based on the SWOT analysis, and in consultation with the MOT, the proposed modified vision for better consideration of sustainable transportation in Palestine is re-formulated to be “Apply the excellence standards to regulate, develop and provide an affordable, integrated, safe, and sustainable multi-modal transportation system, that contributes to the development of Palestinian economy and well-being of the society”.

6.2. Identification of goals and objectives

Considering the key issues and priorities defined as a result of SWOT analysis, the re-formulated vision statement, the strategic goals and objectives towards achieving a sustainable transportation system are then defined. The goals are considered as the backbone of the strategic planning and formulation process and could be inspired to turn the vision into an achievable aim. The following are the identified sustainable transport strategic goals:

- Achieved efficient transportation sector
- Achieved safe transportation system
- Updated regulatory and legislative framework to include the achievement of the clean and sustainable transportation system
- Raised public awareness and delivered better training
- Provided highly efficient and effective technological and modal solutions

As indicated before, for one of these goals, the proposed strategies and actions are presented in more details. The strategic goal associated with providing highly efficient and effective technological and modal solutions, which is considered as one of the most important sustainability-aimed goals transportation sector for the developing countries, is presented hereafter.

This strategic goal considers various relevant vehicle and mode related issues. These fall into major categories of promoting cleaner vehicles and encouraging public and active transportation modes. The following objectives are proposed in order to achieve this strategic goal:

- Objective 1: Achieved transportation system efficiency
- Objective 2: Supported non-motorized modes solutions
- Objective 3: Promoted sustainability-oriented vehicle technological strategies

Different strategies could be used in order to reduce the effect of the high growth in the number of registered vehicles on the streets, and consequently reduce traffic congestion and the associated environmental impact. Those strategies and the related actions are summarized hereafter.

6.3. Formulation of strategies and actions

In this research, and for one of the goals, which is associated with the role of vehicles, a presentation of strategies that define the overall approaches and the related proposed actions to be implemented are presented hereafter.

The proposed strategies include transportation system/organizational strategies, economic/financial strategies, user education, awareness, and behavior strategies, and vehicle-oriented technological/modal strategies, along with the governing strategies concerning the regulatory aspects. These are articulated within an integrated framework considering the approach of Banister (2011), in order to shift towards sustainable transportation, which is arguably requires a holistic strategy that combined the identified strategies into three potential broad strategies; Avoid-Shift-Improve (ASI) strategies. Figure 6 shows the ASI approach according to the GIZ (2015).

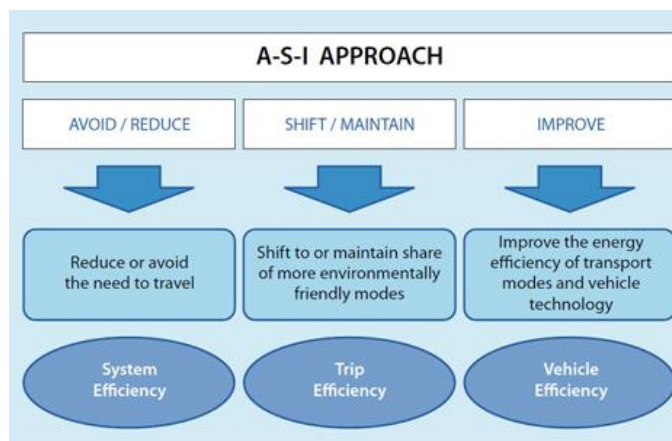


Fig. 6. Avoid-Shift-Improve (ASI) strategies.
Source: GIZ (2015)

The proposed strategies to be adopted in order to achieve sustainable transportation in Palestine, as categorized considering the ASI approach, can be seen on the three different levels; the transportation system (system efficiency) falling under the "Avoid" strategies, the trips (travel efficiency) falling under the "Shift" strategies, and individual vehicles (vehicle efficiency) falling under the "Improve" strategies. These are briefly introduced hereafter.

Strategy 1: "Avoid" Strategies

Efficient transportation systems need to be encouraged. The proposed relevant actions under this strategy include develop multimodal networks which optimize the use of transport resources and by introduction of new traffic management technologies, and thus reducing the demand for transportation, support the development of low carbon modes of transportation to reduce energy consumption in the transport sector, develop logistics services and new technologies to reduce the need to travel, and employ e-communication options including mobile phone use. These

also include encourage teleworking, flexible work, and staggered work shift programs, and establish incentive systems to support the use sustainable modes of transportation, such as car pools and van pools.

Other actions are encouraged under this general "Avoid" strategy, which are characterized as adopting intelligent transportation systems (ITS). The actions proposed here are part of the advanced technological approaches for achieving sustainability of the transportation systems, in order to better manage and control the traffic systems, and thus to reduce their negative environmental consequences. The actions proposed in this regard include design and implement ITS which used advanced technology to predict traffic congestion, among others, and provide alternative routing instructions to vehicles in real time to improve the efficiency of the road network, thus reducing fuel consumption and the environmental impacts. In addition, it is proposed to implement advanced vehicle control and safety systems, which enhance driver's control of the vehicle to make travel both safer and more efficient, which range from collision warning systems to auxiliary-driving cars.

Strategy 2: "Shift" Strategies

Proper actions under this strategy, which are related to travel efficiency, are proposed to include promote shift of demand to more energy efficient modes of transport, like public transport and non-motorized modes to reduce energy consumption per trip, and introduce policy measures such as internalizing external costs through pricing instruments shift to more efficient modes.

Promotion of non-motorized modes (i.e., walking and cycling) could be a sustainable alternative of car transportation. The actions that are proposed to achieve this include implement pedestrian areas and auto-free zones in city centers, design the roads networks with appropriate of bike lanes where appropriate, implement a traffic education of children and school students for proper walking and safety practices, and give priority access to pedestrians and cyclists over vehicles across the cities.

Strategy 3: "Improve" Strategies

Actions under this strategy, which are related to vehicle efficiency, are proposed to include promote and apply energy efficient technologies, operational practices and standards, and efficient driving techniques, promote smaller engines and smaller size of vehicles, and promote efficient engines, and the use of new fuel alternatives.

Actions related to the deployment of fuel-efficient vehicles would lead to less generated emissions. Such actions that are proposed to achieve this strategy include implement measures that affect the amount of fuel used and the GHGs emissions, encourage using the eco-driving modes, support the purchasing of small-engine vehicles, promote cleaner fuels such as biofuels which produce much less emissions, and other alternative fuels including natural gas. It's to be noted that biodiesel can be used in any diesel engine without modification while other fuel types, such as ethanol, gas, or hydrogen, can be used only in specially-produced or modified car engines.

Actions related to the deployment of advanced technology concentrate on cars, buses, and trucks with advanced engines, which would produce fewer emissions than their conventional counterparts. Such actions include promote electric (fuel-cell, battery, or plug-in), hybrid or PHEV cars, which are attractive for use in urban areas, promote and facilitate investment in the charging stations for these cars, with potential production of electricity for the charging stations from the photovoltaic systems in order to reduce the load on the utility grid, and obligate the municipal and governmental authorities to have a plan to replace their service utility vehicles with small engine and fuel-efficient vehicles.

Under the "Improve" strategies fall the actions that are related to implement potential related pricing mechanisms. The adoption and implementation of pricing mechanisms are generally considered to be more effective than the regulatory approaches, because they offer car users more choices and can be adjusted according to different conditions. Such actions include to base the fuel taxes and purchase tax on vehicle emissions.

Finally, other actions under the "Improve" strategy include those which are oriented towards enhancing vehicles fleet management and encourage their renewal. Actions in this regard include to set and implement a subsidization/tax incentive scheme for the renewal of the for-hire fleet, buses, taxis, rental cars, delivery vehicles, and trucks.

7. Conclusions and Recommendations

7.1. Conclusions

This research considered dealing with the challenges of the energy and environmental consequences of the transportation sector resulting from the mounting rates of increase of vehicle ownership in developing countries. It presented the approach followed in one of these countries, Palestine, to formulate a strategic framework that will guide the efforts to assist in achieving the goal of having sustainable transportation. The framework was formulated based on SWOT strategic analysis which utilized the results of field surveys, interviews with experts and decision makers, as well as vehicle related statistical data analysis. Based on that, the key relevant factors were defined. Consequently, the strategic vision, goals, objectives, strategies and related actions were identified to form together the sustainable transportation strategic framework.

The governments' institutional arrangements, policies, and regulatory frameworks were found to be of vital importance in leading towards sustainable transportation, through coordinating national transportation activities with clear responsibilities, introducing incentive measures, disseminating best practices, and establishing partnerships with key stakeholders. It is to be emphasized that the transportation sector taxes, customs and duties, including those of fuels, form a considerable share of generated revenues to the government, thus it would be challenging to reduce such income by having tax-reduction incentives related new technologies and alternate fuels.

The surveys showed that there is lack of awareness about the efficient use of vehicles and fuel consumption reduction practices. On the other hand, there is a clear desire among people to support strategies that would assist in achieving sustainable transportation system, such as use of relevant technologies and use of the public transportation, once it is upgraded, secure, sustainable, and reliable.

The research identified the basic sustainable transportation characteristics and highlights specified goals, objectives, strategies, and proposed actions to achieve sustainable transportation in the example of Palestine. These identified strategies could help the decision makers, the institutions, and the developers, to adopt the resulting framework.

7.2. Recommendations

Based on the findings of this research, there are proposed recommendations in order to facilitate achieving a sustainable transportation system in Palestine, which could be considered for other developing countries. These recommendations are associated with the proposed strategies and actions that were derived to arrive at the formulated goals and objectives related to achieving sustainable transportation. It has to be stated that despite many developing countries have prepared transportation master plans or national developmental plans with transportation components, there is still need to supplement these plans and integrate with them sustainable transportation planning strategies.

It is strongly recommended to adopt the proposed strategic framework after proper debate with the relevant key stakeholders that have to be engaged in the detailed strategy development and action plan implementation. Proper adaptation on the country level of the general framework of the "Avoid-Shift-Improve" strategies is recommended. Therefore, it is recommended to embark on the identification of proper applicable measures and setting action plans to implement these. Special attention can be given to vehicle-oriented measures that fall under the "Improve" strategies which were proposed to include encouraging fuel efficiency and alternative fuel and devising regulations related to emissions, and implementing tax related incentives and measures. Attention also need to be given to measures that fall under the "Avoid" strategies, which need to be integrated also with the educational, awareness, and behavioral related measures for driver and passengers, which fall under the "Shift" strategies.

Proper supportive organizational and regulatory government frameworks to promote effective sustainable transportation are recommended. Clear responsibilities and roles of the involved actors in this regard need to be defined and coordinated. In addition, the regulations need to be created or updated to support achieving the identified goals and objectives.

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