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Sustainable Urban Mobility in Istanbul: Transition and Planning

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ABSTRACT

Sustainable urban mobility reduces environmental impacts, promotes social equity, and increases economic efficiency. This paradigm aims to improve the long-term quality of life of individuals, communities, and cities. Urban mobility in Istanbul is on the way to becoming more sustainable with plans and projects undertaken; however, there are still issues such as poor air quality, worsening traffic density, noise, and inefficient public transport. The inadequacy of existing public transport systems in the city causes many people to use private vehicles, which increases problems such as traffic congestion and environmental pollution. This paper presents an overview of the state of sustainable urban mobility in Istanbul regarding its transition management and planning. An overview of key planning changes and transport projects and key challenges must be addressed to achieve sustainable urban mobility.

1. Introduction

With its unique geographical location, historical and cultural heritage, Istanbul stands out as one of the most important cities of both Turkey and the world. This metropolis has become a large urban conglomeration with a population exceeding 15 million [1]. However, this rapid population growth and urbanisation process puts great pressure on Istanbul's transport infrastructure and makes the necessity of a sustainable urban mobility system even more evident.

Sustainable urban mobility concept aims to reduce environmental impacts, promote social equity and accessibility as well as increasing economic efficiency. One of the key aims of sustainable urban mobility to improve the long-term quality of life of not only individuals, but also communities and cities. Sustainable urban mobility has become more important today with increasing environmental awareness. Development of low or zero carbon transport alternatives, increase of the modal share for public transport, and having more bike lanes are some examples of sustainable urban mobility schemes [2].

Urban mobility in Istanbul has a rich variety of different modes including metro, bus, tram, ferries, and suburban rail services, and the railway network which includes metro and trams is shown in

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Figure 1. However, this diversity also brings with it some difficulties. For example, environmental problems such as traffic density, air pollution and noise make it difficult to create a sustainable urban mobility system. The inadequacy of existing public transport capacity in the city leads to modal shift towards private vehicles, which increases problems such as traffic congestion and environmental pollution. With the growing population of Istanbul, these problems become even more complex [3, 4].

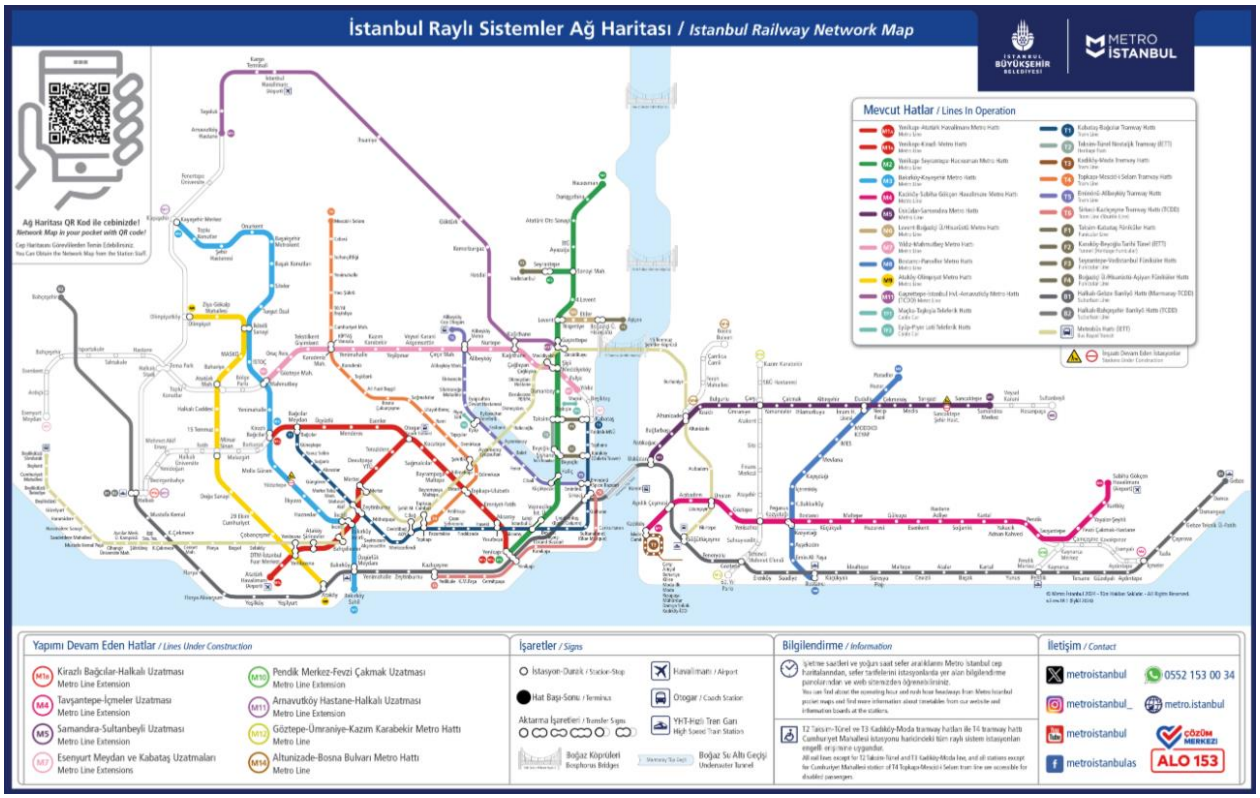

Fig. 1. Istanbul railway network map (https://www.metro.istanbul/en/YolcuHizmetleri/AgHaritalari)

Istanbul's geographical layout and topography also adds to difficulties in transition to sustainable urban mobility. Natural obstacles in and around the Bosphorus, which separates the European and Asian sides of the city, make planning public transport lines such as metros difficult and limit the effectiveness of the current transport system in terms of capacity provision. However, despite all these difficulties, the potential for sustainable urban mobility in Istanbul is quite promising. In recent years, the local government, Istanbul Metropolitan Municipality (IMM), has taken various steps to develop a sustainable urban mobility paradigm. IMM issued a sustainable urban mobility plan (SUMP) in 2022 for Istanbul, setting out key policies for achieving sustainability [5]. Projects such as increasing bicycle lanes and paths, encouraging the use of electric vehicles as well as buses and integrating public transport modes, particularly metro lines and bus routes, support the sustainability objectives in Istanbul's urban mobility policies.

In this paper, the current status, challenges and future potential of sustainable urban mobility in Istanbul will be discussed. An overview of the state of sustainable urban mobility in Istanbul, in terms of its transition management and planning, is given together with key planning changes and transport projects to achieve a sustainable urban mobility.

2. Sustainable Urban Mobility Paradigm

The concept of sustainable urban mobility helps cities design and manage transport systems based on environmental, social and economic sustainability principles. This concept aims not only to increase the efficiency of urban mobility systems but also to ensure that all segments of society benefit from urban mobility opportunities in an equitable and fair way. The basic principles of sustainable mobility include low carbon emissions, energy efficiency, social equity and environmental protection [6]. Although there has been a recent rise in zero or low carbon transport options such as electric, hydrogen fuel-cell, hybrid, etc. there are still a sizeable amount of fossil fuel-based transport vehicles in cities leading to high carbon emissions. Sustainable urban mobility encourages the use of alternative energy sources. For example, the spread of low-emission alternatives such as electric vehicles, bicycles and public transportation systems make significant contributions to reducing environmental impacts. Such transport solutions help improve the air quality of cities, while also contributing to the fight against climate change [7].

Another key element of sustainable urban mobility is social equity. Every individual should have access to urban transport services irrespective of the geographical conditions and socio-economic status of the place where they live. Therefore, the needs of vulnerable and disadvantaged segments of the society should be given consideration, and priority where necessary, when planning transport systems. Urban transport systems should be designed to increase access to opportunities for social groups such as the elderly, the disabled and low-income individuals. This not only ensures accessibility of urban mobility services, but also increases social engagement and participation [8].

Sustainable urban mobility also plays an important role in economic efficiency. Efficient urban mobility systems enable goods and services to be transported faster and at lower cost. This supports trade and economic growth, while also increasing labour efficiency and productivity. For example, a well-planned urban mobility system enables individuals to reach their workplaces more quickly and efficiently, increasing overall economic productivity [9]. On the other hand, in order to successfully implement sustainable urban mobility aims, local and national governments, the private transport operators and society should work together and develop collaborative engagement. It is important for local governments to invest in infrastructure projects that support sustainable urban mobility policies, to raise public awareness and to organise educational programs to encourage the public to adopt these policies. Furthermore, the integration of smart technologies is necessary to increase the efficiency of urban mobility systems. Smart transport systems optimise passenger information, regulate traffic flow and provide a better experience for passengers [10].

Sustainable urban mobility paradigm combines various key sustainability elements such as environmental protection, social justice and economic efficiency. This approach is critical to meeting the future transport needs of cities and, therefore, needs to be effectively implemented in large metropolises such as Istanbul.

3. Urban Transport Network and Infrastructure in Istanbul: An Overview

In addition to being Turkey's largest and most populous city, Istanbul has been an important transport hub throughout its history. Since the city has a complex geographical and topographical structure with the Bosphorus separating the European and Asian sides, the development of a resilient urban transport infrastructure has required a challenging process. Today, Istanbul's urban transport infrastructure spans three main areas: land, sea and air. Key mobility modes include metro, bus, bus

rapid transit (BRT), tram, light rail, ferry, minibus, and suburban rail (Marmaray). Although this diversity increases mobility within the city, it also brings with it some challenges.

In terms of land transport, Istanbul has an extensive bus and minibus network. Public bus routes operated by IETT, Istanbul's public bus authority, have a wide coverage area throughout the city. However, this system often provides a troublesome experience due to traffic congestion, density, and crowding. According to 2022 data, more than 3.3 daily trips were made by buses in Istanbul, including 800,000 daily BRT trips, and this rose to 3.7 million daily trips in 2023 [11]. The BRT (Metrobus) system has become a key part of Istanbul's urban mobility, and Figure 2 shows how the BRT (Metrobus) lies on the critical East-West axis of Istanbul.

Fig. 2. Istanbul BRT (Metrobus) system on Istanbul Map

Increasing integration of rail systems (metro, tram, light rail, and suburban rail) with the bus and minibus network over the years has increased the accessibility of urban opportunities. In particular, the expansion of the metro system has increased passenger capacity and reduced environmental impacts. Metro Istanbul, the urban metro operator of Istanbul, currently operates 241.35 km of metro network with 18 lines serving more than 3 million passengers daily. Overall rail network, including the suburban rail lines operated by Turkish State Railways Transport (TCDD), has reached 380.70 km as of 2024 [12].

Maritime transport is also an important element of Istanbul's urban mobility system. The city has a maritime transport system with sea buses and ferries serving both European and Asian coastlines. This system specifically reduces traffic congestion and offers passengers an alternative transport option. However, the effectiveness of sea transport may vary depending on weather conditions. Currently, urban maritime transport makes up only 4% of overall modal share [13]. Although, there have been efforts by the city management to increase this rate, with new ferry lines opened across the Marmara Sea and Bosphorus, there is still a wide gap between what has been achieved and the target for modal share, which is 10%.

Another important element in Istanbul's transport infrastructure, impacting its urban mobility system, is air transport. Istanbul Airport has become an important transport hub in global air transport, which strengthens the city's international connections. New metro lines M11, U1 & U2, connecting Istanbul Airport with the city's urban mobility network have also strengthened the capacity of urban transport. Despite the increasing connectivity and capacity of the urban transport network, Istanbul's urban mobility faces many challenges due to its complex structure and high

demand. However, these problems can be overcome by improving existing systems and integrating sustainable urban mobility options.

4. Sustainable Urban Mobility in Istanbul: Key Developments & Challenges

Sustainable urban mobility schemes in Istanbul have been developed to both reduce environmental impacts and ensure equity. In recent years, the city administration and non-governmental organizations have taken important steps with various projects. The development of a sustainable urban mobility plan (SUMP) has been the most significant of these projects [5]. The SUMP has provided a framework to streamline the sustainable urban mobility schemes in Istanbul. To better understand these schemes, it is important to focus specifically on projects such as enhancing public transport systems, the integration of electric vehicles, cycle lanes & paths, and pedestrianisation. With respect to sustainable urban mobility, Figure 3 shows the critical projects for 'the transition to low carbon' theme and Figure 4 shows the critical projects for 'reducing traffic congestion' theme in the Istanbul SUMP report.

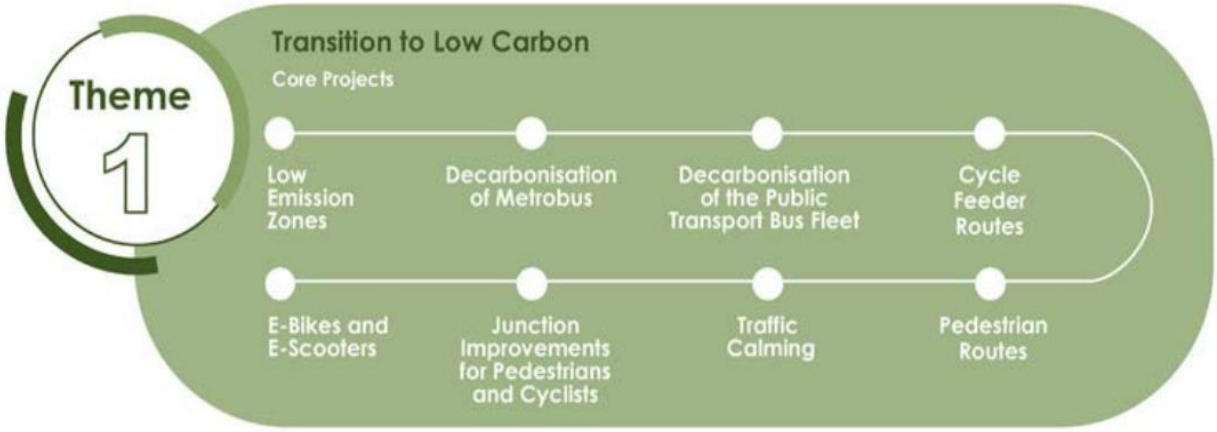

Fig. 3. Istanbul SUMP Report: Projects for the 'Transition to Low Carbon' Theme [5]

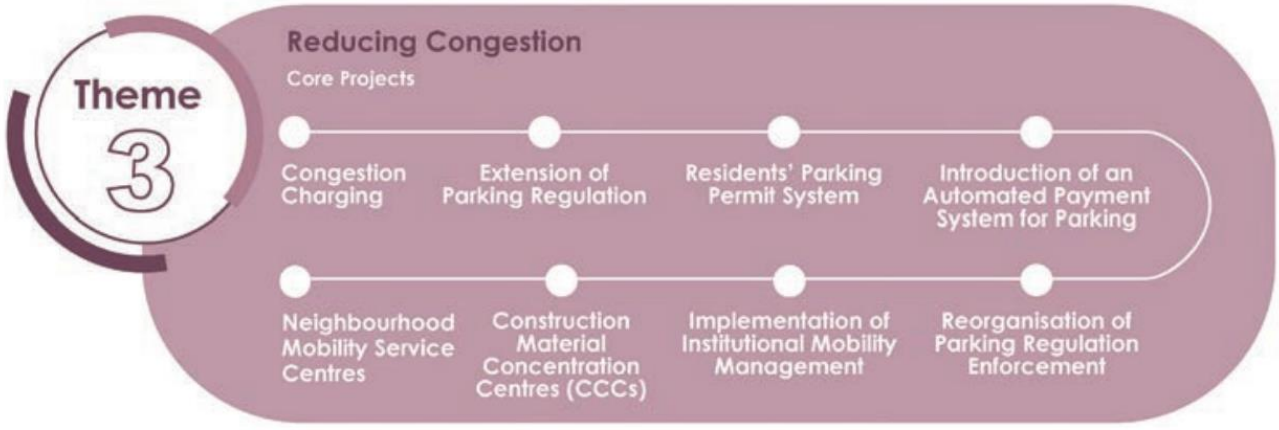

Fig. 4. Istanbul SUMP Report: Projects for 'Reducing Congestion' Theme [5]

Increasing cycle paths has become an important part of sustainable urban mobility in Istanbul. As of 2024, a total of more than 300 km of cycle paths have been built in the city [14]. As can be seen in Figure 5, the cycle network is mostly concentrated around the coastlines of Istanbul. These paths offer an environmentally friendly alternative transport option. Public transport systems also have a critical role in Istanbul's transport infrastructure. Smart transport solutions such as IstanbulKart enable the integrated use of different public transport vehicles including buses, metro, tram, and ferries. This increases the use of public transport systems and reduces people's use of private vehicles.

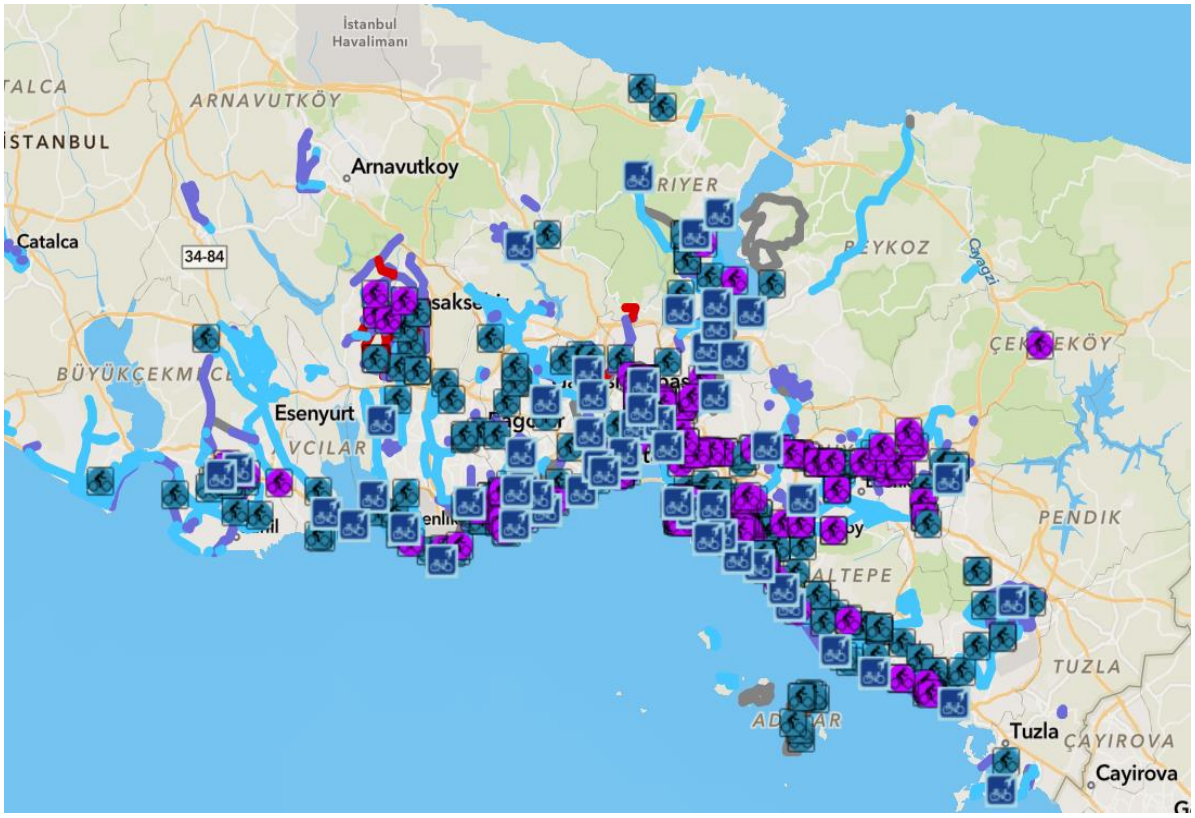

Fig. 5. Istanbul Cycle Map (https://bisiklet.ibb.istanbul/haritalar/istanbul-bisiklet-haritasi)

The use of electric vehicles is another sustainable transport practice encouraged in Istanbul. Increasing the number of electric buses as well as electric vehicles reduces fossil fuel use and air pollution in the city. Charging stations for electric vehicles have been placed at key points, making the use of these vehicles even easier. In addition, incentives provided by local governments in this regard may increase individuals' electric vehicle acquisition.

The challenges faced by sustainable urban mobility in Istanbul arise from both infrastructural and socio-economic factors. Understanding these challenges is critical in developing sustainable urban mobility in Istanbul. First of all, Istanbul's rapid population growth increases the pressure on the capacity of public transport systems. With a population of more than 15 million, Istanbul is among the most populous cities in the world, and this causes both the public transport system to be inadequate and traffic congestion to increase [15]. Bus and metro systems, which carry more than 6 million passengers daily, become overcrowded during peak hours, which negatively affects public transport use and perception [16].

Traffic congestion is one of the most major urban problems of Istanbul. The constant increase in the number of vehicles in the city causes existing roads to become inadequate and air pollution to increase. In 2022, Istanbul was one of the cities with the most traffic congestion in the world [17]. Traffic congestion causes both loss of time and a decrease in the quality of life of individuals. Figure 6 shows a typical traffic density map which shows the most congested roads in Istanbul.

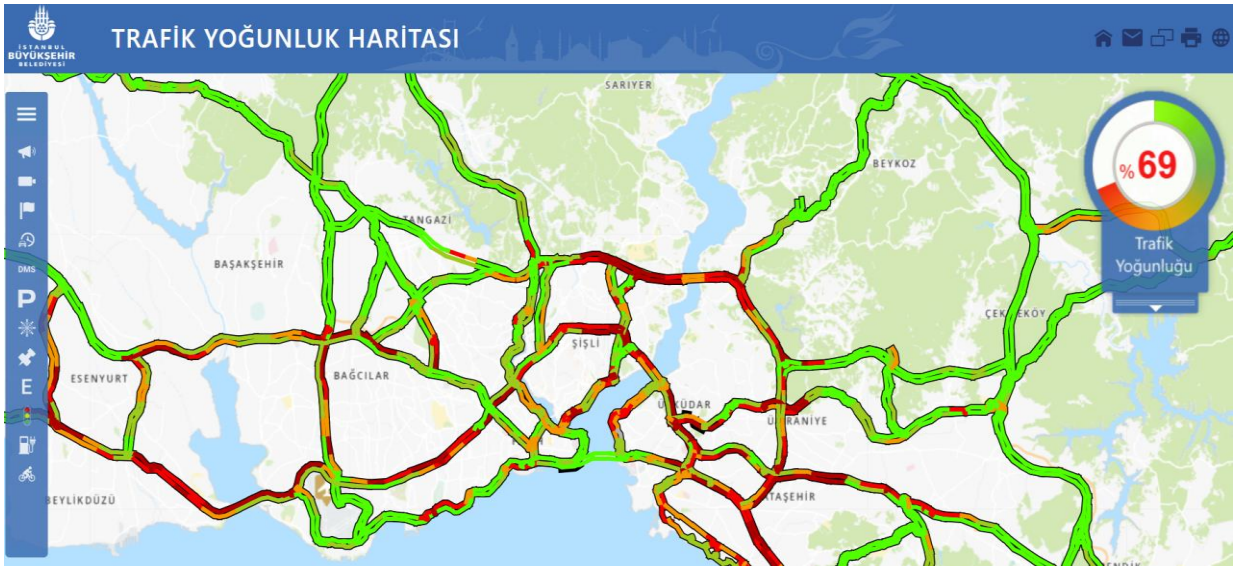

Fig. 6. Istanbul Traffic Density Map (https://uym.ibb.gov.tr/yharita6/)

Financing problems are also one of the important obstacles to the design and implementation of sustainable transport schemes in Istanbul. The lack of sufficient funding in public transport infrastructure causes the projects to progress slowly. In particular, providing the resources required for the integration and modernisation of new systems poses a great challenge [18]. In addition, the fact that these investments do not reach a sufficient level also reduces the effectiveness of existing systems.

5. Discussion and Conclusions

Istanbul, with its historical and cultural richness, is one of the most populous and dynamic cities in the world. However, dense population and rapid urbanisation have led to serious difficulties in urban livability as a result of deteriorating transport. Sustainable urban transport is of critical importance not only in reducing environmental impacts but also in increasing social equity and economic efficiency. In this context, sustainable development of Istanbul's existing transportation infrastructure has become a vital necessity for both the future of the city and social welfare.

The effective implementation of sustainable transport schemes has great potential to improve Istanbul's air quality and reduce traffic congestion. Modernisation of existing transport systems in the city, integration of smart transportation systems and promotion of alternative transport modes will be important steps in achieving sustainability goals. In particular, increasing bicycle paths and electric vehicle charging stations will enable individuals to choose more environmentally friendly transport options.

In order to find solutions to Istanbul's transport issues, not only infrastructure but also social participation and awareness is important. Local governments' involvement of different segments of

society in the development of sustainable transport schemes will contribute to making these policies more effective. Awareness needs to be increased so that all segments of society can benefit equally from transport systems. Awareness campaigns and training programmes to be organized for this purpose will help spread sustainable transport culture.

However, Istanbul's transport problems should not be considered only as a local problem. These problems also have an important dimension in terms of global climate change. Istanbul's adoption of low-carbon transport solutions will both improve its quality of life and contribute to global environmental goals. Therefore, it is of great importance for city governments to consider international standards and practices when developing sustainable transport policies.

Moreover, the implementation of recommendations to improve sustainable mobility in Istanbul requires a combination of short-term and long-term strategies. In the short term, the aim should be to improve existing public transport systems and encourage alternative transport options such as cycling, micromobility, and walking. In the long term, adopting sustainability principles in city planning and strengthening the existing transport infrastructure with innovative solutions play a critical role.

Developing sustainable transport schemes in Istanbul will not only relieve traffic congestion problems but also significantly improve the quality of life in the city. This transformation will be possible with social participation, awareness and cooperation [19]. The cooperation of local governments and society is one of the most important elements that will enable Istanbul to step into a sustainable future [20]. Reshaping Istanbul's transport infrastructure in line with sustainability goals can benefit all individuals in the city.

The role of national governments for supporting sustainable urban mobility plans in cities is another key factor [21]. Developing a sustainability oriented urban mobility plan is often supported within multilevel governance contexts, and national governments' support in terms of funding and guidance is key to facilitate the development of sustainable urban mobility plans. However, there is a lack of national guidance as well as sustainable long-term funding in Turkey for leading sustainable urban mobility developments in localities. Given the critical role of Istanbul in Turkish national economy, this lack of coordination between local and national planning needs to be overcome with a long-term vision.

Developing key performance indicators (KPIs) for the progress of sustainable urban mobility goals is crucial in identifying, assessing, benchmarking, and prioritising key areas of focus so as to facilitate the role of policy makers in developing sustainable transport strategies [22, 23]. This KPI framework should also be supported with a monitoring scheme to ensure its continuity. However, while doing our research, there is a lack of data and KPI availability for Istanbul's urban mobility in terms of sustainable urban mobility measures being developed and shared with the public. Having an open-source KPI framework along with actual figures which would be developed around sustainability principles can improve public scrutiny and transparent governance.

Efforts to reduce traffic congestion in the city, prevent environmental pollution and make transport systems more efficient will increase the general welfare of the society and strengthen the image of Istanbul in the global scene. Istanbul has the potential to become an exemplary city not only in Turkey but also throughout the world in this process. Achieving these goals is critical to improving the quality of life of both the city's current and future generations.

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Conflicts of Interest
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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