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Urban Mobility and Smart Transportation Solutions

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Abstract

Urban mobility is a critical aspect of modern city planning, directly influencing economic productivity, environmental sustainability, and the quality of life for residents. As cities grow, traditional transportation systems face significant challenges, including traffic congestion, pollution, and inadequate infrastructure. Smart transportation solutions, driven by advancements in technology and data analytics, offer innovative approaches to address these challenges and enhance urban mobility. A range of technologies such as the Internet of Things (IoT), artificial intelligence (AI), big data, and blockchain. These technologies enable the development of intelligent transportation systems (ITS) that can optimize traffic flow, reduce emissions, and improve safety. Key components of smart transportation include autonomous vehicles, connected infrastructure, shared mobility services, and integrated public transit systems.The implementation of smart transportation solutions requires collaboration among government agencies, private sector companies, and the public. Policy frameworks, data sharing agreements, and investment in infrastructure are essential for successful deployment. Moreover, addressing concerns related to data privacy, cybersecurity, and equitable access is crucial to ensure that the benefits of smart transportation are distributed fairly across all urban populations.

Keywords*: Urban mobility, Smart transportation, City planning, Quality of life, Internet of Things (IoT), Artificial intelligence (AI), Intelligent transportation systems (ITS).*

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INTRODUCTION

Urban mobility refers to the various means of transportation and logistics that enable people and goods to move within and between urban areas. Effective urban mobility is essential for the functioning of cities, affecting economic activities, social interactions, and environmental sustainability. However, traditional transportation systems in many urban areas face significant challenges, such as traffic congestion, pollution, and inefficiencies, prompting the need for innovative solutions.

Smart transportation solutions are advanced technologies and strategies aimed at enhancing urban mobility. These solutions leverage data, connectivity, and automation to create more efficient, safe, and sustainable transportation systems.

1. Public Transportation Innovations:

- Providing real-time updates on bus, train, and tram schedules helps passengers plan their journeys more efficiently.
- Implementing unified ticketing systems that allow passengers to use multiple modes of transportation with a single payment method.
- Reducing emissions and reliance on fossil fuels by incorporating electric and hybrid vehicles into public transportation fleets.

2. Intelligent Traffic Management:

- Using sensors and AI to optimize traffic light timings based on real-time traffic conditions, reducing congestion.
- Dynamically managing traffic flow by adjusting signal timings, speed limits, and lane usage in response to real-time data.
- Quickly identifying and responding to traffic incidents to minimize disruptions.

3. Autonomous and Connected Vehicles

- Autonomous vehicles that can navigate and operate without human intervention, potentially reducing accidents and improving traffic flow.r.

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4. Sustainable Transportation Solutions:

- Promoting the adoption of electric cars, scooters, and bicycles to reduce greenhouse gas emissions.
- Using renewable energy sources to power public transportation systems and charging infrastructure for EVs.
- Developing bike lanes, pedestrian zones, and greenways to encourage non-motorized transportation.

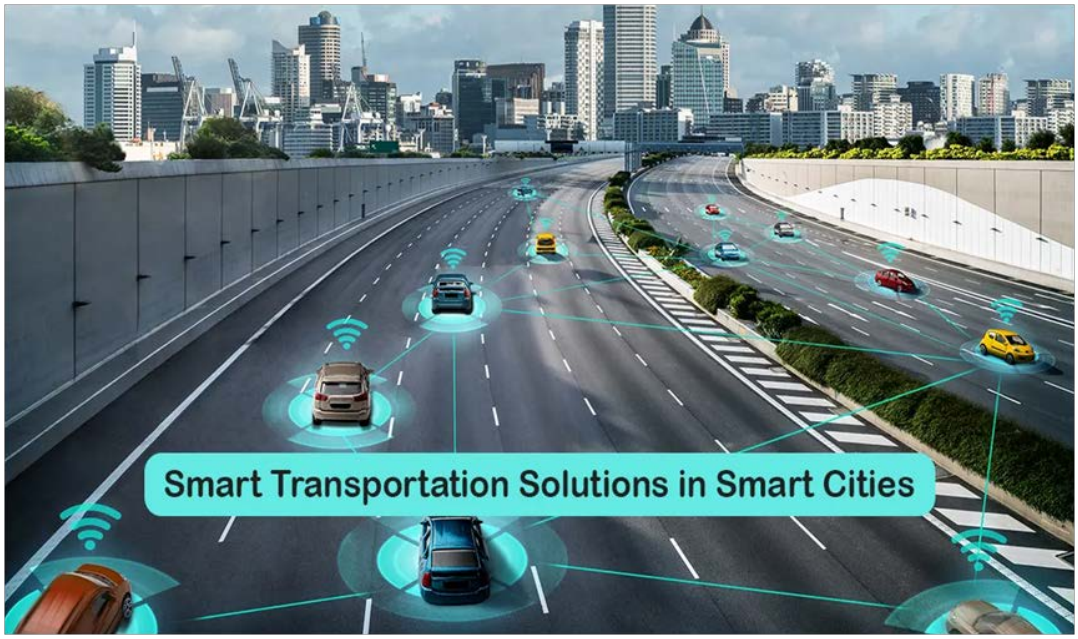


Figure 1: Smart transportation Solutions in smart cities

The development of sustainable and smart urban transportation solutions is associated with the sustainable development goals (SDGs) of the United Nations. By approving the Agenda 2030, the United Nations has defined 17 Sustainable Development Goals to target the global sustainability challenges related to the poverty, inequality, and environmental pollution. In 2015, SDGs were adopted by 193 countries of the United Nations, which have recognized that achieving these sustainability ambitions will require financial and non-financial efforts from policymakers, entrepreneurs, consumers, and society in general. The progress achieved in the SDGs is monitored and annually evaluated by specifically defined indicators for each of the goals. The United Nations has emphasized that an efficient and well-designed transport system helps to improve the quality of life for society, as it provides access to education, health, and social care, work and business opportunities. In addition, an efficient and

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environmentally friendly transport system and transport vehicles reduce environmental pollution and climate change.Although none of the goals directly mentions the development of sustainable transport and mobility, certain goals are closely related to it, such as Sustainable cities, Responsible consumption, Industry, innovation, and infrastructure, Decent work and economic growth. Good health and well-being, Clean water and sanitation, Affordable and clean energy. Most of the action plans of international organizations and governments have focused on improving the development and availability of public transport, as the proposed possibility of reducing transport emissions and creating other positive environmental effects. The current problem is that urban congestion is too high, the number of cars per person has increased and the population continues to grow. The mentioned problems create challenges in the urban transport system and promote the search for more efficient, smart and sustainable mobility development.

However, the COVID-19 pandemic has changed the behavior and preferences of transport users. The International 2020 Consumer Trends Chart reflects the changes brought about by the COVID-19 pandemic. The most important elements in the TOP 10 consumer trends of 2020 are adaptability and durability. Consumers have highlighted the need for safety and security, balanced time planning, thoughtful spending, and flexible solutions to reduce anxiety and worry. The COVID-19 pandemic has shifted priorities to personal safety and enhanced hygiene, the desire for comfort, which in turn changed consumption preferences from always available to experiences. Researchers previously concluded that the need for safety and health encouraged transport users to distance themselves and choose individual means of vehicles instead of the public transport. In comparison to 2020, the experts underline that: “consumers are putting their plans into motion, taking chances and seizing the moment”. The pandemic has made consumers reconsider daily conveniences, preferring private transport and reducing the use of public transport, which has also had an impact on climate change and the environment. Air pollution, traffic congestion and parking are just some of the areas affecting the urban environment where the development of mobility is introducing new opportunities to promote the well-being of citizen. The main determinants for the sustainable transport within urban areas can be characterized by low or zero emissions, smart technological solutions, and behavioral change of citizens–transport users.

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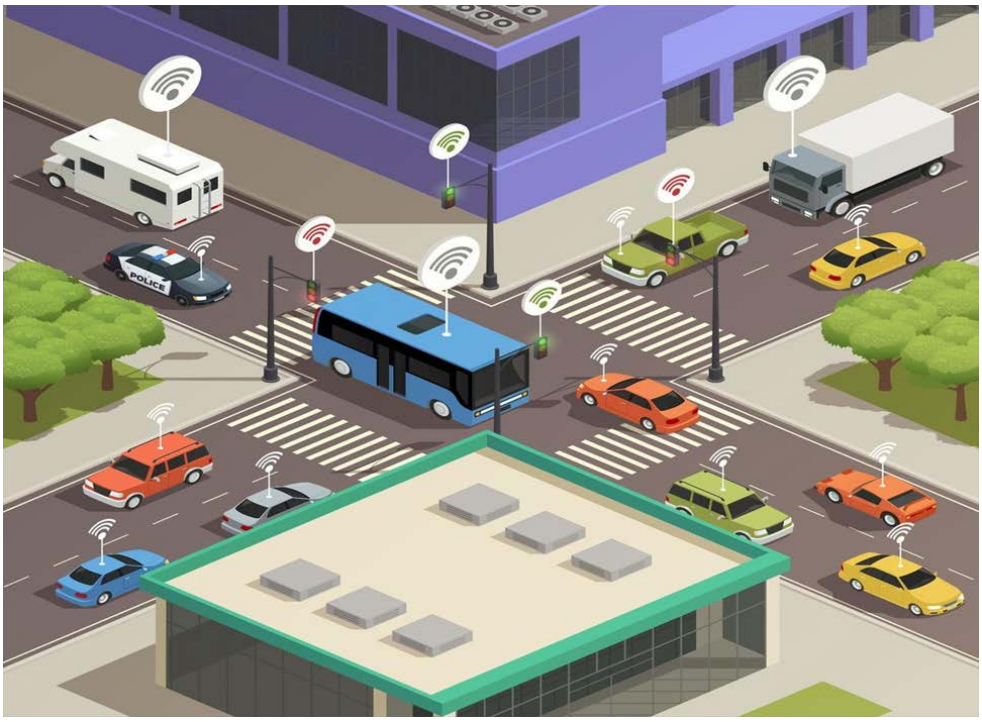


Figure 2: traffic solutions

LITERATURE REVIEW

Hamamurad et al: The Smart city as a city that uses ICT, technology, and innovation with the aim of developing the city as a whole and improving the quality of life of its inhabitants, to promote the development of the economy, the sustainable environment and ensure effective urban management including smart mobility.

Anthopoulos: Believes that a modern Smart city should include attributes such as resources, transportation, urban infrastructure, living, government, economy, and coherency. The creation and efficient usage of excellent infrastructure, including the urban mobility system, is central to the achievement of sustainable development goals. However, it also requires citizens to participate in local governance and innovation processes.

Tregua et al:A three-level Smart city structure environment such as smart environment and smart mobility, smart people, smart lifestyle and smart management and economy as a smart economy.

Access to public transportation is linked to several community health benefits and environmental benefits.Despite this, bus public transportation and streetcar

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publictransportation in the United States suffered from a sharpdecline in the mid to late 1900s due to the increase of accessto cars, the building of highways, and reduced funding. Renewed interest in public transportation to increaseenvironmental sustainability, improve community health, andrevivepreviously thriving cities provides an opportunity toincorporate the use of smart city and smart transportationtechnologies to achieve these goals.Definitions of smart cities and their characteristics have beenevolving over the decades. While smartcity research is interdisciplinary, research does take placewithin isolated research groups causing branching definitions.The branched definitions separate much of the research into afocus on smart city policy or smart city technology. Whileresearch groups will address both aspects, research tendedto place either policy or technology as the primary focusrather than presenting a balanced view of both. Additionally,in many cases, research neglected to focus on a third focus inconjunction with policy and technology, the third focus and referredto by Joss as social, is described in literature as community engagementcivic engagement, citizenengagement, or civic participation.

Schaffers et al. (2011)consider the Smart city (SC) concepts one of the ideological solutions of sustainable city development. Thus, SC's concept has become a central concept of academic discussions on urban and urban models in recent years.

Zygiaris (2013)initially, the SC concept was intended to provide intelligent solutions to traffic or waste management through the efficient use of ICT and technology companies such as IBM, HP, Siemens or Cisco Harrison and Donnely (2011).

METHODOLOGY

Intelligent transport systems (ITS):

It utilizes the latestinformation and communication technologies (ICT)to improve the overall efficiency and safety of the transportation system. Originally introduced as a way of controllingtraffic via route guidance ITS also includes wide applications within public transport, private travel, sharedmobility, advanced analytics and traffic safety, andsmart infrastructure. In fact, as interest in smart mobilityhas grown in sync with rapid technological advances, the useofITS has become commonplace as cities strive to use newtechnology as a way of managing and developing a moreholistic view of the transportation system. ITS hasbeen applied to a wide range of areas relating to the management, control, and operation

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of the transportation system. The importance of data sharing and communication,the innovations such as 5G, internet-of things (IoT), cloudcomputing, artificial intelligence (AI), blockchain, and connected and wearable devices are becoming critical which willassist in the performance of ITS.

Alternative fuel systems:

It refers to a range of vehicle types which utilize fuel sources that do not necessarily rely on the use of fossil fuels. Smart mobility articles generally focus on alternative fuel vehicles which operate on battery-powerelectric vehicles (EV) and use charging stations fueled by the power grid, hydrogen or, solarenergy (EV) are not a new technologyearly prototypes weredeveloped concurrently with ICEV, however, the recentdevelopments in lithium-ion batteries has increased the practicality of using EV for everyday transportation needs.Advances in battery powered technology has also led to anincrease in the use of Powered Micromobility Devices (PMD).PMD are a type of vehicle used for transporting single commuters over short distances and are typically designed foroff-road use (e.g. footpaths, or bikeways). They are operatedon battery power, or the battery is used to assist physicaleffort. They are quick to charge and make short distance traveleasier and quicker without the need for physical effort.

Theirsmall size makes them easy to store and transfer betweenmodes. PMD have been identified as a potential way to bridge the‘first and last mile’ gap between home and public transportand work. Some examples include: e-bikes, powerednon-self-balancing boards (e.g. e-skateboards), poweredself-balancing boards (e.g. segways, e-unicycles), powered skates, powered seated scooters, and poweredstanding scooters. These vehicles have become a central art of the transportation strategy for many cities, to reduceprivate vehicle travel particularly through the implementationof free-floating shared schemes in high-density areas.

Driving Automation Systems:

Autonomous vehicle (AV), also known as automated vehicles, self-driving vehicles,driverless vehicles, or robotic vehicles, refer to any vehicle .g. automobile, trucks, buses,trains and drones that can sense their environment and drivewithout human input for all or part of their journey.These vehicles are considered one of the most cutting-edgeinnovations in the smart mobility realm and are representativeof the substantial developments driving automation

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systemshave made in recent years.Various types of driving automation systems have been inuse for several years providing some cross over with ITS anddriver assistance systems such as cruise control, automaticbraking, and parking assistance. To provide a distinctionbetween fully AV and vehicles with partial automation theSociety of Automotive Engineers International (SAE) hasdeveloped a 5-level classification system to measure vehicleautomation levels. This classification is widely consideredto have become industry standard and is often cited in academic literature. The levels of automationrange from Level 0 (where all tasks are controlled by thedriver) to Levels 4 and 5 (where the vehicle is consideredfully autonomous).

Shared Mobility Systems:

Shared mobility system is a broad term used to describe a number of different transportation services where vehicles are either shared at different times (i.e. car, scooter and bikesharing), orvehicles are shared with other riders, for all, or part,of the duration of the trip (i.e. ridesharing and ridesourcing).Shared mobility has existed in some form for many years. For example, taxis, public transport, and carpooling are all forms of ridesharing. Similarly, car or bike rental services are a form of car or bikesharing. A summary shared mobility term related to passenger transportation and derived from SAE International The movement towards shared mobility is being enabled by rapid advances in ITS, ICT, GPS, and the use of smartphones. While the prevalence of ridesourcing, bikesharing, and scootersharing schemes have become commonplace in large cities, the schemes continue to be identifiedas a potential solution to the first- and last-mile problemassociated with accessing public transport and as a way toreduce private vehicle ownership and travel.As such, shared mobility is commonly identified as a central component of smart mobility and the development of smarter cities.

Demand Responsive Transport:

Demand Responsive Transport (DRT), otherwise referred to as alternative transport servicesor on-demand services, is a type of service where vehiclescan change either routes or schedules (or both) dependingon user demand. DRT services generally use low capacityvehicles such as small buses, shuttles, vans, or taxis, and charge per-passenger. Passengers are collected and returned to specific locations according to their needs. DRT was promoted as far back as the 1970s, primarily as a replacement for low occupancy public transport services that were not cost effective. Initially, users would pre-book trips using the

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telephone with the service operators then planning routes and schedules based on the daily demand commonly referred to as dial-a-ride. Nowadays, advances in ICT and the prevalence of smart phones means users can book online, usually via a smart phone app, and much of the routing is automated. The primary advantage of DRT relates to its ability to provide greater service coverage and flexibility than regular public transport. It has been identified as a potential feeder system to connect low density and rural areas with major public transport hubs, potentially improving the attractiveness of public transport and reducing reliance on privatevehicles. DRT either work to replace underutilized public transport systems or support these systems byproviding divergent routing or schedules in less accessibleor lower occupancy areas. Areas of operation are typicallydefined with the range of flexibility, dependent on regionalneeds and resources.

Sustainability Evaluation:

The following section evaluates the six identified smart mobility innovations against five sustainability evaluation criteria

- safety
- congestion
- energy consumption
- environmental impact
- accessibility

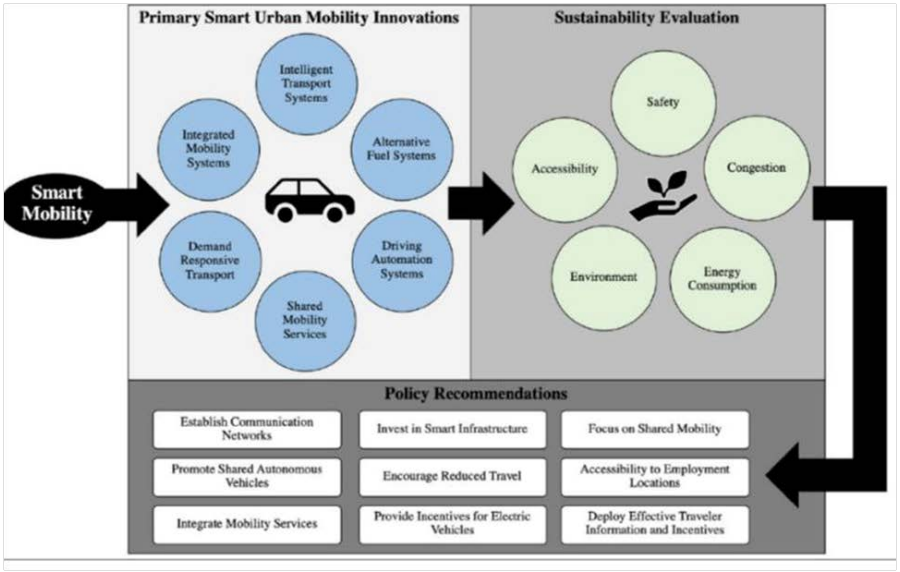


Figure 3: Methodology

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POLICY RECOMMENDATIONS

Establish communication network: As a smart urban mobility becomes increasingly reliant on ICT and the use of smart devices it is critical for decision-makers to invest in high speed communication networks to ensure adequate coverage over all areas where transportation services are required. Furthermore, decision-makers should look to 5G networks to establish high-speed internet in rural and remote areas to ensure social equity issues associated with accessing the new transportation technology is not further exacerbated by geographical disadvantage. Establishing security standards is paramount to ensure the safety of these networks. Standards should be flexible enough to ensure measures can adapt to changing needs and maintain user trust.

Invest in smart infrastructure: Whether maintaining thestatus quo, introducing AV, managing electrical grids, promoting stand-alone shared mobility, DRT or MaaS the advantages of ITS for managing traffic flow, and providing real-time information to users, and service providers remains important to help policy or decisionmakers monitor, control, and manage the safety, efficiency, impact, and accessibility of the transport system. Decision-makers should therefore consider investing in smart infrastructure so that future innovations in transport are able to harness the advantages of these systems

CONCLUSION

In this paper, we conducted a systematic literature survey on methods and indicator used for evaluating smart city mobility projects on the local level. Based on literature review we conclude that there exist set of available and suitable methods for smart-mobility projects evaluation, although the use of particular method will depend on type of smart-mobility project and also on data availability. As already mentioned the smart-mobility projects are very heterogeneous in the meaning of its potential impact on society. Selection of correct output indicators is therefore more sensitive on particular type of the smart-mobility project.

This paper also summarises standard indicators for each category of the smart mobility projects. Selecting the suitable indicators is not important only in the process of the project evaluation, but also and maybe more important in the process of developing strategic development plans in area of smart-mobility. Correct selection and monitoring of socio-

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economic indicators in planning phase is crucial condition for correct evaluation of the development plan as well as the effective decision making process from the pool of the proposed smart-mobility project. This can approach can support the public administrations to improve and prove the socio-economic impact of implemented smart-mobility development plans and projects. The information obtained from research papers is important for city managers and planners as well as consultants dealing with smart-mobility strategic documents design and projects selection. Results provided in this will provide them with information about the suitable evaluation methodologies and socio economic indicators according to different categories of smart mobility projects.

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