



Jana Pieriegud^{a)}, Jakub Zawieska^{b)}

a) b) Department of Transport, SGH Warsaw School of Economics, Poland

MOBILITY-AS-A-SERVICE – GLOBAL TRENDS AND IMPLEMENTATION POTENTIAL IN URBAN AREAS IN POLAND

Abstract

Urbanisation and digitalisation are global trends whose interaction results in visions and new business models of urban mobility. Smart mobility is a crucial part of the smart city approach. The concept of Mobility-as-a-Service (MaaS) is one of the most recent innovations in the transport sector. This paper presents the current state-of-the-art of defining and understanding the MaaS idea as well as delivers examples of already existing MaaS systems in urban areas worldwide, with particular focus on MaaS components already operating in Poland. It also gives an assessment of the potential of new mobility solutions (such as ride-hailing, car-sharing, bike-sharing, scooter-sharing) in three Polish urban areas.

Keywords: smart city, urban mobility, new business models, MaaS, mobility on demand, car-sharing, bike-sharing, scooter-sharing, Poland, urban area

Introduction

New concepts of urban mobility which emerged in the second decade of the 20th century under the influence of the dynamic development of telematics technologies and changes in the transport behaviour of residents are closely related to the development of the smart city concept. A manifestation of the so-called smart mobility is to strive for optimal – from the point of view of the entire transport system of an urban centre – use of the resources from various branches of transport (i.e. ensuring intermodality) and new business models, as well as definitely greater involvement of individual stakeholders in initiatives related to sustainable urban development.

The concept of Mobility-as-a-Service (MaaS) belonging to the latest instruments in the provision of transport services, is to radically change the way in which the transport services market operates, especially in large cities and urban areas. Dissemination of this new concept of mobility will require cooperation of many subsystems and cooperation of numerous groups of stakeholders from the transport sector, as well as other sectors of the economy, including but not limited to administrators and operators of public transport, taxi corporations, car-sharing system providers, transport infrastructure administrators, manufacturers of vehicles, enterprises from the IT/ICT and electric power industries.

The aim of the article is to show the mutual relations between the smart city and MaaS concepts, present the current state of knowledge on the functioning and implementation of the MaaS concept in the world, as well as the potential for implementing specific components of this concept in Poland. The main research method in the first part of the study was critical analysis of the literature on the subject, which allowed identifying the most important concepts related to the development of modern cities and urban mobility. In the second part of the article, the definition of the MaaS concept is reviewed, and solutions using the MaaS approach in selected cities around the world are presented using the case study method. The last part of the article presents new forms of mobility, which were available in Poland in September 2018, as well as an assessment of their development potential by 2030 on the example of three selected Polish urban areas.

1. Evolution of smart city approaches

Since the early 21st century, many publications have been devoted to various aspects of the development of contemporary cities. Depending on the selected main area of analysis of the urban area on which the investigations of individual researchers are focused, a whole range of concepts related to urban development have been created (Table 1).

Table 1. Review of concepts related to the development of contemporary cities

Concept	Key area
Information city, virtual city, cyber city, wireless city, mobile city, technocity, digital city, intelligent city, connected city, wired city	IT/ICT, technical infrastructure, social media
Eco-city, green city, slow city, techno-ecological city	Environmental protection, sustainable consumption, renewable energy resources, smart grid
Knowledge-based city, creative city, clever city	Intellectual capital, education, social and human capital
Interactive city, cooperative city, responsive city, idea-city	Social and human capital, co-creation of values, co-participation of residents in management processes
Just city	Social and human capital, democracy, human rights
Happy city, dream city, liveable city, slow city	Social and human capital, quality of life, sustainable consumption, revitalization

Concept	Key area
Sustainable city, smart city, smart-networked city	Convergence of intelligent solutions in many areas: ICT, electrical grid, transport infrastructure, mobility, security, management, combined with the activity of residents

Source: (own elaboration based on: Anthopoulos, 2015, pp. 10–14; Graham, 2016; Montgomery, 2013; Hausner, Kudlacz, 2017, pp. 195–228; Fainstein, 2011; Goldsmith, Crawford, 2014; Patti, Polyák, 2017)

To face contemporary challenges of cities and urban areas, local authorities worldwide are constantly looking for more effective and smarter solutions of problems, and they realise that new, innovative technologies offer enormous possibilities. This brings about the concept of a smart city. In the relevant literature, smart, intelligent, knowledge, sustainable, digital, and wired cities tend to be used interchangeably, as their definitions and principles largely overlap. However, smart is the most often used label (Nam, Pardo, 2011). The so-called intelligence of the city, which lies at the basis of many concepts of the cities of the future, is currently being considered in a few dimensions as:

- more and more widespread use of advanced information and telematics technologies in the municipal economy: supply of electricity and heating, water management and waste management, mass public transport services, etc. (smart economy, smart environment, smart grid, smart mobility);
- more and more frequent use of the available solutions by residents by means of various types of mobile applications (smart people, smart living);
- increasing the awareness of city authorities regarding the possibilities and the need to use the latest city governance technologies (smart governance).

All the above-mentioned components of smart city are interrelated although they refer to different aspects of human activity. Initially, the idea of a smart city emphasised the need to implement the latest technologies in cities, as proposed by the ICT sector. This was followed by so-called Smart City 2.0, which assumed a greater degree of involvement of the local authorities in the choice of areas for the application of the latest technologies (Zawieska, Pieriegud, 2018, pp. 42–43). Therefore, the smart city concept should be seen as the ability of the city centre to adapt digital solutions and to disseminate cyber-physical systems to fulfil the vision of its individual stakeholders, including the expectations and creativity of its residents in the development of the urban space. Functionally, a smart urban area of the future (Smart City 3.0) will be a digital platform that will facilitate the synergy of physical and virtual networks (technical infrastructure, social connections, stakeholder interaction and cyberspace) and will ensure their interoperability, allowing them to offer new business models in urban mobility, such as Mobility on Demand and Mobility-as-a-Service (Table 2).

Table 2. Features of development stages of the urban mobility concept

Urban mobility system element	Mobility 1.0	Mobility 2.0 (Smart City 2.0)	Mobility 3.0 (Smart City 3.0)
Basic means of transport ensuring urban mobility, including non-mechanised mobility	Individual motorisation (combustion engines) and public transport (partially electrified), horse-drawn vehicles, traditional city bike	Individual motorisation (combustion and hybrid engines) and public transport (using mainly electric powertrains and traction), popularisation of single- and two-wheelers with electric powertrains	Public transport (almost exclusively electric powertrains and traction) and individual motorisation (with growing importance of autonomous vehicles), mass use of single- and two-wheelers with electric powertrains
Basic ICT technology supporting transit of vehicles	Radio	Radio networks On-board computers GPS (navigators) Mobile Internet (digital maps, applications) Bluetooth networks	Integrated Internet platform Connected car Virtual mobility (AR, VR, MR)
Dominant business model form offered to residents in: – individual journeys	Traditional car rentals Traditional taxi services Traditional rentals of bicycles and scooters	Rentals with mobile application support (car-sharing, bike-sharing, scooter-sharing) Platforms intermediating in transport services (carpooling, ride-hailing, taxi-hailing/sharing)	MaaS – service available on the user’s request, integrating travels by various means of transport and providers into one system using a single digital platform
– public transport	Mass transit	Combined products/services Tariff integration Applications for travel planning and transactions	

Source: (own elaboration)

2. Mobility-as-a-Service: a review of definitions and business implementations

One of the creators of the Mobility-as-a-Service concept is Sampo Hietanen, founder of MaaS Global Ltd., according to whom MaaS is ‘a mobility distribution model in which a customer’s major transportation needs are met over one interface and are offered by a service provider’ (Hietanen, 2014, pp. 2–4). Matyas and Kamarjanni (2017) from University College London define MaaS as ‘a user-centric, intelligent mobility distribution model in which all mobility service providers’

offerings are aggregated by a sole mobility provider and supplied to users through a single digital platform'. Transport System Catapult, a British-based research and development company dedicated to intelligent transport, describes the MaaS concept as 'using a digital interface to source and manage the provision of a transport related service(s) which meets the mobility requirements of a customer' (Transport System Catapult Milton Keynes, 2016, p. 11). A group of researchers from Dutch universities (Jittrapirom et al., 2017, pp. 15–16) distinguishes nine key characteristics relevant to the implementation of MaaS business models in practice: (1) integration of transport modes, (2) tariff option, (3) one platform, (4) multiple actors, (5) use of technologies, (6) demand orientation, (7) registration requirement, (8) personalisation, (9) customisation.

In the different studies, MaaS often comes together with the latest trends and socio-economic phenomena, for example, as a component of the concepts of Internet of Things, smart city, Industry 4.0, and the notion of sharing-mobility as part of a broader concept of sharing economy (Eckhardt et al., 2017; Kamargianni et al., 2018). Accenture (2018) in their approach focus on the aspect of sharing the means of transport and define MaaS as a digital tool for the implementation of car-sharing and ride-hailing systems – combined trips occurring primarily in urban areas. Transport systems in cities as the primary area of application of MaaS are also distinguished by CIVITAS (2017), an initiative of the European Union to implement sustainable, clean and energy efficient urban transport measures.

When reviewing the definitions of MaaS, it should be remembered that this concept is still at an early stage of the technology development life cycle which is often characterised by raising excessive expectations wherefore some experts believed the estimates of the future MaaS potential to be overoptimistic (Giesecke, Teemu, Hakonen, 2016, pp. 1–11). Understanding of the MaaS concept in subsequent decades may significantly differ from the contemporary approach. This mainly results from the rapid technological progress, especially in the area of digital technologies, including the development and dissemination of solutions classified as narrow artificial intelligence.

The modern MaaS solutions usually take the form of digital platforms and applications similar to travel planners. In this case, however, they allow not only checking the most convenient route from point A to point B in real time, but also choosing and ordering the means of transport to complete this journey, even with the use of several separate ways of moving. An important feature of such solutions is also the booking and payment for the selected transport service integrated with the application, regardless of the preferred means of transport – public or private. An advantage of MaaS is taking into account the online data about the traffic overload on specific sections and nodes of the transport infrastructure, as well as about the occurrence of failures and breaks in its operation. One of the objectives of the MaaS concept is to reduce the degree to which individual cars are used as the basic means of transport by way of providing alternative means of transport, providing similar or higher comfort and freedom of travel than by a passenger car. The use of this type of solutions makes it possible to settle all formalities and payments related to the choice of a given means of transport using a single service and 'one click'. One of the effects MaaS implementations will be

a reduction in the number of passenger cars used on a private ownership basis. This will allow reducing household expenditures intended for financing fixed expenses, e.g. insurance policies, permanent parking spaces.

Although created relatively recently, the MaaS concept is more and more frequently tested in pilot projects worldwide. In recent years, many cities around the world have run pilot projects and implemented MaaS components into their transport systems, including but not limited to Paris, Eindhoven, Hanover, Gothenburg, Barcelona, Vienna, Los Angeles and Singapore (Table 3). The implemented solutions concern mostly selected components of the theoretical concept of this model adapted to the local conditions of the transport system. The most developed system is Whim introduced and managed by MaaS Global, one of the world pioneers on this market. Whim started to be operated in Finland, and in 2018 offered its services to residents of several regions throughout Europe: Helsinki, West Midlands County in England, Amsterdam and Antwerp. The company's offer is constantly evolving – currently users can choose from three types of subscriptions, ensuring different access to specific means of transport.

Table 3. Examples of solutions using the MaaS approach in the world

Application or project, Website	City, country	Description of operation
Whim www.whimapp.com	Helsinki, Finland West Midlands, England Amsterdam, the Netherlands Antwerp, Belgium	The users of the application can choose from subscriptions ensuring various access to specific means of transport: public transport, taxis, city bike and car-sharing systems.
Ubigo www.ubigo.me	Gothenburg, Sweden	Originally a pilot project for approx. 200 users (80 households) launched in 2014. It offers integrated access to all means of transport in the city: public transport, car rental systems, car sharing systems, taxis and the city bike system.
Moovel www.moovel-group.com	Germany Boston, Portland, USA Helsinki, Finland	Application owned by Daimler. It allows planning the journey, booking and paying for the selected mode of transport; the range of the available means of transport varies depending on the region, including public transport, car-sharing systems, taxis and rail transport.
Beeline SG www.beeline.sg	Singapore	An application for booking seats on buses of private carriers, allows payment and tracking of bus locations. It also allows submitting proposals for new routes.
SMILE www.smile-einfachmobil.at	Vienna, Austria	A pilot project on 1000 participants implemented in cooperation between private and public transport operators in Vienna. The application allows planning the journey, booking and paying for the selected means of transport.

Application or project, Website	City, country	Description of operation
Bridj www.bridj.com	Boston, Kansas City, Washington, USA	A bus-on-demand system to order a bus using the application. Bus routes are flexible and adapt daily to the needs of passengers.
Communauto/Bixi montreal.bixi.com www.communauto.com	Quebec City and Montreal, Canada	Packages of services offered by public transport operators, including access to municipal bike systems (Bixi) and car-sharing systems (Communauto).
Smart Mobility jointventure.org/initiatives/mobility/smart-mobility	Silicon Valley, California, USA	An application connecting drivers and passengers on a ride-sharing basis. It provides additional financial bonuses for people regularly using the service.

Source: (own elaboration based on: Goodall et al., 2017; Kamargianni et al., 2015, and dedicated websites)

MaaS offers benefits to many stakeholders creating and using the services of this solution. For residents of urban centres, these include: simplifying the process of booking and payment for any transport service included in the system and planning a trip using data analysed in real time. The expected effect is supposed to be a significant reduction in the need for owning a passenger car, which is nowadays desirable for comfortable and flexible journeys. The benefits for transport providers participating in MaaS systems include the possibility of increasing the market share and profits earned.

Solutions using the MaaS approach are strongly linked to the capabilities of digital technologies, which have been developed at a very rapid pace for many years. The cost of the ICT infrastructure required for their efficient operation also drops significantly. An unquestionable development leap for MaaS may be the introduction of autonomous cars into service, which is expected in the next few years in the most technologically advanced economies in the world. Major changes in the area of transport autonomy will also bring the expected launch of the 5G telecommunications technology in the near future.

The MaaS model in its current form is a solution dedicated primarily to urban areas. This is also the basic limitation of this concept. MaaS requires extensive transport systems and a large range of potential means of transport to be competitive. This requirement essentially limits the possibility of implementing this concept to large cities and urban areas only. While a properly prepared MaaS offer can effectively persuade to opt out passenger cars when travelling within an urban area, it will not reduce the need to have a car for distant journeys, holiday trips with family, etc. It should also be remembered that with certain socio-economic conditions, the MaaS implementation may even increase the use of cars as the basic means of transport, and as a result, increase the negative externalities, e.g. emission and congestion. At the same time, limiting the traffic of individual cars is needed above all in cities, which is why the MaaS implementation seems to be definitely a desirable process from the point of view of accomplishing the objectives of the contemporary transport policy.

3. New mobility services and the implementation potential of MaaS in Polish urban areas

In September 2018, there was no provider of a fully operational MaaS model in Poland. Barriers impeding the implementation of this solution in Poland are similar to those encountered worldwide. The most significant important of these barriers are of a legislative and organizational nature. An additional issue is the maturity of entities to take up the role of a MaaS provider. Effective functioning of this model requires an established market position of carriers of all modes of transport potentially covered by the provider's activity. However, on the Polish market of transport services, services such as car-sharing or taxi on-demand systems (Uber, iTaxi or mytaxi) are still treated rather as innovative solutions than reliable and economically effective parts of the transport system. Wider integration is also hindered by the relatively short functioning of the market of innovative transport services which results in intense rivalry between entities. For example, in Warsaw there are currently three large car-sharing providers, and the city is planning to introduce its own system in the near future. Combining their offer in one superior application seems to be a very big organizational and business challenge. Another aspect delaying the implementation of MaaS in Poland may also be the great attachment and declared willingness to possess one's own means of individual transport which is much higher than in societies where solutions of such type already exist.

At the same time, one should note the visible, positive changes taking place in the transport systems of Polish cities, preparing them for the future implementation of MaaS systems. The emergence of innovative forms of transport services can be observed in all the largest urban centres in the country. Transport sharing systems that used in Poland on an increasingly wider basis, especially in the largest urban areas, may serve as an example (Table 4). In April 2018, car-sharing systems operating in nine Polish cities offered access to over 2000 cars. It is a market with high development potential, nonetheless it is still very immature, operating in Poland for three years only. The first car-sharing system was GoGet which was launched in Wrocław in July 2015. In Warsaw it was 4Mobility that started to operate in November 2016, and Panek that has been expanding its offer since 2017. The largest provider is Traficar whose services were launched on the Polish market in October 2016 in Kraków. These services have been also available in Warsaw since October 2017, Wrocław, Poznań and the Tricity (Gdańsk, Gdynia and Sopot) since October 2017, and also in Silesia since March 2018. The non-stationary car-sharing model providers (i.e. collection and return of cars in any place) are Traficar and Panek. It is assumed that in future cars operating in car-sharing systems will be exclusively electric vehicles, however, currently these are mostly cars with conventional or hybrid drives.

One of the items with a high potential for development are self-service city bike systems that fit in with the area of the MaaS model operation. The biggest bike-sharing provider is Nextbike Polska, which had bike city systems in 34 cities in the summer of 2018. Most stations have been located in the Warsaw urban area (400 stations in total and over 5,600 bicycles in Warsaw, Piaseczno, Konstancin, Pruszków, Grodzisk Mazowiecki and Otwock) and in Upper Silesia (121 stations in total with around 1040 bicycles in Gliwice, Zabrze, Świętochłowice, Katowice, Michałkowice, Tychy, Siemianowice Śląskie, Sosnowiec, Pszczyna, Kędzierzyn Koźle and Zabrze). In 2019, it is planned to launch a bike-sharing system in the Tricity urban area.

Table 4. Mobility solutions in three selected Polish urban areas (as at September 2018)

Description	Warsaw Urban Area	Upper Silesian Urban Area	Tricity Urban Area
Number of inhabitants of the urban centre(s) constituting the centre of the urban area (as at the end of 2017) (thous.)	The Capital City of Warsaw: 1,758	Group of adjacent cities of which the largest are: Katowice: 296 Sosnowiec: 204 Gliwice: 181 Zabrze: 174 Bytom: 168 Ruda Śląska: 138 Tychy: 128 Dąbrowa Górnicza: 121 Chorzów: 109	Gdańsk: 457 Gdynia: 246 Sopot: 37
Type of metropolitan centre and its specificity	Monocentric, with the largest metropolitan centre, being an important economic, cultural, scientific and political centre	Conurbation, which includes the historical areas of Upper Silesia and the Dąbrowskie Coal Basin. High concentration of industrial plants	Polycentric, bipolar with a linear development axis along the main transport route connecting three cities. Port and city complex. Historical buildings of city centres
Metropolitan area	Warsaw Metropolitan Area (OMW)	Upper Silesian and Coal Basin Metropolis (GZM)	Gdańsk-Gdynia-Sopot Metropolitan Area (OMG-G-S)
Number of municipalities in the metropolitan area	71 and 1 city with district rights	41	57
Metropolitan area, km ²	6,206	2,553	6,755
Population of metropolitan area (thous.)	3,147	2,280	1,568
Traditional transport system	– Urban public transport: underground (Warsaw), trams (Warsaw), buses (urban and suburban), suburban railways (WKD, SKM in Warsaw), regional railways (Koleje Mazowieckie) – Taxi – Traditional car rentals – Passenger cars – Traditional bicycle and scooter rentals – Non-mechanised individual transport	– Urban public transport: trams (13 municipalities), trolleybuses (Tychy), buses (urban and suburban), regional railways (Koleje Śląskie) – Taxi – Traditional car rentals – Passenger cars – Traditional bicycle and scooter rentals – Non-mechanised individual transport	– Urban public transport: trams (Gdańsk), trolleybuses (Gdynia), buses (public and suburban), rapid urban railways (PKP SKM, PKM), water buses – Taxi – Traditional car rentals – Passenger cars – Traditional bicycle and scooter rentals – Non-mechanised individual transport

Description	Warsaw Urban Area	Upper Silesian Urban Area	Tricity Urban Area
New business models in individual journeys	<ul style="list-style-type: none"> – Ride-hailing: Uber, iTaxi, mytaxi (Warsaw), Taxify (Warsaw) – Car-sharing: Panek (Warsaw, Pruszków), 4Mobility (Warsaw), Traficar (Warsaw) – Bike-sharing: Acro Bike (Warsaw), NextBike system: Venturilo (Warsaw) KRM (Konstancin-Lake), GRM (Grodzisk Maz.), Pruszków Town Bike (Pruszków), Piaseczno Town Bike (Piaseczno), Otwock Town Bike (Otwock) – Scooter-sharing: Blinker (Warsaw, Milanówek), JedenŚlad (Warsaw), Scroot (Warsaw) 	<ul style="list-style-type: none"> – Ride-hailing: Uber, iTaxi, mytaxi – Car-sharing: Traficar (free-floating in Katowice and Chorzów, other cities – in the service availability zone) – Bike-sharing: NextBike system: CitybyBike (Katowice), Gliwice City Bike (Gliwice), Municipal Bike (Michałkowice), Pszczyna Town Bike (Pszczyna), Tychy City Bike (Tychy), OK Bike (Kędzierzyn Koźle), Zabrze City Bike (Zabrze), Sosnowiec City Bike (Sosnowiec), Siemianowice City Bike (Siemianowice Śląskie), Świętochłowice City Bike (Świętochłowice) – Scooter-sharing: sharING – JedenŚlad (Katowice) 	<ul style="list-style-type: none"> – Ride-hailing: Uber, iTaxi, mytaxi – Car-sharing: Traficar – Bike-sharing: none – Scooter-sharing: Blinker
Innovative solutions for collective transport	<ul style="list-style-type: none"> – ZTM – KM – WKD integrated ticket – Metropolitan ticket – Online payments: moBilet, mPay, SkyCash, jakdojade.pl – Electronic contactless card of ZTM in Warsaw – Warsaw payment card (PKO Polish Bank, Capital City of Warsaw and ZTM) – Electronic student card, doctoral candidate card, university graduate/employee card combined as a carrier of long-term tickets 	<ul style="list-style-type: none"> – Integrated metropolitan ticket (bus, tram, trolleybus) for lines operated by KZK GOP, MZK and MZKP – Online payments: moBilet, mPay, SkyCash, jakdojade.pl – Silesian Public Services Card (ŚKUP): transport services, parking, recreation and sports, culture in 21 municipalities of the Katowice urban area and Municipal Transport Union of the Upper Silesian Industrial District (KZK GOP) 	<ul style="list-style-type: none"> – Online payments: moBilet, mPay, SkyCash, jakdojade.pl – eBilet (ZKM in Gdynia, ZTM in Gdańsk, MZK Wejherowo; student ID for higher education institutions)

Source: (own elaboration based on websites of transport service providers)

In 2017, scooter rentals also began to develop on the Polish market. In April 2018, approximately 360 scooters were available in Warsaw, including 200 electric ones offered by JedenŚlad. In June 2018, in Katowice, as part of the partnership of ING Bank Śląski and JedenŚlad, the sharING system (50 scooters) was launched.

An example of an innovative solution helpful in the implementation of MaaS can also be the integration of means of public transport. This concept is part of traditional transport systems, however, these systems can be prepared for further integration within the MaaS model with the appropriate use of telematics technologies, for example, by creating digital, automatic interfaces or enabling payment for tolls and tracking vehicles through a smartphone application. Similar solutions are already being implemented by the largest cities and urban areas in Poland. In 2020, it is planned to launch an electronic ticket in Tricity and in the Pomeranian region as part of the project to implement an integrated mobility services platform.

The development of new forms of mobility in Polish urban areas (Table 5) will depend on both the characteristic features of individual urban areas (e.g. settlement pattern, urbanization processes) and the ability of local governments to effectively implement the latest technologies and solutions supporting the management of a contemporary city and cooperation with the private sector for the smart city concept.

Table 5. Assessment of the potential for the development of new forms of mobility in three selected urban areas in Poland by 2030

New mobility services	Warsaw Urban Area	Upper Silesian Urban Area	Tricity Urban Area
Ride-hailing*, incl. electric**	High Medium	High Medium	High Medium
Car-sharing*, incl. electric**	High High	High Medium	High Medium
Bike-sharing*, incl. electric**	High Low	High Low	High Middle
Scooter-sharing*, incl. electric**	Medium High	Low High	Low High

* Estimated development growth of a given form of mobility on the Low/Medium/High scale.

** Estimated share of the number of means of transport (battery electric vehicles (BEV), electric bicycles or scooters) in the total number of means of transport used to provide a given form of mobility: Low (less than 25%), Medium (25–50%), High (more than 50%).

Source: (own estimation)

Conclusions

The MaaS concept is one of the most promising innovations in the transport services sector. The first MaaS solutions operate in the world too short to be able to fully assess their strengths and weaknesses and impact on the functioning

of transport systems in the long run. In the largest Polish urban areas there is already an extensive offer of transport services including various means of transport and new business models, which is the required starting point for MaaS adaptation. Nonetheless, due to the limited scale and lack of comprehensive solutions it is not possible as yet to speak that even the largest Polish urban area is entering the era of Smart City 2.0 and Mobility 2.0 (see Table 2).

Currently, there are a number of barriers to the development of this concept in Poland. They include both legislative as well as organizational, business and social issues. The MaaS model requires full cooperation and openness in access to sensitive data between entities providing transport services in a given region. A barrier to the development is also the still strong attachment to the need to own a car in Poland. Similar problems with wider implementation of MaaS occur all over the world and their gradual reduction along with the growing level of affluence and public awareness should be expected. Considering the conditions and barriers to the development of MaaS in Poland, the first operating MaaS systems can be expected not earlier than in ten years' time.

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Corresponding authors

Jana Pieriegud can be contacted at: jana.pieriegud@sgh.waw.pl

Jakub Zawieska can be contacted at: jakub.zawieska@sgh.waw.pl