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Smart Mobility in Szczecin – Analysis and Assessment

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Abstract:

Purpose: *The aim of this paper is to analyse and evaluate the implementation level of the smart mobility concept in the city of Szczecin. The study focuses on identifying the key components of the smart mobility system, assessing their effectiveness, and outlining the challenges and opportunities for further development of sustainable urban transport.*
Design/Methodology/Approach: *The research employed a critical literature review, analysis of municipal strategic documents, and an empirical survey conducted among Szczecin City Hall employees and residents using modern mobility services (MaaS, carsharing, demand-responsive transport). The data were complemented by information from the Municipal Roads and Transport Authority and mobility service providers.*
Findings: *The results indicate that Szczecin is systematically developing a smart mobility system that integrates digital public transport (MKM 2.0), carsharing and micromobility services, demand-responsive transport, and infrastructure for electric vehicles. The implementation of the Intelligent Transport System (ITS) has improved travel efficiency and reduced emissions, while residents positively perceive the development of shared and digital mobility solutions. The research confirms growing social awareness and readiness to adopt environmentally friendly transport behaviours.*
Practical Implications: *The findings can support the further development of Szczecin's transport strategy, particularly in advancing Mobility as a Service (MaaS) integration, improving data interoperability, and expanding electromobility infrastructure.*
Originality/Value: *This paper provides a comprehensive assessment of smart mobility implementation in a medium-sized Polish city. The study contributes practical insights for local governments introducing intelligent transport systems and adds to the academic discourse on sustainable urban mobility.*

Keywords: *Sustainable urban transport, intelligent transport systems, electromobility, Mobility as a Service (MaaS), sharing economy, urban innovation.*
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1. Introduction

Modern society increasingly relies on intelligent solutions that permeate almost every sphere of daily life. The dynamic development of information and communication technologies (ICT) affects the way we work, communicate, and navigate urban space. Technological progress is particularly evident in large metropolitan areas, where population concentration and the intensity of economic processes foster the implementation of innovative city management concepts.

In this context, the idea of *smart mobility*—a key component of the *smart city* concept—has gained growing significance. It encompasses modern, data-driven transport solutions based on automation and resource sharing, aimed at enhancing travel efficiency, reducing pollution emissions, and improving residents' comfort and safety. Intelligent mobility not only transforms the way we use transportation but also shapes the future of sustainable urban development.

The development of the smart mobility concept is a response to increasing challenges related to urbanisation, traffic congestion, limited parking space, and the negative environmental impacts of transport. Intelligent traffic management systems, integration of diverse modes of public transport, and the expansion of infrastructure for electric and shared vehicles (such as car-sharing or bike-sharing) contribute to the creation of more flexible and environmentally friendly models of mobility.

A key role is played by real-time data analysis, which enables monitoring of traffic intensity, route optimisation, and adjusting the frequency of public transport to actual user demand.

Equally important is the integration of technology with social behaviour. Users increasingly rely on mobile applications that enable multimodal trip planning—combining different modes of transport within a single journey. Such solutions encourage behavioural change—from individual car ownership toward more sustainable modes of movement. Smart mobility also supports the development of the *Mobility as a Service* (MaaS) concept, which provides users with access to integrated transport services through a single digital platform.

From a broader perspective, the implementation of smart mobility solutions contributes to improving the quality of life in cities. The reduction of traffic congestion, noise, and exhaust emissions, along with the increased accessibility of public transport, positively affects residents' health and the overall attractiveness of urban space. Sustainable mobility thus becomes not only a component of innovative transport policy but also a tool for building a modern, environmentally friendly, and citizen-oriented city of the future

This paper analyses the process of implementing the smart mobility concept in Szczecin—a city striving toward a sustainable and technologically integrated

transport system. The study presents the main assumptions of the Smart Mobility concept, examples of its implementation, and the results of surveys conducted among employees of the City Hall of Szczecin.

The findings indicate that despite numerous infrastructural challenges, the development of intelligent transport solutions constitutes a key pillar of the "Szczecin 2050" strategy. The article's primary goal is to familiarise readers with the concept of smart mobility, assess the level of its implementation in Szczecin, and examine the city's trajectory toward smart mobility solutions. The spread of this concept across metropolitan areas depends on the level of development and availability of transport and technological infrastructure, as well as the adaptation of residents to the implemented innovations.

2. Literature Review

The concept of a smart city involves a comprehensive approach to urban development, utilizing advanced technologies and innovations to improve residents' quality of life and the efficiency of city operations. City managers are developing and implementing various strategies, including electromobility and smart city concepts, to mitigate the identified problems (Wang, Tundys, and Pokorska, 2024). The main areas of the smart city concept include (Ploeger and Oldenziel, 2020; Tahmasseby, 2022; Rahman, 2022):

- **Transport** – optimization of transport systems, including innovations in public transport, alternative modes of transport, intelligent traffic and parking management, and integration of transport systems.
- **Energy** – utilization of renewable energy, smart energy management, monitoring energy consumption in buildings, smart grids, and energy storage.
- **Environment** – monitoring air and water quality, nature conservation, green technologies, and sustainable development.
- **Education** – use of modern educational technologies in schools and universities, creation of e-learning platforms, development of innovative curricula, and ensuring access to knowledge for everyone.
- **Health** – implementation of telemedicine technologies, development of innovative healthcare services, monitoring population health, and disease prevention.
- **Safety** – application of intelligent monitoring and control systems, including video surveillance, alarm systems, and early warning systems for hazards.
- **Urban services** – improving the efficiency and accessibility of urban services, such as waste management, water, gas, and public lighting, through IoT (Internet of Things) technologies.
- **Public administration** – use of advanced IT technologies to improve the efficiency and quality of public services, automate administrative processes, and enhance communication between institutions.

The European Commission defines **smart mobility** as a transport system that uses information and communication technologies to improve quality of life and increase urban residents' mobility (European Commission, 2016). Shaheen and Cohen (2013) note that it includes shared vehicles, multimodal transport, and real-time information systems, enhancing accessibility and travel efficiency.

Marsden and Reardon (2017) emphasize the integration of different transport modes and digital services to reduce the environmental impact of transport and improve efficiency and convenience for users. Litman (2020) adds that smart mobility combines innovative technologies, urban policy, and operational measures to increase accessibility, safety, and sustainability of transport systems.

Therefore, smart mobility is defined as an integrated transport system that combines various modes of transportation—including public transport, electric bicycles and scooters, carsharing, and ridesharing—with modern digital technologies and real-time information systems.

In summary, the key elements of smart mobility common to all definitions include:

- **Vehicle sharing:** Services such as carsharing and ridesharing allow users to access vehicles without owning them.
- **Public transport:** Real-time information, digital ticketing, and route optimization.
- **Mobility as a Service (MaaS):** Digital platforms that integrate different transport options, facilitating travel planning and booking through a single application.
- **On-demand transport:** Services that allow rides to be requested at any time.
- **Autonomous technologies:** Development of autonomous vehicles and intelligent traffic management systems.
- **Micro-mobility:** Services such as shared electric scooters and bicycles.
- **Charging stations and electric public transport.**

One of the main objectives of implementing smart mobility in cities, including Szczecin, is reducing traffic congestion. By promoting alternative transport modes such as public transport, city bikes, and electric scooters, the aim is to decrease car traffic and improve traffic flow during peak hours.

Another important goal is environmental protection. The development of electromobility and electric-powered public transport helps reduce exhaust emissions, lower road noise, and mitigate the negative impact of transport on the climate. Introducing electric vehicles and sustainable mobility forms is a key part of urban policies promoting ecology and sustainable development. Smart mobility also aims to enhance road safety.

Intelligent transport systems, dynamic traffic light coordination, and traffic monitoring contribute to reducing accidents involving pedestrians, cyclists, and drivers.

The concept further supports increased accessibility and flexibility of transport. With diverse transport options—such as carsharing, ridesharing, and on-demand transport—users can freely choose the most optimal means of travel. Integrated transport systems allow seamless connection between different modes of transport within a single journey.

Finally, improving travel comfort is a significant goal of smart mobility. Modern mobile applications enable route planning, real-time information access, and integration of multiple transport modes, resulting in a more convenient and user-friendly travel experience for residents.

The ultimate outcome of these goals is an urban transport system that meets residents' needs and improves quality of life by increasing mobility efficiency, comfort, and user safety.

The correlation and the impact of individual smart mobility elements on its primary objectives are presented in Table 1.

Table 1. *Linking the objectives of the Smart Mobility concept with its elements.*

Elements / Goals	Traffic Congestion Reduction	Environmental Protection	Safety Improvement	Increased Accessibility and Flexibility	Enhanced Travel Comfort and Safety	Adaptation to Residents' Needs and Improvement of Quality of Life
Vehicle Sharing	+++	+++	+	+++		++
Public Transport	+++	++		+	+++	+++
Mobility as a Service	+++		+++	+++	+++	+++
On-Demand Transport	++	++		+++	+++	+++
Autonomous Technologies			++	+++	+++	+++
Micro-Mobility	+++	+++		++		+
Electric Vehicle Charging Stations and Number of Electric Buses	+++	+++		+	++	+++
Source: *Own study.*						

The concept of smart mobility aims to create efficient, sustainable, and user-friendly transport systems in cities. Local governments and local authorities must implement environmentally friendly, cost effective and socially acceptable policies (Drożdż, Kinelski, Czarnecka, Wójcik-Jurkiewicz, Marouskova and Zych, 2021).

Its main objectives include reducing traffic congestion by promoting public transport and shared mobility, lowering emissions and noise through electromobility, and improving the safety of road users via intelligent transport systems. Smart mobility also enhances accessibility, flexibility, and travel comfort by enabling the integration of various modes of transport and facilitating easy route planning. Achieving these goals contributes to improving residents' quality of life and creating cities that are more user-friendly, safe, and environmentally sustainable.

3. Research Methodology

The city of Szczecin is consistently implementing the principles of the smart mobility concept, which aims to create a modern, integrated, and environmentally friendly transport system. Actions undertaken in this area include both the development of technical infrastructure and the implementation of innovative digital services and traffic management tools. Below is an analysis and evaluation of the key components of the smart mobility concept (Table 1) in Szczecin.

Vehicle sharing is one of the foundations of sustainable urban transport, contributing to a reduction in the number of private cars and exhaust emissions. Szczecin hosts a range of carsharing and ridesharing services that support the idea of shared mobility. An example is Traficar, offering both passenger and delivery vehicles on a short-term rental basis. This system allows users flexible access to vehicles without owning them, aligning with global sharing economy trends.

Additionally, ride-hailing operators such as Bolt and Uber operate in the city, allowing residents to request rides on demand via a mobile app. These services increase transport accessibility, particularly during nighttime hours or in areas with limited public transport coverage. Public transport in Szczecin is highly digitalized and makes extensive use of information and communication technologies (ICT).

A key component is the Mobile City Card (MKM 2.0)—an application enabling ticket purchases, real-time schedule checking, and notifications about service disruptions. Service status data is integrated with external platforms such as Google Maps, greatly facilitating travel planning. The city is also gradually expanding its public transport infrastructure, focusing on eco-friendly modes, including electric and hybrid buses.

A high level of digitalization in public transport supports service transparency and increases the attractiveness of public transport compared to private cars. The concept of Mobility as a Service (MaaS) represents one of the key directions for transport

development in smart cities. Szczecin's Electromobility Strategy 2035 foresees gradual integration of different transport modes—public, shared, and individual—within a single digital platform.

Although full MaaS integration has not yet been achieved, preparatory measures are underway, such as developing electric vehicle charging networks, supporting carsharing services, the Bike_S city bike system, and improving interoperability of payment and booking systems. In the future, an integrated MaaS system will allow residents to plan and pay for trips through a single interface, significantly increasing mobility efficiency across the city.

To ensure equal access to public transport, Szczecin has implemented a demand-responsive transport (DRT) service in peripheral districts, such as Podjuchy and Gumieńce. This system allows passengers to book rides by phone, and dedicated vehicles transport them to the nearest public transport stops. This solution increases mobility for residents in less connected areas while reducing the need for private cars. It also has a social dimension, promoting transport inclusion and reducing so-called "transport white spots." Szczecin actively invests in the development of Intelligent Transport Systems (ITS), which form the basis for implementing automated traffic management solutions.

In 2022, the city launched a Traffic Management System (City Hall, 2022), covering 68 intersections equipped with sensors, cameras, and dynamic traffic light coordination. The system enables automatic traffic control, analysis of traffic intensity, and prioritization of public transport vehicles. According to the Szczecin City Hall (2023), the implementation of the system reduced bus travel times by 10–15% and decreased exhaust emissions by approximately 8%. The ITS also provides a foundation for future deployment of autonomous vehicles, integrating data from multiple sources in real time.

In the area of micro-mobility, Szczecin offers a wide range of services supporting flexible, low-emission individual mobility. Bolt provides electric scooters across the city, which recorded a total of 1.8 million rides in 2024. In parallel, the Bike_S system, launched in 2014, allows year-round bike rentals, including winter months.

The system currently operates a fleet of 85 bikes available for longer-term rentals (e.g., weekend or weekly), increasing flexibility for users. The development of micro-mobility in Szczecin aligns with broader trends in urban transport transformation toward low-emission, compact mobility solutions. Electromobility development is a strategic element of Szczecin's transport policy.

The city is gradually modernizing its public transport fleet and expanding charging infrastructure. In November 2024, an agreement was signed for the delivery of 14 new Solaris electric buses, including four Urbino 12 and ten Urbino 18 models. Once implemented, the number of electric buses in the city fleet will rise to 30.

Simultaneously, the network of electric vehicle charging points is being expanded—by October 1, 2025, there were approximately 298 publicly accessible points, ranking Szczecin third in Poland, after Warsaw and Gdańsk. These actions are consistent with European transport decarbonization policies and support the achievement of EU climate goals by 2030.

4. Research Results and Discussion

To assess the perception of the smart mobility concept among key stakeholder groups, a survey was conducted in the city of Szczecin. The study was quantitative in nature and carried out between March 1 and April 30, 2025, using a standardized questionnaire developed specifically for this research project.

The study sample included two groups of respondents:

1. **Employees of the Szczecin City Hall** – the survey included 90 individuals employed in various departments of the city administration, particularly those involved in spatial planning, transport, environmental protection, and urban policy. The aim of this part of the study was to identify the level of knowledge and engagement of local government administration in the development of smart mobility solutions, as well as to gather employees' opinions on the barriers and opportunities for implementing the smart mobility concept in urban conditions.
2. **Residents of Szczecin** – the survey included 900 users of modern transport services, including MaaS (Mobility as a Service) systems and carsharing. Respondents were recruited from users of mobile applications enabling shared urban transport. The aim of this part of the study was to explore residents' experiences with smart mobility services, evaluate their usability, satisfaction levels, and expectations for the further development of these solutions in the city.

The survey was conducted online (CAWI), allowing access to a wide range of respondents and ensuring anonymity of responses. The collected data were used to analyze the perception of the smart mobility concept in a local context and to identify factors facilitating or limiting the development of integrated transport services in Szczecin. Additional data were obtained from the Szczecin Road and Municipal Transport Authority, as well as from the companies Solaris, Bike_S, and Bolt.

The survey results among City Hall employees indicate that 78% of respondents believe smart mobility will positively impact the quality of life in the city, 42% declare familiarity with the concept and functioning principles of intelligent transport systems, and only 30% assess the organizational readiness of the administration as high. Forty-five percent of respondents consider it moderate, pointing to the need for better interdepartmental cooperation and greater

digitalization of processes. Open-ended responses included suggestions regarding training, improved communication, and the creation of a mobility data center. These results show that the smart mobility concept is well perceived within the administration but requires further education and development of digital competencies.

The results of the survey conducted among users of modern transport services in Szczecin, regarding each element of the smart mobility concept, are presented in Table 2.

Table 2. *Results of the survey conducted among users of modern transport services in Szczecin.*

Type of Mobility	**Number of Users / Passengers**	**Number of Vehicles / Stations**	**Key Indicators**	**Source / Notes**
Carsharing / Ridesharing	500 survey respondents; 45% use at least once a month	Traficar + Bolt + Uber fleet (approx. 200 vehicles)	70% of users report reduced need for owning a private car	Survey 2025
Public Transport	900 survey respondents; 85% use real-time data	MKM 2.0 used by 63% of passengers	Punctuality: 91%	ZDiTM Szczecin, 2025 data
MaaS (Service Integration)	500 respondents; 18% used integration	Digital platforms combining public transport, bikes, scooters	57% know the concept of MaaS	Survey 2025
On-Demand Transport	3,600 passengers in half a year	Lines 904 and 908	Average waiting time: 22 min; user satisfaction: 4.3/5	ZDiTM Szczecin, pilot 2025
Autonomous Technologies (ITS)	N/A	100% of main intersections with dynamic coordination	Peak-hour traffic flow increased by 12%	ZDiTM Szczecin, ITS 2025
Micro-Mobility – Bikes and Scooters	112,000 bike rentals in 2024; avg. 1.8 rentals/scooter/day	85 bikes, 48 stations; 140 scooters	62% of rentals during summer season	Bike_S, Bolt, Eroller Rent 2024/2025
Charging Stations / Electric Public Transport	85,000 monthly passengers on electric buses	298 charging points; 30 electric buses	Average bus mileage: 9,500 km/month	Solaris, ZDiTM Szczecin 2025

Source: *Author research.*

Research conducted in Szczecin indicates that the smart mobility concept is being consistently implemented and is gaining increasing interest among residents. The analysis covered various forms of urban mobility—from vehicle sharing and public transport, through MaaS services, on-demand transport, autonomous technologies, micro-mobility, to the development of electric infrastructure and electric public transport.

The results show that 45% of residents regularly use carsharing or ridesharing, contributing to a reduced need for private car ownership. The Bike_S city bike system, with 85 bicycles and 48 stations, recorded over 112,000 rentals in 2024, most of which occurred during the summer months, confirming the seasonal nature of micro-mobility usage.

E-scooters, with a fleet of approximately 140 vehicles, generate an average of 1.8 rides per day per scooter, indicating stable popularity of this mode of transport. Public transport in Szczecin demonstrates high efficiency—service punctuality is 91%, and 85% of passengers use real-time data, reflecting the effectiveness of service digitalization.

The pilot on-demand transport service in the Podjuchy and Gumieńce districts served 3,600 passengers in the first half-year, with an average waiting time of 22 minutes. The development of autonomous technologies and Intelligent Transport Systems (ITS) has improved traffic flow by 12% during peak hours, while investments in electric transport include 30 electric buses and 298 charging points, placing Szczecin third in Poland in terms of charging infrastructure (Urząd Miasta, 2022).

In summary, the implementation of the smart mobility concept in Szczecin yields tangible benefits: it increases public transport accessibility, reduces traffic congestion and emissions, and promotes environmentally friendly and integrated forms of mobility. The survey results indicate growing resident interest in new mobility options and significant potential for further development of MaaS services and electromobility.

Smart mobility in Szczecin constitutes a key element of the city's long-term development vision. Implemented technological solutions, such as the Traffic Management System, electromobility initiatives, and open data platforms, demonstrate the consistent direction of local government actions. Survey analysis revealed high acceptance of the concept among city hall employees, representing an important social capital for further initiatives.

Challenges primarily concern the integration of IT systems, ensuring data interoperability, and building competencies in spatial and mobility data analysis. Further development of smart mobility in Szczecin requires increased investment in digitalization and automation of transport processes, development of open urban

data platforms, engagement of residents in co-creating mobility policies, and continued scientific collaboration with universities. Smart mobility is not only a technological innovation but also a tool for social and environmental transformation, which can make Szczecin a city of sustainable mobility for the future.

In conclusion, the implementation of smart mobility in Szczecin achieves its strategic objectives: it reduces traffic congestion, supports environmental protection, improves travel safety and comfort, and increases the accessibility and flexibility of the transport system. The outcome of these actions is an improved quality of life for residents and a more efficient and sustainable urban transport system.

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