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The effect of smart mobility performance in mitigation of climate change, the experiences of European cities

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Abstract

Smart and sustainable urban improvement is the current priority. Mobility is one of the most difficult topics to face within the urban regions. Great mobility for citizens and businesses incredibly increases the attractiveness and competitiveness of cities. The transport sector is one of the biggest contributors of CO2 emissions and other greenhouse gasses. In order to decreasing the global average temperature by CO2, critical and transformative activities in urban portability are required. As a sub-domain of the smart-city concept, smart-mobility-solutions integration at the municipal level is thought to have environmental, financial and social benefits, e.g., decreasing air pollution in cities, giving modern markets for alternative mobility and ensuring widespread get to to open transportation. Therefore, this article points to analyze the significance of smart mobility in creating a cleaner environment and provide strategic and practical illustrations of smart-mobility services in four European cities: Berlin (Germany), Kaunas (Lithuania), Riga (Latvia) and Tartu (Estonia). The paper presents a systematized writing review approximately the potential of smart-mobility services in reducing the negative natural affect to urban situations in different cities.

1. Introduction

Climate change mitigation requires transformative changes in cities. Rapid urban population growth, traffic congestion and related air pollution, as well as ageing infrastructure and energy usage put cities at the center of the climate mitigation agenda. In 2018, 4.2 billion of the world's population lived in cities. This number is expected to reach 6.5 billion by 2050(United.Nations, 2023).

Environmental implications are highly related to the consumption of natural resources for energy production and greenhouse gas emissions (GHG), which contribute to climate change. Currently, cities are responsible for 60 to 80% of all energy consumption and approximately 70% of carbon emissions in the world(United.Nations, 2023). The transport sector is one of the main contributors to greenhouse gas emissions. At the global scale, transportation accounted for 28% of the global final energy demand and 23% of global energy-related CO2 emissions in 2014 (Masson-Delmotte. el 2018). The transport sector's emissions, such as particulate matter (PM10 and PM2.5), nitrogen dioxide (NO2), carbon monoxide (CO) and other gases, mostly depend on the type of fuel used, with diesel and gasoline being the most popular. (World Urban Forum, 2014).

In the early 1990s the phrase "smart city" was coined to signify how urban development was turning towards technology, innovation and globalization (Schaffers and all, 2018). The World Foundation for Smart Communities advocated the use of information technology to meet the challenges of cities within a global knowledge economy. However, the more recent interest in smart cities can be attributed to the strong concern for sustainability, and to the rise of new Internet technologies, such as mobile devices (e.g., smart phones), the semantic web, cloud computing, and the Internet of Things (IoT) promoting real world user interfaces. (Komninos, 2002 and 2008).

2. Method

The study is based on the literature sources analysis and data regarding of smart urban development with a special regard to smart mobility indicators.

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2.1. Role of Smart-Mobility in Urban Environment Improvement

Smart-city discourse and its concept application is widely analyzed in scientific literature.

The smart-city concept is placed at the center of the urban agenda and is used as a tool for ensuring competitiveness and sustainability in urban areas. In a broad sense, it means a long-term vision, which includes usage of intelligent solutions and knowledge (Zawieska & Pieriegud, 2018), information and communication technologies, for efficient natural resource management, environmental impact reduction and better quality of life creation for citizens (Torre, T.; Braccini, A.M.; Spinelli, 2016).

In sustainability concept, urban mobility needs to consider improvement of natural environment condition, increase of social cohesion and economic competitiveness. Therefore, specific measures such as transport optimization, co-modality between public and private transport, and development and implementation of sustainable mobility plans could contribute in addressing these sustainability goals (Strulak-Wójcikiewicz & Lemke, 2019). Therefore, smart-mobility services are a complementary layer to conventional transport systems (Figure 1). It includes integrated ICT infrastructures, sustainable transport systems, and logistics to support better urban traffic and mobility (Cledou et al., 2018). Smart urban mobility uses technology for data generation and sharing; information and knowledge for decision-making; enhancement of vehicles, infrastructure and services; and improvement of transport system operators, users, and stakeholders (Lyons, 2018). Moreover, the term "smart mobility" is not only related to sustainable and efficient transport systems based on contemporary technology, but it also contributes to cleaner mobility pattern changes and decision effectiveness in the transport sector.

Mobility is also a necessary element in creating more resilient cities, which could be able to deliver natural and manmade shocks. The reduction of negative environmental impact of transportation during the COVID-19 pandemic crisis by improving air quality was proved by Feiferyt ˙ e-Skirien ˙e and Stasiškien ˙e (Skirienė & Stasiškienė, 2021), and Pepe et al. (Pepe et al., 2020). During the same crisis, smart-city systems, IoT sensors and Machine learning were used for timely insights provision, based on a real-time data, for assessing pedestrian levels and traffic volumes, as well as for effective decision making (James et al., 2020).

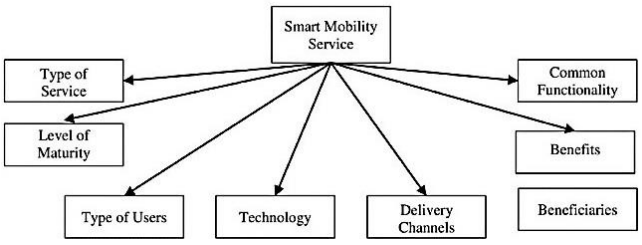


Figure 1. A smart-mobility service taxonomy (Cledou et al., 2018).

2.2. Smart-Mobility Strategies for Climate Mitigation

This analysis focuses on four main European cities—Berlin, Kaunas, Riga and Tartu—where the main strategic documents of these cities are analyzed in order to highlight sustainable mobility objectives, which were/are planned for making the mobility sector in urban areas smarter.

Public transport in Berlin is regulated at the State of Berlin and federal levels. There are a number of types of public transport modes such as buses, tram, subway, ferries and ridesharing. When comparing air-quality data in the four selected cities, we see that Berlin has the highest rates of air pollution from NO_2 and PM2.5. According to the municipality, NO_2 emissions were caused by traffic, heating and industry; PM2.5 was mainly caused by traffic (diesel vehicles and tire abrasion), heating, industry, the building sector. Due to COVID-19 pandemic restrictions, the emissions from the main pollutants decreased in 2020.

In Kaunas, public transport is regulated by national law acts, for example, the Law of the Republic of Lithuania on the Framework of Transport Activities. Buses, trolleybuses (electric) and buses are publicly operated transport modes, which currently exist in the city. Kaunas has the highest PM10 levels, it was the third from the four cities in NO2 emissions' concentrations.

Riga is a city in Northeastern Europe and the capital of Latvia. In Latvia, public transport is regulated by the Law on Public Transport Services. Currently, public transport modes in the city include buses, tram, trolleybuses (electric) and microbuses. Comparing all selected cases, Riga was the second city according to air emission rates (NO2, PM2.5 and PM10) in 2019. A majority of residents prioritize private transport for travelling inside the city, therefore, it could be presumed that the emissions could be caused by vehicles, which are powered by diesel and have a long period of use. However, it is not possible to indicate air-quality changes in 2020, as the data are not provided.

Tartu is the second largest city in Estonia, located in Northeastern Europe. Types of publicly operated public transport modes include buses, tram, subway, ferries and ridesharing. Tartu is the most environmentally-friendly city taking the lowest rates or main air emissions used in the study. Since the beginning of 2020, public transportation vehicles were fully powered by renewable fuel—biomethane—produced by recycled bio-waste.

Figure 2. Publicly operated smart-mobility services in Germany and the Baltic countries.

3. Results

3.1. Berlin "Urban Development Plan for Mobility and Transport" (2021–2030)

The report highlights the significance of mobility for inclusion, the financial sector and social cohesion. It too

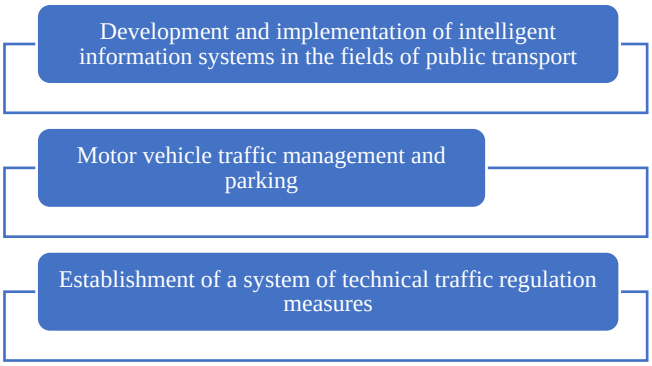
outlines that mobility has negative impacts on air quality, noise, wellbeing and the climate. Appropriately, the arrange characterizes overarching objectives related to a change of transport (82% ecomobility by 2030, with 23% cycling, 30% walking and 29% public transport), climate mitigation (42% CO2 reduction of the transport sector in comparison to 1990), wellbeing (decrease NOx and other air pollutions, as well as noise). Building on these objectives, the plan defines specific targets, related to characteristic assets, global environment and city-compatible traffic. The advancement arrange moreover sets target to decrease energy consumption related to traffic by 34% in 2030.

3.2. Sustainable Urban Mobility Plan in Kaunas City (2019–2030)

There are two main documents which address smart-mobility-concept integration in Kaunas City—Strategic Development Plan of Kaunas City Municipality Up to 2022 and Sustainable urban mobility plan in Kaunas city.

High quality and safe transport infrastructure is one among the long-term priorities in the city of Kaunas.

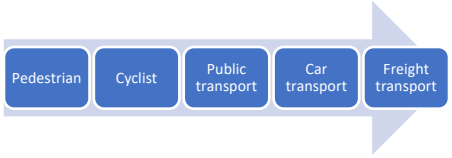
Table1. Specific targets and detailed measures for this plan implementation



3.3. Riga Sustainable Development Strategy Until 2030 (2014–2030)

Development of a "smart" traffic control system and facilitation of the development of the latest technologies, economically effective transport services are the targets of the strategy. A number of the measures are set in order to achieve the latter targets such as reconstruction and construction of modern traffic infrastructure, development pedestrian traffic infrastructure, pedestrian street network and network of mobility points, improvement of parking service, modernization of public transport, provision of a flexible ticketing system, integration of public transport into a single network of bus and train routes, improvement of the operation of the traffic management center and introduction of smart traffic lights.

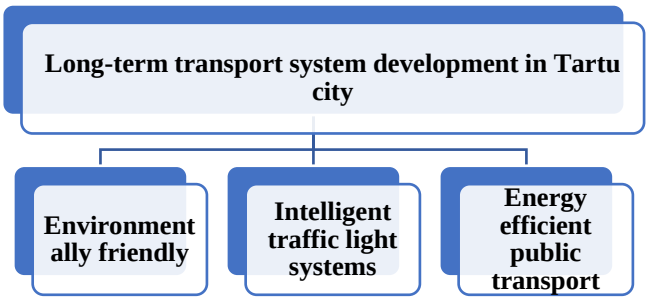
Table 2. Priority sequence in the development of transport infrastructure is formed as follows.



3.4. The Development Strategy "Tartu 2030+" (2006–2030)

One of the targets are related to the increase of public transport capacity and environmentally friendly public transport vehicles. The Strategy also highlights the importance of the completion of the construction of main streets, bridges and different level streets and road crossings to guarantee smooth traffic, the organization of an efficient parking system and the development of public and light transport.

Table 3. The priorities for long-term transport system development in Tartu city until 2030



4. Discussion & Conclusion

The results of the literature review showed that smart mobility is an important component of the smart-city concept. Smart mobility is a vision, based on the smart-city concept, and could result in a more sustainable future of cities. The installation of new smart-mobility innovations may reduce the negative environmental impact from the transport system; stimulate new (healthier and cost-effective) citizens' mobility patterns; and contribute to more efficient decision-making, urban-mobility policy planning and implementation. The involvement of decision-makers, public transport companies, private companies, citizens, experts, researchers and innovators is a necessary component in the planning process (both in top down and bottom-up initiatives) to form realistic and clear goals, targets and measures.

Intelligent transport systems installation, intelligent parking systems, traffic management systems, the importance of public transport services and integration of new technologies for smart-mobility development are important parts for rendering smart cities sustainable. The cities already integrate smart technologies such as intelligent transport systems installation, smart-mobility management platform, intelligent parking system, telematics systems, traffic management system, pollution control and transport air pollution- control-system sector speedometers. Even if the real impact of smart technologies is not assessed, smart technologies must provide the value and solutions, based on real-time data, in order to achieve global, the EU and municipal goals. The European Green Deal is a promising financial tool for cities to integrate more additional intelligent technologies in urban areas in the future.

The analysis of four selected cities—Berlin, Kaunas, Riga and Tartu—provided examples of different smart-

mobility services in European cities. Modal split results in the cities revealed a high citizens' dependence on private cars in Kaunas, Riga and Tartu, non-motorized transport modes (walking, cycling) are more preferred in Berlin. It also showed that public transport is one of the preferred modes of mobility. Regarding these findings, the examples of smartphone application, mobile ticketing app, smart bike-sharing and mobility point provided by the public sector could change these mobility patterns in a more sustainable way. Moreover, the data are not yet accessible that could be used for real contribution to CO2 and greenhouse gas reduction assessment. Therefore, it is necessary not only to provide smart-mobility services, but also use the beneficial output generated from/by these services in an intelligent way, to further benefit the smart-city system. The air-pollution data showed that, when comparing the four selected cities, Berlin had the highest levels of NO2 and PM2.5 emissions, while Kaunas had the highest rates of PM10 emissions. The best air-quality results were found in Tartu.

In particular, sustainable mobility strategies should focus on aligning ambitious climate mitigation with pandemic recovery measures, by investing in environmentally friendly mobility, i.e., biking, walking and public transport infrastructure, as well as ensuring universal and affordable access to urban mobility services. Furthermore, emphasis should be placed on rendering public transport more resilient for future crisis situations. Smart-mobility solutions should be integrated within overall mobility decarbonization to ensure that solutions that minimize transport's climate footprint in cities are replicated.

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