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Supply Chain Management (SCM)

Postgraduate Dissertation

Comparative analysis of national transport plans in Greece, EU, and
non-EU countries with emphasis on sustainable development and
urban mobility

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Patras, Greece, July 2024

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This dissertation is dedicated to my family
for their unconditional love and continuous support
throughout my whole life

Abstract

The present dissertation aims at providing a comparative analysis of the national transport plans in Greece, EU, and non-EU countries placing emphasis on the issues of sustainable development and urban mobility. For this reason, the national transport plans of various countries from the above-mentioned groups will be studied and compared to the Greek national transport plan based on their structure, their goals, their accordance with each other, and their conformity to international targets regarding sustainable development. Following this analysis, an attempt is made to pinpoint possible gaps and shortcomings of the Greek national transport plan, while also suggesting potential improvements and adjustments that could be implemented in order to accomplish the goals regarding sustainable development and urban mobility.

Keywords

Transport, plans, sustainable, development, urban, mobility

Συγκριτική ανάλυση εθνικών σχεδίων μεταφορών στην Ελλάδα, στην Ε.Ε. και σε χώρες εκτός Ε.Ε. με έμφαση στη βιώσιμη ανάπτυξη και την αστική κινητικότητα

Ιωάννης Ζαντήρης

Περίληψη

Η παρούσα μεταπτυχιακή εργασία στοχεύει σε μία συγκριτική ανάλυση των εθνικών σχεδίων μεταφορών στην Ελλάδα, στην Ε.Ε. και σε χώρες εκτός Ε.Ε. δίνοντας έμφαση στα θέματα της βιώσιμης ανάπτυξης και της αστικής κινητικότητας. Για το λόγο αυτό θα μελετηθούν τα εθνικά σχέδια μεταφορών διαφόρων μελών από τις προαναφερθείσες ομάδες χωρών και θα συγκριθούν με το ελληνικό εθνικό στρατηγικό σχέδιο μεταφορών με βάση τη δομή, τους στόχους, τη συμφωνία ανάμεσά τους και την προσαρμογή τους στους διεθνείς στόχους που αφορούν τη βιώσιμη ανάπτυξη. Στη συνέχεια αυτής της ανάλυσης επιχειρείται μία προσπάθεια να εντοπιστούν ενδεχόμενα κενά και ελλείψεις του ελληνικού εθνικού σχεδίου μεταφορών, ενώ επίσης προτείνονται πιθανές βελτιώσεις και προσαρμογές που θα μπορούσαν να εφαρμοστούν ώστε να επιτευχθούν οι στόχοι που αφορούν τη βιώσιμη ανάπτυξη και αστική κινητικότητα.

Λέξεις – Κλειδιά

Μεταφορές, σχέδια, βιώσιμη, ανάπτυξη, αστική, κινητικότητα

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List of Abbreviations & Acronyms

BRT	Bus Rapid Transit
CNG	Compressed Natural Gas
ERTMS	European Rail Transport Management System
EU	European Union
FTIP	Federal Transport Infrastructure Plan
FUA	Functional Urban Area
GDP	Gross Domestic Product
GHG	Greenhouse Gas
ITS	Intelligent Transport System
LEVI	Local Electric Vehicle Infrastructure
LGV	Large Goods Vehicle
MaaS	Mobility as a Service
NTP	National Transport Plan
OECD	Organisation for Economic Cooperation and Development
PATHE	Patra-Athens-Thessaloniki-Evzonoi (corridor)
PRM	Persons with Reduced Mobility
SUMP	Sustainable Urban Mobility Plan
TEN-T	Trans-European Transport Network
ZEV	Zero Emission Vehicle

1.Introduction

1.1 Definition and importance of national transport plans

National transport plans are strategic roadmaps that provide important guidelines for a country to achieve future goals with regards to vital transport issues. They offer guidance on managing and improving the national transport infrastructure, thus ensuring fast and efficient movement of people or goods and helping the economy of a country grow.

In the modern world, where the environmental issues are becoming increasingly relevant, a national transport plan can propose measures and solutions that can lead to environmental protection and sustainability by promoting transport methods that greatly reduce CO₂ emissions, utilize renewable energy sources, and do not irreversibly harm the natural environment.

In addition, forward-looking national transport plans can contribute to public safety by ensuring that the transport infrastructure of a country is able to withstand unpredictable events or emergencies, such as natural disasters, pandemics etc.

Moreover, a well-devised national transport plan can mitigate social exclusion and inequalities by providing access to education, healthcare and job opportunities for populations of geographically isolated areas of a country, thus improving the general welfare.

1.2 Sustainable development and urban mobility

Sustainable development is a focal point of modern transport planning, as governments and international organizations attempt to build and maintain transport systems that are characterised by robustness, efficiency, financial feasibility, and ecological awareness. This involves creating transport systems that serve the fundamental cause of moving people and goods, while simultaneously ensuring that the natural environment and resources are utilized efficiently and are also preserved and protected for the sake of the next generations.

Urban mobility is an important aspect of the general philosophy of sustainable development that deals with the transport that takes place in urban areas and aims at promoting more

sustainable ways of moving people and goods in the cities. By utilizing eco-friendly vehicles and renewable energy sources, promoting the use of public transport, prioritizing cycling lanes and walking areas, the goal is to reduce or even totally eliminate CO₂ emissions and air pollution in order to render the urban environment more habitable, impede the factors that cause climate change, and improve the quality of life in the cities. Furthermore, urban mobility contributes to more efficient transport by making use of the latest technological advancements, such as intelligent transport systems that use real-time data for route planning, thus limiting excessive traffic and improving the level of service of the transport network.

1.3 Scope of the comparative analysis

The purpose of this comparative analysis is to provide a detailed study of the Greek national transport plan along with the examination of the relative plans of other EU and non-EU countries. Emphasis will be placed on the aspects of sustainable development and urban mobility, as they play an important role in modern transport planning.

By comparing the various transport plans, similarities and differences will become evident regarding the approach that each country follows and the targets it sets, while trying to deal with the modern transport challenges. Moreover, by highlighting innovative ideas and best practices, a series of proposals and suggestions will be presented in order to improve the Greek national transport plan in terms of encouraging sustainable growth and enhancing urban mobility.

1.4 Methodology, main findings, and limitations of the dissertation

The methodology applied on this dissertation included theoretical review of several national transport plans and policies from different countries both in the European Union and outside of it. In addition, statistical data from the database of the Organisation for Economic Cooperation and Development were utilized to compare the transport performance of these countries and their biggest metropolitan areas in terms of environmental impact, accessibility, and other criteria.

According to the analysis made, the dissertation found that the Greek national transport sector and the biggest metropolitan areas of the country in Athens and Thessaloniki scored worse in

terms of CO₂ emissions and average transport performance per mode of transport compared to the other countries and metropolitan areas examined. After these findings, interpretations and possible causes were provided to explain them along with suggestions for improving the situation.

Unfortunately, the data utilized refer to the period 2015-2021, as there were no data availability for more recent years in the OECD database. In addition, effort was made to review the most recent versions of the national transport plans and policies of the selected countries in order to include possible updates and modifications of the initial versions.

1.5 Outline of the following chapters

Below, an outline of the following chapters is provided along with a brief description of their content.

Chapter 2 contains the literature review presenting various interesting studies and research papers dealing with national transport plans and policies, sustainable development, and urban mobility. Furthermore, examples of comparative studies are provided that involve transport policies in different cities, countries, and regions of the world.

Chapter 3 focuses on the Greek national transport plan. It starts with a historical review of the country's transport infrastructure and describes the current condition of it. After that, it reviews the plan's objectives and discusses the policies and measures proposed by the plan with regard to sustainable development and urban mobility.

Chapter 4 presents the main EU transport policies, such as the European Green Deal and the Sustainable and Smart Mobility Strategy, and summarizes their targets. Subsequently, the national transport plans and policies of five selected EU countries are examined, including Germany, the Netherlands, Italy, Estonia, and Croatia.

In chapter 5 there is the review of the national transport plan and policies of four countries outside the European Union, namely the United States, Japan, India, and the United Kingdom.

Chapter 6 contains the analysis of statistical data from the database of the Organisation for Economic Cooperation and Development regarding the performance of the Greek transport

sector in terms of environmental impact. The results are compared with the relative data of the other countries examined. After that, a similar analysis is made comparing different metropolitan areas of the world with the biggest Greek ones in Athens and Thessaloniki using as criteria the average transport performance of different transport modes. Finally, an attempt is made to interpret the results and identify their causes.

Chapter 7 provides recommendations for improving the Green national transport plan and policies in terms of promoting sustainable development and urban mobility. Suggestions for upgrades are offered along with proposals for legislative reforms.

Lastly, chapter 8 is the conclusive part of the dissertation that summarizes the key findings and presents potential directions for future research.

2.Literature review

2.1 Existing research on national transport plans, sustainable development in transport planning, and urban mobility

The existing literature comprises of many interesting studies and research papers that underline the impact of forward-thinking planning on developing transport systems that promote sustainability and enhance urban mobility.

The paper by Schafer and Victor (2000) [20] provides a model to forecast future transport trends for eleven regions and the world through the year 2050 concluding that there is a worldwide shift towards faster transport modes stemming from increases in income and demand for transport.

A study by Hickman, Hall, and Banister (2013) [10] supports the view that sustainable mobility in urban areas is attainable on the condition that there is substantial funding for improving transport infrastructure combined with strategic urban planning. The paper presents a series of scenarios and strategies to describe future transport conditions in two different areas, London and Oxfordshire.

Another relative article is that of Bertolini, Le Clercq, and Straatemeier (2008) [3] which deals with the challenges that urban transport planning faces and proposes a shift from traditional planning methods to more integrated and collaborative strategies that require effective communication skills in order to mitigate conflicts and achieve a wide collaboration.

2.2 Comparative studies on transport policies

Comparative studies on transport policies contribute to a better understanding of various aspects and challenges of modern transport planning by presenting how different cities, countries, and regions deal with contemporary transport issues, while also helping to identify innovative solutions and best practices.

The survey-based analysis by Haustein and Nielsen (2016) [9] utilizes Eurobarometer data collected in twenty-eight EU countries in order to create six country clusters based on eight different mobility styles. The study concludes that the European transport policies should take into account the differences in mobility cultures across the EU to ensure the successful implementation of future transport policies regarding sustainable mobility.

A study by Pucher and Buehler (2008) [19] using national aggregate data and case studies from different cities in each country examined how the Netherlands, Denmark, and Germany have rendered cycling attractive to their citizens. The paper underlines the importance of education, cultural factors, funding, and effective policies in promoting cycling as a sustainable means of urban mobility.

Another comparative analysis by Pucher (1995) [18], consisting of two parts, studies the urban passenger transport system in the United States and how it differs from the European one. The article focuses on public policies regarding car ownership and taxation, public transport funding, land use, and their impact on the different way in which the urban transport has evolved in the two continents. The analysis concludes that European policies have enabled a more balanced mobility profile between the use of car and public transport, whereas in the United States the use of car is more dominant due to lower population density and less supportive policies towards public transport and non-motorized means.

3.National transport plan of Greece¹

3.1 Overview

3.1.1 Historical background

Greece's national transport infrastructure has progressed significantly the last decades driven by the advantageous but also highly demanding reality of the country's strategic geographic location and the need to close the gap with the more developed European countries.

The end of the second world war found the country with basic level transport infrastructure that had sustained serious damage, thus the next decades were focused on road construction that could help the country's economic recovery and growth by connecting the major urban centres.

After the country became an EU member in 1981, there was an acceleration in the upgrading of the country's transport infrastructure aided by the technical expertise and considerable funding provided by the EU. As a result, the country was able to realize challenging transport projects, such as the Egnatia Odos highway, the Athens Metro system, and the Rio-Antirrio bridge.

In 2014, the Ministry of Infrastructure, Transport and Networks submitted the Strategic Framework for Investment in Transport that addressed the capital investment needs of the country regarding transport projects for the period 2014-2025. However, the plan did not succeed in setting quantifiable objectives and establishing a clear connection between each investment and the respective problem.

Consequently, in 2015 the Ministry proceeded with the decision to develop a National Transport Plan with a medium (2027) and a long-term horizon (2037), as a roadmap for improving the country's transport sector, enhancing economic growth and environmental sustainability, supporting regional and international connectivity, ensuring safety and security, and providing accessibility and social inclusion.

¹ (National Transport Plan for Greece, 2019) [14]

3.1.2 Modern times

Greece's modern transport infrastructure consists of an extensive network of roads, railways, ports, and airports, each one of which plays an important role in the country's economic growth and connectivity.

The road network is a focal point of the country's transport system consisting of major highways like Egnatia Odos and PATHE (Patra-Athens-Thessaloniki-Evzonoï corridor) which connect key cities and regions. It is noteworthy that 97.1% of Greece's inland freight transport in 2021 was done by road (Statista, 2024) [21]. Nevertheless, despite the substantial investments for initial construction, ongoing maintenance and upgrades remain critical issues.

The rail network appears less developed compared to the road network, although there have been necessary interventions mainly on the Athens-Thessaloniki route, which is essential for both passenger and freight transportation. Nevertheless, other sections of the rail network still need serious upgrade to improve accessibility, connectivity, efficiency, and level of service. Thus, railway can emerge as a competitive and sustainable alternative to road transport.

Greece's ports, especially those in Piraeus and Thessaloniki, constitute crucial gateways for international trade. Especially Piraeus port has seen extensive upgrades rendering it a vital hub for maritime transport in the Mediterranean. Moreover, recent geopolitical developments, such as the war in Ukraine, have upgraded the role that the ports of Alexandroupoli and Patras can play regarding the energy security of the southeastern Mediterranean region.

Regarding the airport infrastructure, it supports both domestic and international flights, while significant funds are being allocated to expanding the capacity of Athens International Airport and modernizing other regional airports. These facilities play a crucial role for tourism, which is a major contributor to the Greek economy. Nonetheless, challenges such as congestion during peak travel periods and the need for additional infrastructure improvements persist.

3.2 Sustainable development measures

The Greek national transport plan considers sustainability as a high-level objective due to its major environmental, economic, and social implications. Therefore, much emphasis is placed on ways to achieve this challenging goal.

3.2.1 Reduction of environmental impacts

The plan aims at reducing the vehicle operating costs by promoting greener transport modes, which will result in multiple socio-economic benefits. In addition, by 2037 the plan anticipates a substantial annual decrease in pollutants, specifically 14,000 tonnes of CO and 5,000 tonnes of NO_x per year, resulting in a 17.5% annual reduction in environmental impacts of transport. Moreover, a net reduction of 300,000 tonnes of CO₂ per annum by 2037 is projected, translating to net economic benefits of over €10 million per year due to reduced environmental costs calculated according to the Update of the Handbook on External Costs of Transport (2019) [1].

3.2.2 Promotion of low-emission vehicles

The renewal of the vehicle fleet in Greece is deemed necessary, as it consists of old vehicles that contribute significantly to air pollution. The replacement of the old fleet with newer and preferably electric vehicles can help the country realize the green goals set by the European union and enhance the environmentally friendly profile of the transport sector.

To achieve this, the government offers a series of tax reduction measures and subsidies as incentives that will render electric vehicles more attractive and affordable for people and businesses. In addition, investments on infrastructure, such as the construction of charging stations in urban areas and on highways, is of high importance to promoting and facilitating electric powered transportation. Moreover, regulatory framework is proposed in order to discourage the use of old and polluting vehicles, such as by creating low emission zones in urban centres or by introducing a bonus-malus system of taxes and incentives for new vs. old and clean vs. polluting vehicles.

3.2.3 Rail network upgrade

The improvement of the Greek railway is of great importance to the country's plan to increase sustainability in the transport sector, as there is ample potential and margin for upgrading interventions.

The national transport plan advocates the extension of the electrification of the rail network as a measure to reduce energy costs and increase environmental sustainability. Apart from that, investment is needed to the signalling system in order to improve safety and travel speed. Moreover, the train stations infrastructure is poor and does not facilitate accessibility especially for people with reduced mobility. As a result, interventions are required to deal with these problems and boost the attractiveness and ridership of the railway in terms of number of passengers.

Regarding the rail freight transport, the national plan suggests the continuation of the funding towards the upgrade of the PATHE route that connects the three main urban centres of Greece in Patras, Athens and Thessaloniki. This corridor is of fundamental importance to the Greek freight transport sector and its continuous upgrade can alleviate the road network by reducing the number of heavy goods vehicles, as train can be a preferable option for transporting goods. Additionally, enhancing the connection of the railway to the main Greek ports helps multimodality and contributes to an efficient and sustainable transport system.

In terms of regional train lines, the plan proposes the improvement of rail accessibility for regions with limited or zero options, such as western and southern mainland Greece, however there should also be a rationalization of the rail network by identifying and dealing with sections that present low traffic and revenues.

3.2.4 Improvements of ports and airports

Upgrading port and airport facilities is another critical component of the Greek national transport plan aimed at enhancing the country's role in international trade, tourism, and regional connectivity, while also addressing environmental and operational challenges.

The NTP focuses on transforming Greece as a leading logistic hub for freight transport in the Mediterranean and major ports like Piraeus and Thessaloniki can help in achieving this goal.

Therefore, significant investments are proposed to expand port capacities, improve operational efficiency, and enhance connectivity with rail and road networks.

In line with sustainability goals, the NTP promotes the adoption of green technologies and practices in port operations. Such examples could be the electrification of port equipment, shore power facilities for docked ships to reduce emissions, and the implementation of advanced waste management systems. These measures can lead to minimizing the environmental impact of port activities and improving the overall sustainability of maritime transport.

Greek airports are also undergoing significant upgrades, as they are crucial units especially for the tourism sector in Greece. Athens International Airport is the country's largest airport, thus it is continuously being modernized to handle increasing passenger volumes efficiently. Improvements include the expansion of terminal facilities, enhancement of passenger services, and the introduction of smart technologies for better operational management. Furthermore, regional airports are also being upgraded to boost connectivity and support economic development.

Improving connectivity across ports, airports, and the other parts of the transport network is another key focus of the NTP. This includes developing multimodal transport hubs that facilitate seamless transfers between different modes of transport, which in turn can contribute to a more integrated and efficient transport network that supports economic growth and sustainable development.

Additionally, the NTP proposes specific environmental initiatives for ports and airports, such as increasing the use of renewable energy sources, implementing green technologies, and enhancing resilience against climate change impacts. These initiatives are designed to reduce the carbon footprint of Greece's transport infrastructure and contribute to the country's broader environmental goals.

3.2.5 Legal and institutional reforms

The NTP recognizes that the legal framework that regulates the transport sector is particularly complex and fragmented. For this reason, it is deemed necessary to simplify and harmonise the relevant legislation in order to speed up procedures and increase efficiency. In addition,

the plan proposes streamlining and modernizing the institutions and organisations that deal with transport at regional and national levels. In this way, better support and implementation of sustainable transport initiatives can be ensured.

3.3 Urban mobility initiatives

Regarding urban mobility, the national transport plan outlines several measures to improve this field placing special emphasis on the cities of Athens and Thessaloniki.

3.3.1 Sustainable urban mobility plans (SUMPs)

According to the relevant EU and national legislation, SUMPs are plans that promote sustainable transport patterns for people and goods in urban areas aiming at improving the quality of life, reducing air and noise pollution, enhancing road safety, encouraging the use of public transport and other green modes, such as cycling and walking, and ensuring accessibility to the transport network for all citizens.

The NTP highlights the need to establish a legal framework for urban mobility planning and supports the development of SUMPs for metropolitan areas like Attica and Thessaloniki. Furthermore, it promotes the use of green vehicles and fuels in urban public transport, while also calling for expansion of the metro and light rail systems in major urban areas. Apart from that, it proposes the implementation of intelligent transport systems to achieve enhanced traffic management and safety.

3.3.2 Public transport and road infrastructure improvements

To further boost urban mobility, the NTP suggests the extension and upgrade of key road networks, particularly in the Attica region, in order to alleviate traffic congestion.

Additionally, the construction of new tunnels and bypass roads is proposed as a solution to improve traffic flow and mitigate future bottlenecks, such as the one predicted for the section between Schimatari and Thiva by 2027.

Regarding public transport, the plan calls for improved connections between the various transport modes in order to foster multimodality. Moreover, it encourages the upgrade and

expansion of the suburban rail networks with new lines, such as the Athens Airport-Rafina. Furthermore, it highlights the need to render public transport accessible to persons with reduced mobility and proposes the development of platforms for multimodal transport information and ticketing.

Undoubtedly, the proposed interventions should not be seen as isolated projects, as they should be part of a broader strategic national development plan that aligns the capabilities, consumption patterns, and production requirements of each region with transport infrastructure improvements.

3.3.3 Legal framework upgrade

As mentioned previously, the NTP recognizes that the legal framework governing urban and regional transport needs to be revised and simplified to ensure better coordination among local authorities. Apart from that, institutional reforms are necessary to enhance strategic planning capacities within the Ministry of Transport and other relevant bodies.

4. EU countries

4.1 Overview of EU transport policies

The European Union implements a series of policies that foster sustainable development, promote urban mobility, and render the European transport sector more environmentally friendly and efficient.

4.1.1 European Green Deal²

The European Green Deal, presented by the European Commission in December 2019, is a collection of policy initiatives that accelerate green transition and aim at transforming Europe into the first climate-neutral continent in the world by the year 2050. Other key objectives include the reduction by 55% of the net greenhouse gas emissions by 2030 compared to 1990 levels and the planting of three billion additional trees in the EU also by the year 2030.

Regarding the transport sector, the Green Deal targets a 90% reduction in transport emissions by 2050 in order to achieve the broader goal of climate neutrality. In addition, it aims at increasing the efficiency of the transport system by boosting multimodality. This includes transferring a substantial part of inland freight from road to rail and inland waterways. Therefore, measures and initiatives are considered to increase the capacity of the European railways and inland waterways along with the revising of transport directives to support multimodal freight operations.

To help with the green transition, initiatives are planned to ramp up production and deployment of low- and zero-emission vehicles that will in turn create the need for approximately one million public recharging and refuelling stations by 2025. Furthermore, the development of smart traffic management systems and the promotion of Mobility as a Service (MaaS) are deemed necessary to mitigate traffic congestion and air pollution in urban areas.

4.1.2 Trans-European Transport Network (TEN-T)³

The Trans-European Transport Network relies on an EU transport policy that aims at creating a comprehensive, sustainable and efficient transport network across Europe by developing nine corridors, which include roads, railways, inland waterways, ports, airports, and rail-road terminals to avoid duplication and increase synergies. It is aligned with the EU's goals under the European Green Deal by focusing on enhancing rail and inland waterway transport,

² (European green deal, 2019) [5]

³ (TEN-T Revision) [23]

promoting multimodal hubs, integrating urban mobility with broader network plans, and ensuring the deployment of alternative fuels infrastructure.

4.1.3 Sustainable and Smart Mobility Strategy⁴

Another EU policy that aligns with the goals of the broader European Green Deal is the Sustainable and Smart Mobility Strategy that constitutes a plan to create a resilient, efficient, and environmentally friendly transport system across Europe by following an integrated approach, which combines sustainability, digitalization, and multimodality.

The strategy includes ambitious goals, such as doubling high-speed rail traffic, achieving carbon-neutral collective travel for distances under 500 km within the EU, and ensuring 100 European cities are climate neutral by the year 2030. Furthermore, by the year 2050 it is expected that the high-speed rail traffic will triple, the rail freight traffic will double, and the TEN-T network will be fully operational and modernized.

4.1.4 SUMPs⁵

As mentioned in the sub-section 3.3.1, the Sustainable Urban Mobility Plans are strategic plans designed to satisfy the mobility needs of people and businesses in cities and their surroundings for a better quality of life. They aim to address urban mobility challenges and improve the accessibility and quality of urban transport systems.

To achieve their broader purpose of improving the quality of life in urban and suburban areas, the SUMPs set specific goals, which include the promotion and implementation of zero-emission mobility, multimodality, enhanced safety, accessibility, and inclusivity, reduced traffic congestion, improved air quality and noise levels, as well as enhanced efficiency and sustainability of urban logistics and freight transport.

⁴ (Mobility Strategy) [12]

⁵ (Sustainable urban mobility planning and monitoring) [22]

Based on their pursued goals, the SUMPs are in accordance with the other EU policies, such as the Green Deal and the Sustainable and Smart Mobility Strategy, and all of them together highlight the EU's commitment to a more sustainable and efficient transport sector.

4.2 Examples of EU countries' transport plans and policies

After examining the main EU transport policies, some examples of transport plans and policies from various EU countries will be presented. For this reason, five countries have been chosen, namely Germany, Netherlands, Italy, Estonia and Croatia. The selection was made based mainly on geographic criteria in order to ensure the representation of a wide geographic area of the continent and the number of countries was kept to a minimum, thus avoiding an unnecessarily long and tiring for the reader analysis. In addition, the selected assortment of countries seems to provide adequate variety in order to present how EU countries with different socioeconomic, geographical, and historical backgrounds deal with the modern challenges of the transport sector.

4.2.1 Germany

In 2016 Germany presented the 2030 Federal Transport Infrastructure Plan (FTIP) [24], which is a comprehensive plan for the development and modernization of the country's transport infrastructure with a future horizon of ten to fifteen years. The plan highlights sustainable development and urban mobility, while also trying to address the challenges of climate change, and it underlines Germany's commitment to establishing an efficient, reliable, and environmentally friendly transport system.

Regarding the aspect of sustainable development, the plan prioritizes structural maintenance over new construction, as approximately 69% of the total funding (€141.6 billion) is allocated to maintaining and modernizing existing infrastructure. Interestingly, the FTIP seeks to limit land take for settlement and transport purposes to 30 hectares a day, aligning with the Sustainable Development Strategy and the National Biodiversity Strategy. Also, it aims to preserve unfragmented areas and reconnect habitat networks through wildlife crossings in road upgrading projects. Thus, this approach ensures the longevity and efficiency of the current transport network, minimizing environmental impact.

In addition, the plan incorporates measures for climate change mitigation with key initiatives like the Mobility and Fuel Strategy, and the Electric Mobility Act, which promote the use of vehicles powered by green sources, thus contributing to reduced gas emissions.

Moreover, FTIP emphasizes the integration of different transport modes to create a cohesive and efficient transport system, which includes enhancing connections between road, rail, and waterways, and ensuring seamless transitions between these modes. By fostering intermodal connectivity, the plan also aims at facilitating the incorporation of greener modes, such as rail and waterways, into the logistics sector.

In terms of urban mobility, the plan mentions initiatives, such as the National Cycling Plan and the German Unity Cycle Route, which aim at promoting cycling as a sustainable mode of transport with projects that include the creation of dedicated bike lanes, bike-sharing programs, and secure bike parking facilities.

Furthermore, it mentions the allocation of funds by the federal government to the federal states for public transport investments, which include modernization projects, expansion of networks, and integration of different modes of transport.

Apart from that, the FTIP promotes the utilization of Intelligent Transport Systems and supports initiatives like the Strategy for Automated and Connected Driving, which can contribute to better traffic management, enhanced road safety, efficiency, and sustainability.

4.2.2 Italy

In 2021 the European Council approved Italy's recovery and resilience plan [13], which was later updated in 2023. The plan aims at helping the country become more sustainable and resilient by proposing reforms that promote the green and digital transition in various sectors, including the transport one.

Regarding the sustainability on the transport sector, the plan puts special emphasis on hydrogen infrastructure with the development of at least 40 hydrogen refuelling stations for light and heavy vehicles by 2026, located at motorway service areas, logistic warehouses, and ports. Additionally, it proposes the construction of at least 10 hydrogen refuelling stations along six railway lines by 2026, preferably near local renewable hydrogen production sites.

Moreover, it plans to support at least 10 R&D projects focusing on green hydrogen production, storage technologies, fuel cells, and smart management systems.

Apart from hydrogen, the plan also includes investments on electric vehicle infrastructure with the installation of at least 7,500 and 13,755 fast public charging infrastructure points along freeways and urban areas respectively by 2025.

In terms of road infrastructure improvements, to ensure better maintenance and increased road safety it is planned to transfer ownership of bridges, viaducts, and overpasses to higher-ranking roads, while also adopting guidelines for the classification and management of risks, evaluation of security, and monitoring of existing bridges.

With regard to port and airport upgrades, the simplification of port planning processes and competitive concessions in ports is suggested as a reform to ensure intermodality with European communication lines, improving energy efficiency, and integrating ports better into the logistics chain. Furthermore, investments in the digitalization of air traffic management systems are planned to enhance operational efficiency and reduce environmental impact.

About the railway, the plan mentions the construction of 119 km of high-speed railway infrastructure for passengers and freight on lines such as Napoli-Bari, Salerno-Reggio, and Palermo-Catania. Moreover, it includes investments to equip 2,785 km of rail lines with modern traffic management technology like the European Rail Transport Management System (ERTMS). Additionally, it plans to upgrade 38 railway stations to ensure accessibility and compliance with EU railway safety regulations, while also electrifying 650 km of railways in the South, including airport and port links.

As far as the logistics sector is concerned, one important reform is the creation of an interoperable digital system between public and private actors for freight and logistics, focusing on the de-materialization of documents and the exchange of data and information to simplify procedures, processes, and controls.

Regarding the aspect of urban mobility, the upgrade of the public transport fleet is deemed necessary with the procurement of at least 3,000 zero-emission low-floor buses and 1,000 charging stations by 2026, while also acquiring and putting into service at least 69 zero-emission passenger trains and additional carriages. In addition, the plan aims at improving the cycling infrastructure by constructing at least 565 km of cycling lanes in metropolitan areas.

4.2.3 Netherlands

In 2019 the Dutch Ministry of Infrastructure and Water Management presented its plan for the future of public transport in the Netherlands by 2040 [17] structured around three main pillars, which underline the strengths of public transport, the need for seamless travel, and the importance of safety, sustainability, and efficiency.

In terms of sustainable development, the plan sets emissions reduction objectives, such as the target of the public transport sector to eliminate emissions by 2030. Additionally, by 2030 all public transport operators will fully transition to green electricity, while also adopting circular economy principles in construction, maintenance, and service management, reducing waste and promoting resource efficiency. Moreover, the sector plans to halve its use of primary resources by 2030, working towards full circularity by 2050, through reusing and recycling materials to minimize resource extraction and waste generation.

Regarding the climate change adaptation, the transition of public transport from fossil fuels to renewables is deemed essential to meet climate targets. Thus, diesel engines will be phased out and zero-emission bus fleets will be established by 2030. Furthermore, climate change considerations will be integrated into operational strategies and infrastructure development, ensuring resilience to future climate impacts.

As far as sustainability and safety of the public transport are concerned, the sector will grow sustainably aiming to balance environmental impact, social equity, and economic viability. Despite the rising congestion on the railway and the other modes, measures will be taken to reduce environmental impacts and enhance safety, including the implementation of the European Rail Traffic Management System (ERTMS) to improve safety and efficiency.

Another important feature of the plan is the aspect of urban public transport and mobility. The vision calls for increased public transport services to support urban growth. Also, minor interventions will address medium-term bottlenecks in bus, tram, and metro networks by 2030. Moreover, to better integrate spatial development with accessibility it is proposed to concentrate development in existing built-up areas near public transport hubs as a means to protect open spaces and reduce car journeys, maintaining urban liveability. Furthermore,

supplementary spatial policies will include bike and car parking facilities, low-emission zones, and public space planning to support liveability in growing cities.

Aiming at promoting seamless travel door-to-door, investments towards an integrated mobility system are planned. By 2040, people are expected to travel seamlessly from A to B, combining public transport, bicycles, and cars, therefore multimodal interchange hubs will be developed to facilitate easy transitions between different transport modes. These hubs will be efficient, attractive, and will offer various services, while also supporting spatial development.

Regarding the utilization of technological advancements, innovations like MaaS will enhance public transport efficiency facilitating user convenience. In addition, new demand-driven transport concepts, such as shared bicycles, cars, and bus rapid transit, will cater to varying demands. Also, central government will coordinate a national action plan to ensure open data access for seamless travel, while efforts will also be made to make public transport fully accessible to people with disabilities by 2040.

In terms of legal framework, the plan outlines the need to develop frameworks for regional and national transport paths, examining utilization options before investing in infrastructure, and launching pilot projects to test new concepts. Furthermore, it highlights the necessity to align transport and spatial planning policies to achieve sustainable urban growth.

4.2.4 Estonia

Estonia signed the transport and mobility development plan for the period 2021-2035 [25] in 2020 laying out its vision for transforming the country's transport and mobility infrastructure into a more sustainable, efficient, and environmentally friendly system by 2035.

The development plan aligns with the strategic objectives of "Estonia 2035", focusing on promoting a healthy and sustainable lifestyle, reducing greenhouse gas emissions in the transport sector, and increasing the use of public transport, bicycles, and walking for commuting.

Regarding sustainability in the transport sector, the plan emphasizes developing sustainable transport infrastructure such as railways and alternative fuels to reduce air pollution and promote sustainable mobility. In addition, it supports the conversion of public transport to

renewable energy and the development of urban transport systems like bicycle paths and tramways.

Moreover, the plan focuses on making cities inclusive, safe, resilient, and sustainable, with significant attention to reducing emissions of fine particles and promoting public transport, cycling, and walking. Among the measures proposed, there is better public transport management, smarter ticketing, and the development of renewable energy solutions for public transport.

The plan highlights the need for a holistic approach to infrastructure development, considering environmental resources and biodiversity. Furthermore, emphasis is placed on the principles of sustainable mobility, which include minimizing the environmental footprint, supporting energy-efficient fuels, and promoting sustainable urban transport systems.

To promote urban mobility, the plan suggests the development of safe and functional cycling networks in urban areas, including infrastructure for personal transporters like electric scooters and wheelchairs. In addition, for better management of the urban traffic it proposes measures, such as better street design, on-street parking, and speed limits.

As far as public transport is concerned, the plan supports improvements in public transport accessibility, reliability, and service integration, including the development of multimodal hubs and better connection of public transport stops to services. Additionally, it is deemed necessary to introduce dedicated public transport corridors and priority systems to reduce connection times and enhance service efficiency.

In an effort to minimize car dependency, a modal shift from car use to public transport and active modes of transport through infrastructure development and policy measures is encouraged. Furthermore, the plan promotes shared mobility services and carpooling, especially in sparsely populated areas where traditional public transport may not be practical.

Other key projects and investments include the electrification of railway lines, the development of high-speed train services, the adoption of smart technologies for transport management, and the promotion of green maritime transport by making ferry services rely on environmentally friendly fuels and developing sustainable port infrastructure.

4.2.5 Croatia

In 2017 Croatia presented the Transport Development Strategy for the period 2017-2030 [26] focusing on integrating sustainable development principles into the transport sector and improving urban mobility. The strategy outlines specific measures and objectives across various modes of transport, including road, rail, port, airport, and logistics infrastructure, while aligning with European Union guidelines and environmental goals.

To promote sustainability, the plan emphasizes the establishment of infrastructure for alternative fuels such as electricity, natural gas (liquefied and compressed), hydrogen, and biofuels. This initiative aims to create a sustainable transport system with minimal negative environmental impacts and ensure interoperability with neighbouring countries and EU member states.

Other environmental protection measures include initiatives to promote energy efficiency and identifying low-carbon energy sources. This involves enhancing the energy efficiency of transport vehicles and infrastructure to reduce CO₂ emissions and mitigate climate change. Furthermore, another priority set is the implementation of sustainable waste management practices, such as modernizing the fleet of cleaning vessels and ensuring proper disposal and treatment of transport-related waste.

For better climate change adaptation, the strategy encourages the development of resilient transport infrastructure that can withstand extreme weather conditions. This includes upgrading existing infrastructure to meet higher environmental standards and constructing new facilities with sustainability in mind.

As far as urban mobility is concerned, the plan aims to shift the passenger modal split in favour of public transport and zero-emission modes. Moreover, investments in local, regional, and national bus systems, trams, and rail transport are prioritized to reduce urban pollution and congestion. In addition, modernizing public transport vehicles and infrastructure, such as rolling stock and stations, to improve safety, accessibility, and energy efficiency is deemed necessary.

Another key priority is fostering intermodality by developing intermodal passenger hubs to facilitate seamless transitions between different modes of transport. These hubs will connect

public transport systems with major demand centres, including airports and ports, promoting the use of public and active transport modes.

Additionally, the strategy promotes the development of specific bike systems, especially in relation to e-mobility, to improve urban mobility and reduce greenhouse gas emissions. Successful bicycle initiatives in cities like Koprivnica, Varaždin, and Osijek can serve as examples. Moreover, the plan supports the construction of new pedestrian paths and bike lanes, while also enhancing existing ones, to encourage active travel.

With regard to road infrastructure, the strategy prioritizes investments in the maintenance and periodic improvement of state, county, and local roads. This also includes implementing Intelligent Transport Systems (ITS) for adaptive traffic management, public transport management, and parking management in urban areas.

As far as railway infrastructure is concerned, modernizing rolling stock to meet high safety and quality standards, and upgrading infrastructure to improve safety and accessibility are considered key goals. Furthermore, another priority is the development of intermodal passenger hubs to enhance connectivity between rail and other modes of transport, while also reducing greenhouse gas emissions and increasing efficiency.

In terms of port infrastructure, it is considered necessary to modernize fleets with energy-efficient vessels and enhance the public service of search and rescue at sea. Moreover, the plan proposes the establishment of intermodal terminals linked to ports to facilitate the transition to public transport and reduce road bottlenecks.

Regarding airports, the strategy puts emphasis on ensuring that they are well-connected with other modes of transport, such as rail and bus, in order to promote the use of public transport for airport access.

With reference to the logistics sector, the plan highlights the development of main logistic centres in key locations such as Rijeka, Ploče, Split, Vukovar, Osijek, Slavonski Brod, and Zagreb to strengthen Croatia as a logistic hub for the wider region. Furthermore, it calls for infrastructure investments to support the smooth operation of logistic centres and enhance their connectivity with other transport modes.

5.Non-EU countries

After examining the main transport policies of the European Union and the national transport plans of a selection of EU countries, we will now review transport policies and plans from countries outside the EU. For this reason, four countries have been selected that present socioeconomic, geographical, cultural, and transport interest, namely the United States of America, the United Kingdom, Japan, and India.

5.1 Japan

In 2021 Japan endorsed the second Basic Plan on Transport Policy [2], which covers the period from 2021 to 2025. The plan outlines Japan's commitment to sustainable development and urban mobility by putting emphasis on decarbonization, green logistics, resilience, and disaster prevention.

In terms of sustainable development, Japan's strategy underlines the need for adopting eco-friendly transportation options through the promotion of electric vehicles (EVs), fuel cell taxis, and energy-efficient railway vehicles. By transitioning to these new generation vehicles, Japan aims to significantly reduce its carbon footprint in the transportation sector.

Another important feature of the plan is the establishment of carbon neutral ports, which aim to operate with zero emissions, leveraging technologies such as hydrogen-fuelled ships, super-efficient LNG-fuelled ships, and ammonia-fuelled ships. The plan also includes the operation of onboard CO₂ capturing ships, which will contribute to reducing maritime emissions.

Regarding airports, they are also part of the decarbonization process through measures like solar power generation, energy-efficient lighting (LED), and operational improvements. Additionally, the plan aims to make airports more sustainable by enhancing their energy efficiency and reducing their environmental impact.

Emphasis is also put on rendering the logistics sector greener. The logistics sector will undergo a digital transformation to enhance efficiency and sustainability through the development of a Cyber Port data platform to streamline logistics processes, reduce

unnecessary deliveries, and improve loading rates. Moreover, automation of logistics facilities will further contribute to reducing the carbon footprint by optimizing supply chains.

As far as resilience and disaster prevention are concerned, the transition from post-maintenance to preventive maintenance is crucial for ensuring the resilience of transportation infrastructure. By following this proactive approach, Japan aims to maintain the functional health of transport systems reducing the risks associated with natural disasters and infrastructure deterioration. In addition, implementing robust disaster management strategies is essential for maintaining transportation functions during large-scale disasters. An example of such a strategy is the training of TEC-FORCE (Technical Emergency Control Force) to enhance disaster awareness and coping skills among transportation enterprise board members.

With regard to urban mobility, the plan emphasizes maintaining and enhancing local community transportation services through stakeholder cooperation. For instance, the installation of Mobility as a Service (MaaS) systems is an initiative, which can integrate various forms of transportation into a single accessible service.

In terms of urban planning, linking public transport with town planning aims to create "Comfortable and Walkable" towns. This approach supports the development of smart cities, enhancing the liveability of urban areas through improved public transport networks and town planning coordination.

To enhance accessibility and promote social inclusion, especially for elderly and disabled individuals, Japan's transport plan encourages universal designs in transport infrastructure, which include, for example, the installation of platform doors and wheelchair spaces in Shinkansen trains. Furthermore, to render public transport infrastructure more accessible and friendly for tourists, specific enhancements are proposed, such as guidance in foreign languages and free Wi-Fi. Additionally, by supporting various forms of mobility, such as micromobility (e.g. e-scooters), the plan provides diverse and sustainable transportation options. Thus, this inclusivity ensures that all citizens have access to environmentally friendly transport.

Another key aspect of the plan is the use of digital technologies, which includes digital governance in transportation administration and the promotion of open data initiatives. Also, the examination and promotion of automated driving vehicles, autonomous ships, and drones

represent a forward-looking approach to urban mobility, as these technologies promise to enhance safety, reduce congestion, and improve the overall efficiency of transportation networks.

Regarding hygiene and public health, the plan proposes, in response to the COVID-19 pandemic, the implementation of rigorous hygiene protocols and the promotion of public awareness of health measures.

5.2 India

India's transport sector faces significant challenges caused by the country's rapid growth both population- and economy-wise. Due to the substantial energy consumption, greenhouse gas emissions, and air pollution levels, the country has implemented a series of policies and initiatives to mitigate the aforementioned problems, while also promoting sustainable development and urban mobility.

In year 2006 the National Urban Transport Policy [11] was introduced prioritizing the movement of people over vehicles and aiming to reduce air pollution and improve urban mobility. The policy's key strategies included the encouragement of the use of public transport systems, the development of infrastructure for walking and cycling, and the implementation of measures, such as congestion pricing and parking regulations, to reduce the reliance on private vehicles.

In 2008 India launched the National Action Plan on Climate Change, which among others supports the development of low carbon transport systems through better urban planning, modal shifts, and the adoption of alternative fuels such as biofuels and hydrogen.

The Transit-Oriented Development Policy in 2017 set as its objective the integration of land use with transport planning to create high-density urban areas around mass transit stations. The initiative promoted active transport and enhanced connectivity for pedestrians and cyclists to and from transit stations. In addition, it proposed focusing urban development within a 500-800 meter radius of transit stations to reduce travel distances and improve accessibility. Furthermore, the policy supported the design of streets and transit facilities that facilitated accessibility for people with reduced mobility.

Also in 2017, the Green Urban Mobility Scheme was launched to promote the adoption of hybrid and electric vehicles (EVs) and non-fossil fuels across 103 cities with populations over 500,000. Among the interventions proposed there were measures for developing pedestrian pathways and public bike-sharing systems, expanding Bus Rapid Transit Systems, and promoting the use of alternative fuels, such as compressed natural gas (CNG) and electricity for public transport vehicles.

Another transport policy approved in 2017 is the Metro Rail Policy, which highlights the need for high-quality public transport to meet the mobility needs of India's growing urban population. One of the key features of this policy involves the development of mobility plans that integrate metro rail with other modes of transport. In addition, another important objective is the encouragement of the cities to establish authorities that will coordinate urban transport planning and management. Moreover, the policy recommends leveraging the increased value of land around metro stations to finance the development and operation of metro rail projects.

5.3 United Kingdom

The UK government published in 2020 the Future of Transport Programme [7] aiming at creating a sustainable, efficient, and accessible transport system by utilizing modern technology and innovations. The plan also involves significant investments in infrastructure, creating a supportive regulatory environment, providing financial incentives, and engaging with stakeholders to ensure a successful implementation.

One of the main pillars of the programme is the transition zero emission vehicles (ZEVs). The UK government has set ambitious targets for phasing out non-zero emission vehicles, with the goal of having all new cars and vans be zero-emission by 2035 and completely phasing out non-zero emission vehicles by 2040. For this reason, emphasis is placed on creating a regulatory framework that supports the adoption and operation of zero-emission vehicles through updating primary legislation to facilitate the widespread deployment of electric and autonomous vehicles.

In terms of infrastructure investment, significant funds will be used for the development of charging infrastructure through the Local Electric Vehicle Infrastructure (LEVI) Fund

ensuring even distribution of EV charging points across urban and rural areas. In addition, local authorities will be encouraged to develop their own charging strategies to enable more efficient and widespread use of ZEVs.

Regarding financial support, various incentives are being offered to encourage the adoption of ZEVs, such as grants for purchasing electric vehicles and financial support for the installation of home and public charging points. Additional incentives include the promotion of electric vehicles within public transportation fleets and encouraging businesses to transition their company cars and delivery vehicles to electric.

Another important feature of the programme involves the decarbonization of the local roads. The ADEPT Live Labs Program is an initiative that focuses on decarbonizing local highway infrastructure through innovative projects that integrate sustainable practices within the circular economy and localism agendas. Among the projects, there is the reduction of the carbon footprint of road maintenance and construction, as well as the promotion of the use of recycled materials.

With regard to urban mobility, the strategy outlines key principles to ensure that new mobility services are safe, inclusive, and contribute to reducing emissions and congestion.

Furthermore, emphasis is placed on promoting walking, cycling, and mass transit as the best options for short urban journeys, thus reducing reliance on private vehicles. Apart from that, to further reduce dependency on car ownership the plan promotes alternative modes of transportation, such as shared mobility services, while also repurposing urban spaces currently used for parking into green spaces or new housing developments.

As far as urban planning is concerned, the programme pushes towards making cities more liveable and environmentally friendly through redesigning streetscapes to prioritize pedestrians and cyclists, creating more green spaces, and reducing the need for extensive car parking. In addition, initiatives such as the Transforming Cities Fund, a £2.5 billion programme aimed at improving intra-urban connectivity, can support projects that promote cycling, walking, and the use of low-emission vehicles, thereby fostering sustainable urban mobility. Furthermore, the integration of new mobility technologies and services, such as Mobility as a Service (MaaS), can render multimodal journeys easier and more efficient.

Expanding on the utilization of modern technology and innovation, the government is conducting trials of innovative transport solutions, such as shared self-driving vehicles, to

explore their potential benefits in urban settings. Through these trials the aim is to gather data and insights that will inform future policy and regulatory decisions.

5.4 United States of America

The U.S. Department of Transportation presented in 2022 the Strategic Plan for the fiscal period 2022-2026 [8] as a comprehensive approach aiming to create a more resilient, equitable, and environmentally friendly transportation system that supports economic growth and improves the quality of life for all Americans.

In terms of sustainable development, the plan shares the objective of achieving economy-wide net-zero emissions by 2050, which is very crucial given the fact that the transportation sector contributes significantly to greenhouse gas emissions. By promoting climate-friendly vehicles and modes of transport together with investments in EV infrastructure, the plan hopes to accelerate the process of decarbonization. A relevant project is the creation of a national network of 500,000 EV chargers by 2030, which will facilitate the widespread adoption of EVs. Additionally, the plan sets the target to increase the number of zero-emission buses in the national transit fleet by 450% to 7,500 vehicles by 2030.

As far as transport infrastructure is concerned, the U.S. strategy aims to build resilience into the system and mitigate vulnerabilities to climate change, sea-level rise, extreme weather, and natural disasters. In addition, the plan prioritizes the enhancement of emergency preparedness and response capabilities across the transportation sector.

Moreover, to foster climate and environmental justice the strategy focuses on increasing access to clean transportation options in environmentally disadvantaged areas, while also integrating climate justice into environmental review processes and reducing exposure to harmful emissions and noise pollution.

With regard to urban mobility, the U.S. Strategic Plan addresses the problem of traffic congestion, which costs the national economy over \$160 billion annually, by investing in infrastructure improvements designed to alleviate congestion, such as modernizing highways, bridges, and transit systems. In addition, strengthening the coordination between land use and transportation planning is vital for creating sustainable and liveable urban environments.

Furthermore, the plan sets a goal to restore transit ridership in major cities to 2019 levels by 2026 and to increase the percentage of person trips by transit and active transportation modes from 4% to 6% through investments in transit infrastructure and initiatives to make public transit more accessible and reliable.

Another key priority of the strategy is fostering equity in urban mobility and ensuring that transportation projects and programs increase opportunities and serve all communities. By expanding transportation options in underserved rural and urban communities, supporting equitable transit-oriented development, and improving pedestrian-friendly environments, the plan underlines the importance of inclusive planning processes that involve diverse voices and communities.

6.Comparative Analysis

After reviewing the national transport plan and policies of Greece as well as those of various EU and non-EU countries, we can create a table that summarizes and presents the main priorities and objectives of each plan.

OBJECTIVES AND PRIORITIES	TRANSPORT EMISSIONS REDUCTION	ROAD INFRASTRUCTURE	RAIL NETWORK	PORTS AND AIRPORTS	PUBLIC TRANSPORT	URBAN MOBILITY PLANS	CYCLING POLICIES	LOGISTICS	LAND USE POLICIES
GREECE	☑	☑	☑	☑	☑	☑		☑	
GERMANY	☑	☑	☑		☑	☑	☑	☑	☑
ITALY	☑	☑	☑	☑	☑	☑		☑	
NETHERLANDS	☑		☑		☑	☑	☑	☑	☑
ESTONIA	☑		☑	☑	☑	☑	☑	☑	☑
CROATIA	☑	☑	☑	☑	☑	☑	☑	☑	☑
JAPAN	☑		☑	☑	☑	☑		☑	☑
INDIA	☑	☑	☑	☑	☑	☑	☑	☑	☑
UK	☑	☑	☑	☑	☑	☑	☑	☑	☑
USA	☑	☑	☑	☑	☑	☑		☑	☑

Table 6.1 Summary of objectives and priorities of examined national transport plans

After that, we can proceed with the relevant comparative analysis by utilizing statistical indicators that are related to sustainable growth and urban mobility. For the purposes of this

analysis, we will make use of the OECD database that includes useful data for a wide variety of sectors and themes.

6.1 Sustainable development indicators

One of the most important indicators with regard to environmental impact and sustainability of a system is the amount of CO₂ emissions. Given the fact that it is an objective of the Paris Agreement to reach a global net zero state by 2050, it is easily understood why the reduction of CO₂ emissions constitutes one of the main targets for modern transport policies.

For the purposes of the current analysis, we will utilize the amount of CO₂ emissions from transport in tonnes per one million units of current GDP in US dollars, which is an indicator that measures the efficiency of the transport sector in terms of emissions relative to economic output. From the OECD database we can create the following chart with the most recent available data:

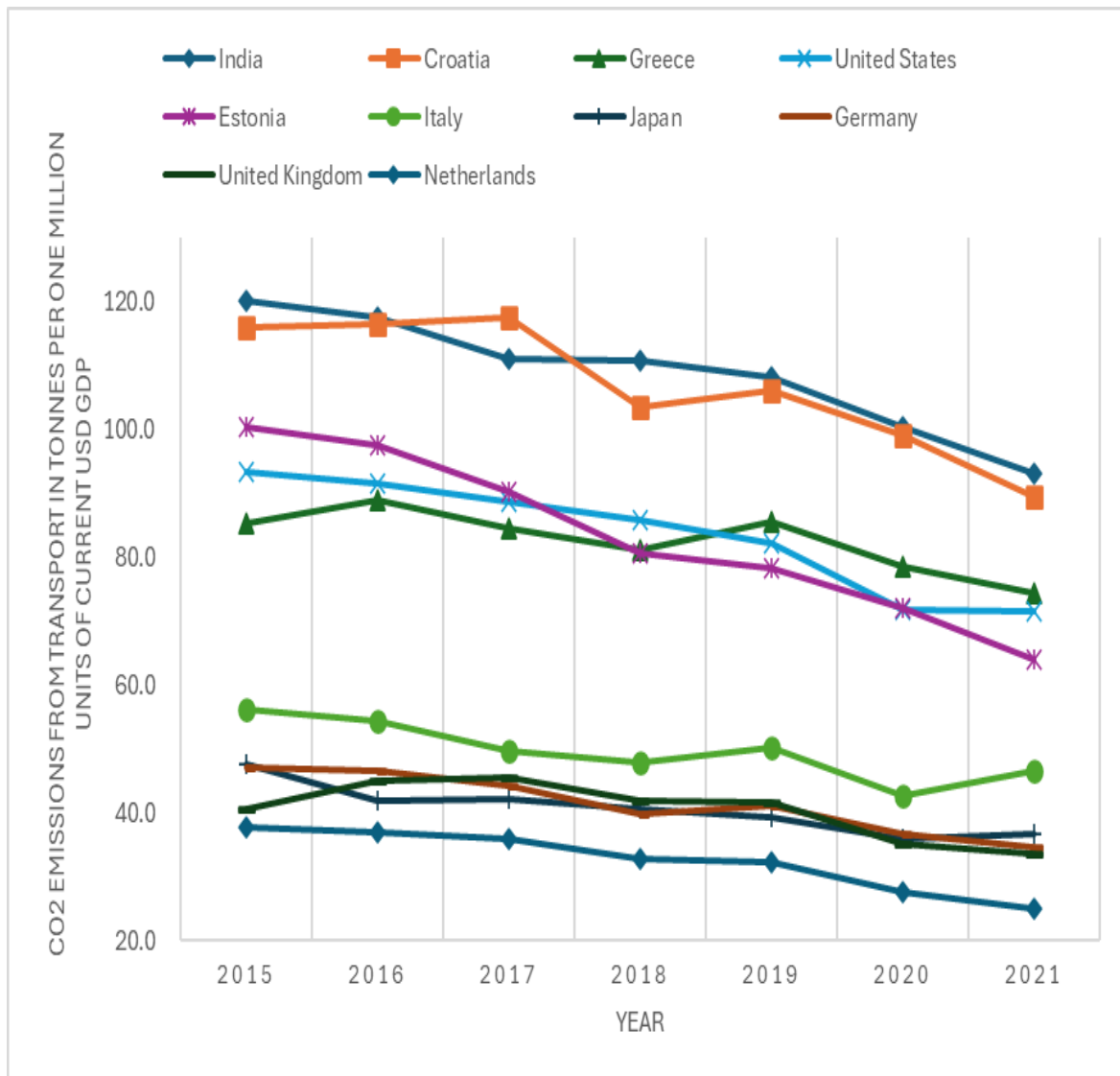


Figure 6.1 *CO2 emissions from transport in tonnes per one million units of current GDP in US dollars (OECD.Stat, 2024)[16]*

We observe that all countries demonstrate a downward trend in CO2 emissions from transport per one million units of their GDP over the period 2015-2021, which offers a positive prospect regarding the efficiency and sustainability of their respective transport sectors. Despite the general decline, countries like India and the U.S.A. have a much higher number of CO2 emissions per GDP units compared to countries like Germany, Japan, the U.K., and the Netherlands, which means that the former countries need to take further measures to render their transport sectors more environmentally friendly and efficient. The same can be said for Greece, as in 2021, for instance, the CO2 emissions from transport per GDP units

were approximately equal to three times those of Netherlands, which means that there is still a lot of room for improvement.

Another useful indicator that we can examine is the share of CO₂ emissions from transport in total CO₂ emissions for each country in order to understand the relative contribution of each country's transport sector to climate change compared to other sectors of the same country. In this way, useful inferences can be made with regard to the degree of the transport intensity and the dependence of an economy on transport. Moreover, it can be an indicator regarding the country's capacity to efficiently manage transport so as to decouple its economic growth from transport based on fossil fuels. From the OECD database we extract the following table:

Indicator	Share of CO ₂ emissions from transport in total CO ₂ emissions						
Year	2015	2016	2017	2018	2019	2020	2021
Country							
Croatia	38.1	38.6	40.8	41.6	42.4	39.6	40.8
United States	34.5	35.4	36.2	35.9	37.0	35.4	36.6
United Kingdom	30.2	32.6	33.9	34.2	35.1	31.5	32.5
Greece	25.9	27.2	26.8	27.9	31.0	30.9	32.1
Italy	31.2	31.2	30.4	31.6	32.6	29.4	31.7
Estonia	16.2	14.9	14.7	16.0	24.9	32.2	28.7
Germany	21.6	21.9	22.7	22.7	24.8	24.0	23.6
Netherlands	18.3	18.3	19.2	19.7	20.2	19.2	18.7
Japan	18.3	18.3	18.4	18.8	19.1	18.3	18.4
India	12.7	13.0	13.3	13.2	13.5	12.9	12.9

Table 6.2 Share of CO₂ emissions from transport in total CO₂ emissions (OECD.Stat, 2024)

Examining the Table 6.2 we observe a generally stable trend which points slightly upwards for each country regarding the percentage of CO₂ emissions from transport compared to the total national CO₂ emissions. Only Estonia and Greece show a significant and concerning trend upwards, which means that during the period 2015-2021 their respective transport sectors have increased substantially their relative negative contribution to climate change or it could also mean that other sectors of their economies have decreased their percentage of CO₂ emissions and the transport sectors did not keep up with this change. Of course, the percentage of a country's contribution to global CO₂ emissions should not be overlooked,

which means that at a global level even a small percentage increase in the emissions of Germany's or USA's transport sector would have more impactful consequences compared to a bigger percentage increase of a low-contributing country in terms of global CO₂ emissions, such as Greece and Estonia. All in all, each country should strive for turning this trend downwards meaning that the national transport sectors as time passes by should contribute less to the total national CO₂ emissions.

6.2 Urban mobility indicators

To connect the national transport plans and policies with the transport sector performance of each country, in terms of facilitating urban mobility, we will again use some indicators that are available on the database of the Organisation for Economic Cooperation and Development website. This time the data will refer to functional urban areas (FUAs) of the countries that we reviewed before. According to OECD, as a functional urban area we can consider a densely inhabited city and a surrounding area (commuting zone) whose labour market is highly integrated with the city.

The first indicator that we will examine is the percentage of population in FUAs that has access to public transport within ten minutes of travel time. This metric can help us generate useful inferences with regard to the accessibility, convenience, inclusivity, and density of a public transport system.

From the OECD Data Explorer webpage, we extract the following table with the most recent data available regarding the year 2022:

Access to public transport - Functional Urban Areas			
Measure: Access to public transport			
Unit of measure: Percentage of population			
Travel time: Within 10 minutes			
Time period: 2022			
Mode of transport	Metro or tram	Bus	Total
Functional Urban Area			
London	21.1	96.6	96.6
Berlin	47.9	91.6	93.9
Athens	22.5	92.1	92.1
Roma	30.6	91.1	91.1
Tallinn	22.7	89.1	89.1
Tokyo	13.6	82.3	82.4
Amsterdam	23.6	80.6	80.7
New York (Greater)	30.7	56.1	56.3

Table 6.3 Percentage of population in FUAs with access to public transport within 10 minutes of travel time (OECD Data Explorer, 2024)[15]

Based on the Table 6.3, the public transport system of Athens is widely accessible as 92.1% of the population has access to it within ten minutes of travel time from their location. This percentage is influenced by the dense bus network, which offers access to public transport to most of the population that lives in the functional urban area of Athens. In terms of access to the metro or tram, the percentage is only 22.5% for the Athens FUA, thus the responsible authorities could look into the possibility of expanding the network of these two modes in order to increase their accessibility following the example of Berlin, where approximately one out of two persons has access to metro or tram within ten minutes from their location.

Next, we will assess the performance of different transport modes , namely driving, cycling, and mass transit, based on the indicator that divides average absolute accessibility with average proximity. As average absolute accessibility, the database considers the average number of destinations that you can reach using the mode being assessed, whereas average

proximity can be considered the average number of destinations that are nearby. In terms of destinations, this includes hospitals, schools, parks, restaurants, and other points of interest. Regarding distance, the metric considers a fifteen minute threshold for absolute accessibility, which corresponds to a four kilometre distance for proximity for driving, cycling, and public transport and to one kilometre for walking.

First, we will examine the performance of driving using the OECD database and the following table with available data from year 2018:

Scale	Entire metropolitan area		
Mode of transport	Driving		
Distance	15 minutes/4 km (1 km for walk)		
Destination	Population		
Year	2018		
Indicator	Average absolute accessibility	Average proximity	Average transport performance
Metropolitan area			
Tallinn	34,883.91	90,979.15	0.38
Rotterdam	47,352.01	129,653.10	0.37
Grad Zagreb	42,669.44	124,217.20	0.34
Amsterdam	43,011.42	136,603.40	0.31
Milan	52,548.87	182,184.80	0.29
Greater Manchester	35,232.95	123,519.20	0.29
Munich	43,977.11	158,088.60	0.28
Berlin	41,508.01	207,017.57	0.20
Rome	34,832.03	192,914.20	0.18
Thessaloniki	45,236.73	270,493.80	0.17
London	35,322.57	260,876.10	0.14
Athens	50,784.63	437,721.60	0.12

Table 6.4 Average performance of driving for various metropolitan areas (OECD.Stat, 2024)

Observing the Table 6.4 we notice that the average performance of driving for the metropolitan area of Athens is the lowest compared to the other metropolitan areas examined. A value of 0.12 means that a person driving for fifteen minutes can reach only 12% of the

possible destinations in a radius of four kilometres from the starting location. The metropolitan area of Thessaloniki performs slightly better than Athens with a value of 0.17. Nevertheless, both Greek cities are at the bottom part of the table meaning that they underperform compared to other metropolitan areas. Among others, spatial planning and traffic congestion are two of the main causes of this underperformance, thus there needs to have better traffic management and road network planning in order to mitigate the issue related to driving.

After driving, we will now examine the performance of mass transit for the same conditions of distance. The relative table can be seen below:

Scale	Entire metropolitan area		
Mode of transport	Public transport		
Distance	15 minutes/4 km (1 km for walk)		
Destination	Population		
Year	2018		
Indicator	Average absolute accessibility	Average proximity	Average transport performance
Metropolitan area			
Rome	50,890.98	192,914.20	0.26
Berlin	50,298.30	207,017.57	0.24
Tallinn	22,089.96	90,979.15	0.24
Amsterdam	29,579.84	136,603.40	0.22
London	46,525.05	260,876.10	0.18
Rotterdam	22,791.22	129,653.10	0.18
Greater Manchester	11,655.35	123,519.20	0.09
Milan	16,403.57	182,184.80	0.09
Athens	34,143.87	437,721.60	0.08

Table 6.5 Average performance of public transport for various metropolitan areas (OECD.Stat, 2024)

Again we observe that Athens occupies the last place of the table 6.5 meaning that also its public transport system underperforms compared to other cities, such as Rome, Berlin, Tallinn, and Amsterdam. This could be caused by traffic congestion, lack of proper infrastructure such as designated bus lanes, limited extent of public transport networks etc. Therefore, the authorities should look into installing intelligent systems that can help with

traffic management, improving the public transport infrastructure such as creating exclusive bus lanes, extending the length of the mass transit networks in order to give access to more destinations etc.

Finally, we will assess the performance of cycling based on the below table:

Scale	Entire metropolitan area		
Mode of transport	Biking		
Distance	15 minutes/4 km (1 km for walk)		
Destination	Population		
Year	2018		
Indicator	Average absolute accessibility	Average proximity	Average transport performance
Metropolitan area			
Tallinn	65,758.08	90,979.15	0.72
Amsterdam	96,045.21	136,603.40	0.70
Grad Zagreb	76,228.59	124,217.20	0.61
Rotterdam	79,333.01	129,653.10	0.61
Munich	96,371.97	158,088.60	0.61
Berlin	125,538.79	207,017.57	0.61
Milan	110,229.20	182,184.80	0.61
Thessaloniki	150,590.60	270,493.80	0.56
London	140,573.60	260,876.10	0.54
Greater Manchester	54,951.32	123,519.20	0.44
Athens	194,329.80	437,721.60	0.44
Rome	78,614.90	192,914.20	0.41

Table 6.6 Average performance of cycling for various metropolitan areas (OECD.Stat, 2024)

As we can see, Athens is penultimate in terms of cycling performance, whereas Thessaloniki performs better but it is still at the bottom half of the table with a huge distance from the best performing cities, such as Tallinn and Amsterdam. The reasons for this disappointing performance of the Greek cities in terms of cycling could be the lack of proper infrastructure and the absence of a national plan to encourage the growth of this transport mode. Facilitating the use of bicycles is of great importance for the sustainability of an urban transport system

and the promotion of urban mobility. Therefore, the competent authorities should invest on cycling infrastructure, such as creating an extensive network of bike lanes and parking places for bicycles, along with the implementation of a national cycling strategy that will create the legal framework and lay the foundations for the healthy development of cycling in Greece.

7.Recommendations for the Greek national transport plan and policies

After assessing the performance of the transport sector of the countries examined in terms of sustainable development and urban mobility by comparing several indicators, we will now focus on the Greek national transport plan and policies. The results from the previous analysis were generally negative for Greece and its two biggest metropolitan areas in terms of sustainability and promotion of urban mobility. Therefore, in this chapter we will attempt to identify possible improvements for the national transport plan and policies, while also highlighting best practices from other countries that could be used as examples and be implemented in Greece in order to enhance the performance of the national transport sector in terms of sustainability, efficiency, accessibility, inclusivity, and encouragement of urban mobility.

7.1 Electrification and renewable energy integration

As we saw on chapter 6 of the comparative analysis, during the period 2015-2021 the share of CO₂ emissions from the Greek transport sector compared to total national CO₂ emissions increased from 25.9 in 2015 to 32.1 in 2021. In addition, the same year (2021) the indicator of CO₂ emissions in tonnes per one million units of GDP in US dollars had a value of 74.2 for Greece, which is very high compared to countries like the Netherlands with a value of 24.8 . For the above reasons, it is imperative to address the problem of CO₂ emissions in order to reach the targets set by the Paris Agreement and the European Union.

The process of electrification of the transport sector along with a better and more efficient integration of renewable energy sources could contribute massively to the reduction of CO₂ emissions, while also rendering the national transport sector more environmentally friendly and efficient.

The first step towards this direction involves the replacement of the current vehicle fleet, which is old and polluting, with new hybrid or fully electric vehicles that produce much fewer or even zero emissions. The government should continue to support this transition by offering incentives through generous subsidies or tax exemptions to owners of less polluting vehicles. Apart from private owners, companies should also be incentivized to proceed with the electrification of their fleet through positive (e.g. tax reduction) or punitive measures (e.g. financial penalties).

Moreover, serious investments should be made with regard to the infrastructure that will support the electric transition. Charging stations should be installed in urban centres and points of public interest as well as along highways and rural areas. Thus, the concerns about electric vehicles and their autonomy can be alleviated and more people will be keen to select them in the future. Additionally, by utilizing renewable energy sources, such as solar or wind energy which are found in abundance in Greece, for producing clean energy for the charging stations the transition to electric vehicles could have multiple positive effects in terms of environmental and financial sustainability of the Greek transport system.

Apart from the vehicle fleet, the Greek railway network is also in need of electrification, as in 2021 only 31.3% of the total network length is electrified [4], while there are still many routes that are served with diesel engines. By electrifying and upgrading the railway network, train can be better promoted as a green transport mode both for passenger and freight transportation. This could also help transfer much of the freight volume that is currently being transported by old polluting large goods vehicles (LGVs) to rail, thus rendering the profile of the freight transport sector in Greece more environmentally friendly and efficient.

Urban public transportation is another area where electrification and use of renewable energy sources could have a significant effect. Greek municipalities and other competent authorities should heavily invest on electric or clean energy buses, as this move could benefit in multiple ways the life quality of their citizens by reducing air and noise pollution as well as enhancing the environmental and economic sustainability of the urban public transportation sector.

Besides electrification, alternative fuels, such as biofuels, should also be promoted and integrated in the national transport sector, especially in the maritime and aviation sectors, where electrification is still at an early stage. Furthermore, funds should be allocated for research on hydrogen and other alternative fuels as well as on new technologies and innovation in sustainable transport solutions in collaboration with universities, research institutions, and startups. In this way, the country could play a leading role in the transport and energy sector in the future given its high potential for renewable energy.

7.2 Promotion and enhancement of sustainable urban mobility

Another observation based on the comparative analysis of chapter 6 was that the Greek big metropolitan areas of Athens and Thessaloniki performed badly in terms of urban mobility, as all transport modes examined, namely driving, mass transit, and cycling, received bottom-half grades in terms of average transport performance compared to other European metropolitan areas.

For this reason, the Greek national transport plan should put more emphasis on policies and approaches that enhance and promote urban mobility in a sustainable way. Starting from the car use, the priority should be to turn people to greener modes, such as public transport. Nevertheless, to improve the average transport performance of driving as a mode, it is imperative to mitigate the serious problem of traffic congestion. Therefore, the deployment of intelligent transport systems is deemed necessary in order to improve traffic management and optimize the traffic flow. Additionally, these systems can help on decision-making by offering valuable data that can be utilized when making decisions on possible infrastructure improvements and maintenance works.

As far as public transport is concerned, the electrification of the fleet, as mentioned above, can contribute to a more sustainable system with enhanced environmental footprint and reduced levels of air and noise pollution. Other upgrades should involve the expansion of the metro and tram networks to boost accessibility along with improvements related to service frequency, level of service etc. In addition, smart and innovative technological solutions, such as unified tickets for all public transport modes, electronic contactless payment option, and Mobility as a Service applications should become second nature to urban residents. These

solutions can foster multimodality and render urban trips more attractive, efficient, and pleasant for the users of the transport system.

Apart from that, the promotion of cycling and walking as green alternative transport modes should also be a fundamental part in any planning process for sustainable urban mobility. Unfortunately, Greece is still lacking in terms of cycling and walking infrastructure, while also not having implemented yet a national cycling plan in contrast with countries like Germany or the Netherlands, which do have national cycling strategies and a cycling culture with deep roots in their societies.

To improve the above-mentioned deficiencies in terms of cycling and walking, the competent administrative authorities should invest heavily on creating dedicated bike lanes and pedestrian zones in urban areas in order to prioritize pedestrians and cyclists, thus ensuring their safety, improving air quality, and promoting a healthy, environmentally friendly, and economic way of moving in urban areas. In addition, bike parking spots should be created near public transport hubs to support seamless multimodal transportation. Moreover, bike sharing apps should be promoted along with campaigns of raising public awareness with regard to the multiple benefits of cycling both for the individual and the society.

Additionally, there needs to be a change in urban planning philosophy to promote the development of high-density residential and commercial areas around public transport hubs, while also offering green spaces and parks. In this way, there will be less dependence on cars, due to the immediate access to the public transport system, and a better life quality since there will be more places with trees for walking and cycling.

7.3 Upgrading and strengthening the legal framework

As mentioned in chapter 3, the Greek national transport plan highlights the need for a revision and streamlining with regard to the legal framework that covers urban and regional transport in order to enable better collaboration among local authorities. Moreover, institutional reforms are needed to improve strategic planning capacities within the Ministry of Transport and other competent authorities.

To achieve better and more effective coordination between the various governing bodies, it is necessary to have an integrated and cohesive national transport strategy that is fully aligned

with the EU policies and the respective goals regarding sustainable development.

Furthermore, legal reforms are needed to simplify and modernize legislation in order to be up to date with the current developments in the world.

Another important measure is the obligatory implementation of the EU policy regarding Sustainable Urban Mobility Plans for all tiers of public administration in Greece. In this way the local authorities will be required to plan strategies for improving urban mobility and life quality for their citizens and the state should supply them with everything they need in terms of technical and financial aid for ensuring a successful implementation. Furthermore, the participation of all stakeholders and social groups should be encouraged during the planning process to enable pluralism and inclusivity.

In terms of enhancing the strategic planning capacities of the relevant authorities, specialized training programmes could be utilized for the personnel that deals with these subjects. Apart from that, broader education reforms are of vital importance, as sustainable growth and urban mobility should be part of the school programme from an early age in order to foster these values in future generations. Additionally, to raise public awareness regarding sustainable transport and encourage positive changes in transport habits, the government and the local authorities should organize informational campaigns to educate the citizens on this issue.

Finally, it is imperative for the planning authorities to establish a common and integrated evaluation and monitoring process to ensure that transport policies and plans are progressing as planned. This process should include the utilization of a series of key performance indicators along with the regular reviews and reporting to ensure transparency and accountability.

8. Conclusion

After the recommendations for improving the Greek national transport plan and policies, we will proceed by summarizing the key findings of the dissertation and proposing possible areas for future research.

8.1 Summary and key findings

The present dissertation attempted to make a comparative analysis between the Greek national transport plan and the ones from selected EU and non-EU countries placing emphasis on the issues of sustainable development and urban mobility.

The examination of the Greek national transport plan started by offering a historical background and continued by presenting the contemporary situation with regard to the national transport infrastructure. Subsequently, the various goals, measures and initiatives of the plan were reviewed regarding sustainable development and urban mobility.

One of the key objectives is the mitigation of the negative environmental impact of the national transport sector by reducing the emissions of CO₂ and other pollutants, such as CO and NO_x. To achieve that the plan supports the promotion of electric vehicles and the upgrade of the railway network. In addition, it proposes upgrades to the infrastructure of the national ports and airports along with the adoption of green technologies and practices.

Another key proposal of the plan is the establishment of a legal framework for urban mobility planning and the support towards the development of SUMPs in Greece. In addition, it recognizes the need for legislative reforms that will render legislation more modern and streamlined with regard to transport policies.

After that, the dissertation reviews the main EU transport policies, such as the European Green Deal, the TEN-T, the Sustainable and Smart Mobility Strategy, and the SUMPs, as well as their objectives. Subsequently, the national transport plans and policies of five selected EU countries, namely Germany, Italy, the Netherlands, Estonia, and Croatia, are presented. Following the presentation of the EU countries' transport plans and policies, we proceed with countries outside the European Union, such as the United States of America, Japan, India, and the United Kingdom.

Next, a comparative analysis was made based on data from the OECD database and utilizing indicators that measured the environmental impact of the transport sector for each country, the accessibility of the public transport, and the average transport performance of different modes in functional urban areas around the world. The analysis found that the Greek transport sector produced more CO₂ emissions per units of gross domestic product compared

to other European countries, such as Germany and the Netherlands. Furthermore, during the period 2015-2021 the share of CO₂ emissions from transport to total CO₂ emissions increased much more in Greece and Estonia compared to the other EU countries examined. Moreover, in terms of urban mobility the analysis indicated that the metropolitan area of Athens offers access to public transport for a high percentage of the population, however the average transport performance for the examined modes, namely driving, mass transit, and cycling, proved to be underwhelming both for Athens and Thessaloniki.

After the comparative analysis, the dissertation proceeded with recommendations for improving the Greek national transport plan and policies. The proposals were focused on the electrification of the transport sector and the integration of renewable energy sources to it. Additionally, the promotion and enhancement of sustainable urban mobility was highlighted by proposing upgrades to the urban public transport systems along with investments on cycling and walking infrastructure. Finally, a revised and modernized legal framework was recommended in order to ensure better coordination between the various competent authorities. Other key proposals included the obligatory implementation of the SUMP's policy for all tiers of local administration, the enhancement of the strategic planning capacities through training programmes and education reforms, and the establishment of a unified evaluation and monitoring process to ensure transparency and accountability in controlling the progress of transport projects.

8.2 Proposals for future research

The field of sustainable development and urban mobility can be a wide research area with new policies, technologies, practices, and data emerging continuously, as time passes by and human societies evolve. As a result, future research could follow several interesting directions.

First of all, future research could examine the long-term impact of the contemporary transport plans and policies after collecting data for a long period of time, such as a decade or more. In addition, an analysis could be made to highlight how transport policies adapt to the evolving technological, socioeconomic, and environmental conditions. Moreover, case studies could be examined to identify specific policies that proved very effective and investigate whether they can be adopted and transferred to different places of the world.

Another area of study could be technology, innovation, and their impact on national transport policies. For instance, research could investigate several new technologies and innovations, such as autonomous vehicles and hydrogen-powered transport solutions, while also identifying their advantages, drawbacks, limitations, and difficulties in their adoption.

Apart from that, from a sociological and behavioural point of view, future research could assess how transport policies affect different social groups placing emphasis on more vulnerable groups of people. Furthermore, research could be made on the public attitude towards transport policies in countries with different socioeconomic and cultural backgrounds.

From an administrative perspective, it would be interesting to see how different governance structures adopt new transport policies and how effective they are in implementing them. Additionally, it would be worth studying the level of participation needed regarding the various stakeholders for a successful transport policy implementation.

Moreover, from a financial point of view, future research could focus on the economic impact of policies that support sustainable development and urban mobility, while also assessing the best and most efficient mechanisms for the sustainable financing of these policies.

Furthermore, based on the Council Recommendation of 16 June 2022 on ensuring a fair transition towards climate neutrality [6], it would be necessary to examine the potential consequences of the transition to a climate neutral transport system in terms of generating inequalities regarding income, employment, living conditions, affordability of clean fuels and transport services, and accessibility.

Finally, it would be worth studying the level of integration of national transport plans with spatial planning and land use frameworks in order to ensure alignment with broader urban, regional, and national development goals that promote economic growth, environmental sustainability, and social well-being.

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