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THE IMPACT OF DIGITIZATION OF MOBILITY SERVICES AND THE USER'S DIGITAL ENVIRONMENT ON SUSTAINABLE MOBILITY

Keywords

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Sustainable
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service

Abstract

Digitization of mobility services in urban areas made it possible to increase the efficiency of existing public transport services and create a new approach to mobility-as-a-service (shared ride, vehicle sharing, on-demand service, etc.). This gives users new opportunities to access information, plan trips and pay for transportation services. On the other hand, it creates new challenges for users who do not have access to digital technologies or do not have the necessary knowledge and skills to use them. For the development of sustainable urban mobility, it is necessary to ensure the availability of public transport services to all categories of users and provide intuitive interfaces for easier access and use of digitized mobility services. Digitization in the field of mobility must be implemented as part of the broader concept of developing the digital environment of a smart city. Digital technologies support changes in user access to mobility services by encouraging a new approach to mobility-as-a-service that includes service sharing and vehicle sharing with less use of personal vehicles. The overall concept of mobility-as-a-service supports sustainable mobility in the urban area. When implementing the digitization process in the field of mobility, the willingness and limitations of users to accept and use new digital mobility services must be taken into account.

1. INTRODUCTION

The development of modern cities is accompanied by the wide application of information and communication technologies in the field of transport, which leads to digitization in the field of mobility. The development of intelligent transport systems has enabled new approaches to solving mobility problems in urban areas. This led to changes in the transport infrastructure, means of transport, the way of providing transport services, the way of using the public transport system and changes in the demands of users in the field of mobility. ITS services in the field of urban mobility have contributed to increasing the efficiency and quality of public transport services in urban areas through better information for users and better management of the fleet of public transport vehicles. This opened up new possibilities and ways of providing public transport services supported by information and communication technologies. The development of the concept of smart mobility and the concept of a smart city has changed the users' view of mobility services by offering them new services that require new knowledge and skills to access and use information and communication technologies. Digitization in the field of mobility should be viewed not only as a process of transforming analog information into digital, but also the willingness and ability of users to use digitized mobility services [1]. Sustainable mobility in urban areas requires reducing the dependence of transport system users on cars, which have a negative impact on the congestion of the road network, have a negative impact on the environment and reduce the level of mobility services in urban areas. Sustainable mobility is a concept that supports the sustainable development of society that contributes to the social, economic and environmental sustainability of society as a whole. The basic goals of sustainable mobility are [2]:

- make it possible to meet the mobility needs of all members of society by ensuring access to mobility services in a way that will protect the safety and health of people and reduce harmful effects on the environment
- ensuring the possibility of choosing mobility services on a market basis
- reduction of emissions, reduction of noise and rational use of land surfaces

Sustainable mobility requires more rational use of the available transport infrastructure and the optimization of transport processes, which can be achieved through the application of modern information and communication systems and the development of intelligent transport systems.

2. MOBILITY-AS-A-SERVICE IN THE FUNCTION OF SUSTAINABLE MOBILITY

The development of intelligent transport systems has enabled a new perspective on mobility and a new concept of mobility-as-a-service (MaaS). This change enables the development of new transport services in the urban area that are aimed at achieving sustainable mobility. Users view transportation services through the means of achieving their efficient movement without relying on transportation by personal vehicle.

Mobility-as-a-service can be viewed from two aspects:

- from the aspect of the private sector, MaaS offers new business opportunities and new services on the market
- from the aspect of the public sector, MaaS offers opportunities for sustainable mobility in urban areas

Mobility-as-a-service enables the development of mobility systems to be directed towards the goals of sustainable mobility while ensuring better accessibility to mobility services for all social strata, regardless of their information skills and economic status. Mobility-as-a-service is not only related to road transport but also includes multimodal transport services with different levels of integration shown in Table 1. The level of MaaS integration ranges from level 0 which includes MaaS without integration to level 4 which includes MaaS services with a high level of integration that enables the achievement of social goals of sustainable mobility.

Table 1. Mobility-as-a-Service MaaS Integration Levels [3]

MaaS integration levels	Ways to integrate MaaS service
Integration level 0	without integration (individual disconnected MaaS services)
Integration level 1	Information integration (multimodal travel planner)
Integration level 2	Integration of reservation and payment of services (reservation and payment of individual trips)
Integration level 3	Integration of service offerings (packages, subscriptions, contracts)
Integration level 4	Integration of social goals (policies, incentives, etc.)

At different levels of integration of MaaS services, different tools are used to encourage this new view of mobility in order to ensure the sustainable development of the transport system in urban areas. The integration of MaaS should result in the integration of the services of different modes of transport into one service adapted to the demands and needs of users.

The development of MaaS services requires a change of view on mobility, which includes [5]:

- consideration of user requests
- integration of mobility services (transportation, information, payment, reservation)
- adaptation of mobility services to user requirements through the development of transport services at the user's request

Accordingly, MaaS integrates conventional and new transportation services into new integrated customer services that include the concept of vehicle sharing and shared transportation services. A mobility-as-a-service system consists of a transportation service that includes the means and infrastructure to perform transportation and

digital MaaS support platforms that enable access to information, reservations, and payment for services via smartphones and tablets.

The development of the mobility-as-a-service concept shown in Figure 1 depends on the following factors:

- technological development that should enable the interoperability of data collection and sharing
- social development that should ensure the acceptance of MaaS by users who will accept the economy of sharing vehicles and sharing services while reducing dependence on the personal car to enable sustainable mobility
- the development of the mobility services market, which will result in new types of services and new service operators in the field of mobility
- management of MaaS development by competent authorities that need to create a regulatory and technological framework for the transformation of the existing approach to mobility towards sustainable mobility that includes the concept of mobility-as-a-service

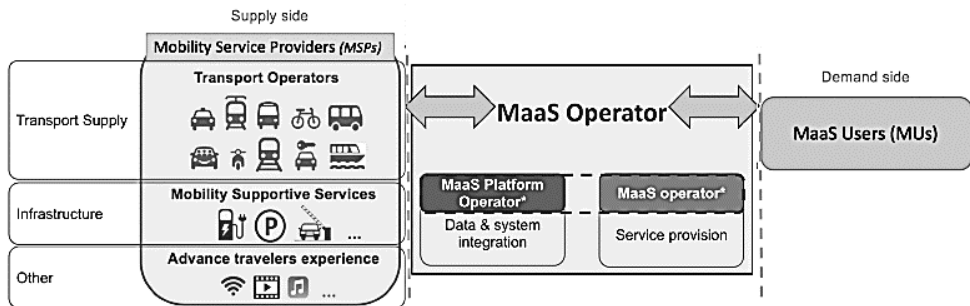


Figure 1. Concept Mobility-as-a-Service (MaaS) [5]

The concept of mobility-as-a-service includes different mobility options with the use of multimodal transport services, the use of different communication technologies and digital platforms for data exchange, which requires the standardization of services and data flows.

3. IMPACT OF DIGITIZATION ON MOBILITY SERVICES

Digitization of transport provides users with new opportunities in planning trips, accessing information, organizing trips and paying for services. Digital technologies present new challenges to users and operators of mobility services in a digital environment. Digitization has taken a central role in users' access to mobility services, which requires users to have the appropriate digital equipment and digital skills to take advantage of the possibilities of digital technologies. Digital technologies provide access to a wide range of information, greater flexibility during travel and meeting individual requirements. Users who do not own digital equipment and the necessary digital skills to use it have limitations in accessing mobility services in the digital environment, which leads to digital inequality in the field of mobility. Solving the problem of digital inequality in the field of mobility is a complex

problem. The problem of digitization in the field of mobility is not only related to having a smartphone. It is related to the way people perceive digital technologies, access to the Internet, how much users trust digital technologies (personal data protection), the type of digital mobility services users want. Limitations of access to digital technologies and lack of digital skills can affect the use of digital services in the field of mobility. Digital technologies are an important part of the sociotechnical system and represent new challenges for meeting the needs of mobility services for vulnerable groups (elderly, visually impaired, children, etc.) [6].

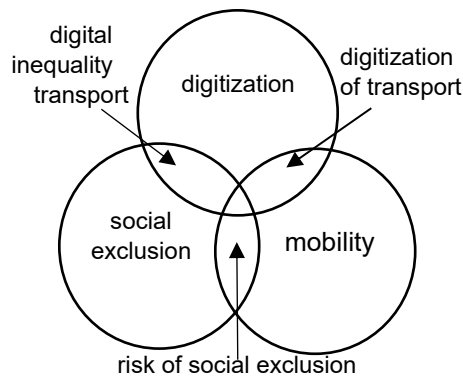


Figure 2. The impact of digitization on social exclusion in the mobility system

Social groups that have access to digital technologies and have digital skills expand their mobility options in a smart city, while groups that have some limitations in the use of digital technologies may have limitations in accessing and using mobility services in a digital environment. Digital technologies support changes in user access to mobility services by encouraging a mobility-as-a-service approach, supporting a shared vehicle and service approach. Carrying out the digitization process in the field of mobility through the transformation of analog information into digital ones must take into account the capabilities of users and their willingness to accept and use new services. Digitization should enable mobility services to be available to everyone. Therefore, digital transformation must include the partial retention of conventional technologies and their use alongside digital technologies due to the different user structure.

Planners, operators and users of mobility services see digitization as an opportunity to improve the planning and management of infrastructure, fleet of vehicles, a higher level of service that enables sustainable mobility.

The positive effects of digitization in the field of mobility are [7]:

- development of new services in the field of mobility
- changes in access to mobility services, information, travel planning and service payment methods
- the use of digital tools that provide support to travelers during their journey
- the integration of planning, booking and payment of mobility services through digital platforms support the development of mobility-as-a-service

Digitization of vehicle and infrastructure management enables real-time management of mobility services, which increases the level of service and user satisfaction.

Digital technologies can influence the improvement of passenger satisfaction, which is reflected in better communication, better information and safety during travel. Digitization has a significant contribution to the development of the sustainable mobility scenario. Sustainable mobility should provide easily accessible mobility services to all groups of society, which would reduce the need to own private cars in urban areas.

4. VULNERABLE GROUPS OF THE TRANSPORT DIGITIZATION

The limitations of certain social groups in accessing digital technologies and the lack of digital skills affect the limitations of their access and use of mobility services in the digital environment. This can lead to social inequality in access to mobility services of social groups that differ according to age (elderly, minors), income level, education level, etc. Elderly people have a harder time following the development of digital technologies and harder to acquire digital skills due to the weakening of their psychophysical abilities. Although younger people acquire digital skills more easily, children may have limitations in owning and accessing digital technologies due to not having a smartphone, credit card, etc.

Table 2. Types of digital skills [8]

Skill group	Skill type	Skill description
Skill related to the medium	Operational skills	Using digital technology in basic ways, such as knowing which buttons to use and how to open a file
	Formal skills	Handling formal media structures, such as understanding how browsers work
Content related skills	Information skills	Searching, finding, selecting and critically evaluating information
	Communication skills	Transfer of data to other people
	Content creation skills	Creating and generating new content and turning it into a product or service
	Strategic skills	Orienting, acting and deciding on information in order to achieve a specific goal and realize benefits

People with lower incomes and less education are considered vulnerable because the transition from off-line to on-line shopping public transport tickets can be a problem. People with communication disorders (auditory, visual and cognitive) may have limitations in the use of digital technologies in the field of mobility.

In addition to access to digital technologies, social groups differ according to the skills of using digital technologies shown in table 2. Information skills and knowledge are needed to search for information, select it and evaluate its quality and reliability of information sources. The negative effects of digitization in the field of mobility can be mitigated by designing digital mobility services in an inclusive, user-centered way. Digital technologies should support users in accessing information and making decisions related to mobility in an understandable and intuitive way adapted to their needs [9]. Supporting vulnerable social groups in the use of digital technologies in the field of mobility will contribute to sustainable mobility in the urban area.

5. CONCLUSION

Sustainable mobility as part of the broader concept of sustainable development requires a digital transformation of the mobility area that will enable more efficient use of the existing infrastructure, changes in the characteristics of means of transport in terms of their greater efficiency and environmental acceptability, and changes in the user's perception of mobility services and the way they are planned, organized and paid for. The wide application of information and communication technologies and the development of intelligent transport systems will increase the efficiency of transport operations and enable sustainable mobility. Digital technologies support changes in user access to mobility services by encouraging a new approach to mobility as a service, supporting a shared vehicle and service approach. When implementing the digitization process in the field of mobility, the willingness of users to accept and use new digital mobility services must be taken into account. Support for vulnerable social groups in the use of digital technologies in the field of mobility will contribute to sustainable mobility in the urban area.

Therefore, in the process of digitizing mobility services, it is necessary to harmonize technological changes and user requirements while respecting social, technical, organizational and human limitations in order to provide equal access to sustainable mobility services to all social groups. Digitization in the field of mobility must be carried out as part of the entire process of smart city development, while enabling access to digital technologies for all layers of society, especially vulnerable groups. Digitalization of transport will influence the development and way of providing mobility services, creating a new digital environment for users. Mobility as a Service (MaaS) integrates conventional and new transportation services into new integrated customer services that include the concept of vehicle sharing and shared transportation services that will contribute to reducing the need to own private cars in urban areas as an important goal of sustainable mobility.

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