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TRANSPORT AS THE BASIS FOR FUNCTIONING OF A SMART CITY – AN EXAMPLE OF SZCZECIN

Transport jako podstawa funkcjonowania inteligentnego miasta – przykład Szczecina

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Abstract: The aim of the article is an attempt to show the role of actions taken in the area of Smart Mobility in the process of shaping Smart City. The paper presents examples of cities from all over the world, which implemented Smart City model solutions into their functional structure. The examples mentioned above concerned mainly the implementation of innovative and effective technologies in the area of transport and mobility, while being safe for the natural environment. As an example from Poland, the city of Szczecin was chosen – indicating ways to apply similar (to those used in the largest metropolises of the world) solutions in the field of transport and mobility, enabling the city to introduce intelligent, sustainable and inclusive development of the local community, and ultimately conducive to improving the quality of its life. The research used desk research analysis, analysis of domestic and foreign literature on the subject, as well as Polish and European legal regulations controlling the procedures related to the subject of the research.

Key words: Smart City, self-government unit, mobility, transport

1. Introduction

One of the characteristics of modern civilization is the continuous process of urbanization, which is significantly influenced by both technological progress and globalization. "Research on urban development points to successive stages of urbanisation, including the transformation of cities into knowledge-based cities, digital cities, eco-cities or Smart Cities. The labels given to cities are primarily a reflection of their individual attributes as owned by the authorities and residents rather than their unambiguous position in the hierarchy of the global settlement system" (Sikora-Fernandez, 2013).

The multiplicity of definitions of one of the concepts – Smart City – hinders its unambiguous systematization. To this end, several basic categories have been specified, to which particular types of activities undertaken in given areas of city functioning have been assigned. These include: Smart Economy, Smart Mobility, Smart Governance, Smart People, Smart Environment, Smart Living.

The main objective of this article is an attempt to show the influence and significance of actions undertaken in the area of Smart Mobility on the process of shaping Smart City. The paper is divided into three parts. In the first part the attributes of a Smart City are discussed, and the basic aspects of Smart Mobility are presented. In the second, on the example of selected cities in the world, examples of innovative and efficient technologies implemented in the field of transport and mobility were presented. In the third one, in order to provide reference for the activities presented in the paper for the development of the Smart Mobility category, a case study of the city of Szczecin was presented. In the end, conclusions were presented that in the creation of Smart Cities, apart from the key role played in this process by urban planning and spatial infrastructure planning, also technologically innovative solutions implemented to the local economy are important, which, among other things, accelerate access to current data and increase social awareness, foster the participation of local entities in the changes introduced in the city, and what is very important – improve the comfort and safety of life in urban space. The research used desk research analysis, analysis of domestic and foreign literature on the subject, as well as Polish and European legal regulations controlling the procedures related to the subject of the research.

2. Attributes of a Smart City

One of the definitions presented in the literature on the subject is that a Smart City is a city that functions well in selected areas in a perspective manner, created as a result of an intelligent (smart) combination of existing conditions of activity of self-determining, independent and conscious residents. It is a transformation of the city towards a city of sustainable prosperity of its inhabitants in conditions of environmental comfort (Jarzemska et al., 2011).

Smart City can be also defined as an ultra-modern urban area that can be implemented based on a strategy that can improve the quality of life for citizens. This concept is very complex involving "different sectors, multiple stakeholders, high inter-dependency, cross-sectoral cooperation, inter-departmental coordination, and novel dynamic, and interactive services" (Bastidas, Bezbradica, Helfert, 2017).

According to the main assumptions of the Smart City concept, the creators of changes in the city should be its inhabitants, who thanks to their high qualifications and competences, creativity and ability to cooperate with the support of information and communication technologies (ICT) will be able to strive for continuous improvement of the quality of life in the city (accessed on: https://www.krakow.pl). Tab. 1 presents the main elements differentiating the different stages of Smart City development as detailed by B. Cohen[1].

A Smart City is one that increases infrastructural efficiency by using the latest technologies, especially those related to information and communication. However, it should be emphasized that technological aspects are only one of many determinants of being smart, and Smart Cities are in fact those that can function efficiently by introducing innovations in key areas of their development. (Centre of Regional Science 2007).

A city is said to be smart if it meets at least five out of the eight attributes in fig. 1. This model has been criticised for not providing a hierarchy or prioritisation of smart aspects or types of applications, which in practice means that all the attributes are assigned the same weight (Höjer, Wangel, 2014).

One of the key features of Smart City is "Smart Mobility, which refers to using modes of transportation alongside or even instead of owning a gas-powered vehicle. This can take on many different forms, including ride-sharing, car-sharing, public transportation, walking, biking, and more. The need for Smart Mobility arose out of increasing traffic congestion and its related side effects, including pollution, fatalities, and wasted time" (accessed on: https://www.geotab.com/blog/what-is-smart-mobility/). To find out more

[1] Boyd Cohen of the Universidad del Desarrollo in Santiago de Chile described three phases of the evolution of a smart city as Smart City 1.0, 2.0 and 3.0.

Tab. 1. Stages of development of the concept of Smart City.

Generations of *Smart Cities*	**Smart City 1.0**	**Smart City 2.0**	**Smart City 3.0**
The way to define a Smart City	An entity that serves technology companies to sell expensive (and not always needed) products and services to local authorities	A concept used by urban authorities to define local policies related to broadly defined technologies	A concept describing urban revolutions taking place in the world's leading metropolises in terms of quality of life
Characteristics	A city designed from scratch as a technological experimentation	A city where local administration consciously uses modern technologies to improve the quality of life of its inhabitants	A city that has fully opened itself to the active attitude of its inhabitants in creating further development
Role of local community	A passive consumer of the products that the city has to offer	The recipient of an urban offer, assessing the quality of goods and services of general interest	Active involvement in local affairs; the community shapes the space it inhabits
Infrastructure development	Sustainable infrastructure and buildings	Smart Networks, Wireless Internet Access Points, 3G/4G, Wireless Broadband Services	Intelligent automated buildings and infrastructure
Transport	Centralized monitoring and transport management systems	Intelligent transport (hybrid systems for transport) – automated traffic management systems (intelligence transport, GIS map)	Related transport (renewable energy for transport) – unmanned control, autonomous service (Connected transport, autonomous vehicle)
Examples of cities	Masdar in the United Arab Emirates; Songdo in South Korea	Warszawa, Wrocław, Łódź, Katowice, Słupsk, Gdynia, Rzeszów, Lublin	Barcelona, Vancouver, Wiedeń, Kopenhaga, Amsterdam

Source: Own work based on: http://www.inteligentnemiasto.com/smart-cities/smart-city-30 [20.05.2019]; Bashynska, Dyskina, 2018.

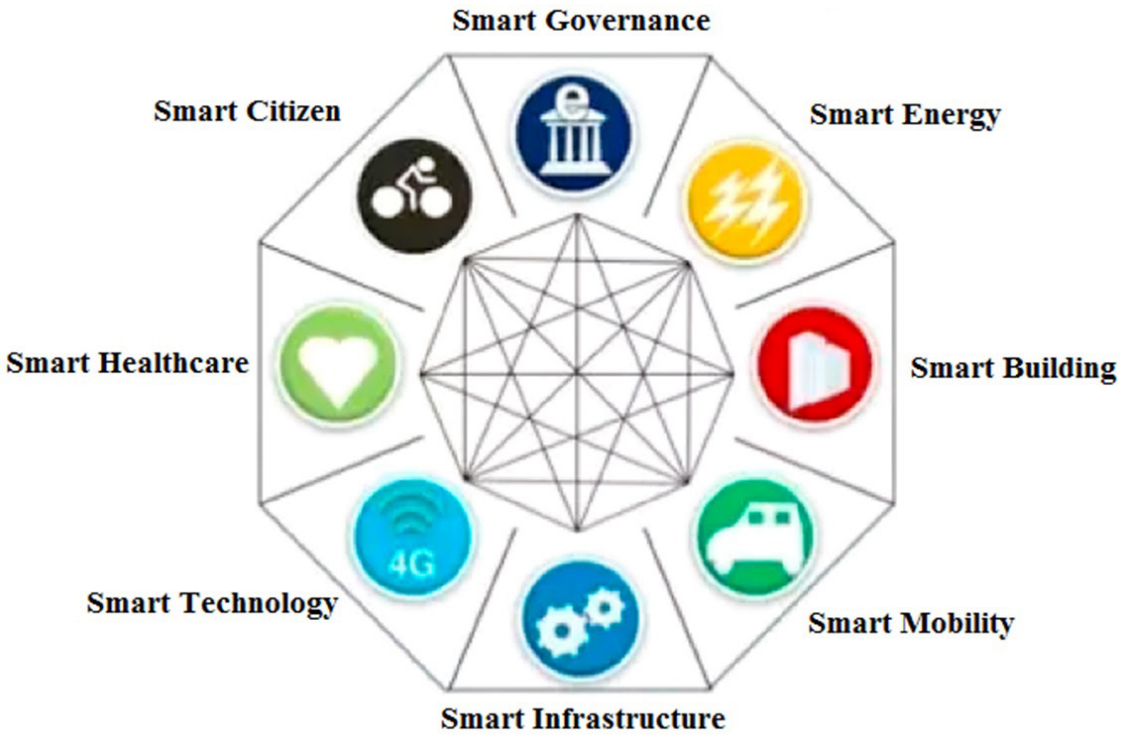
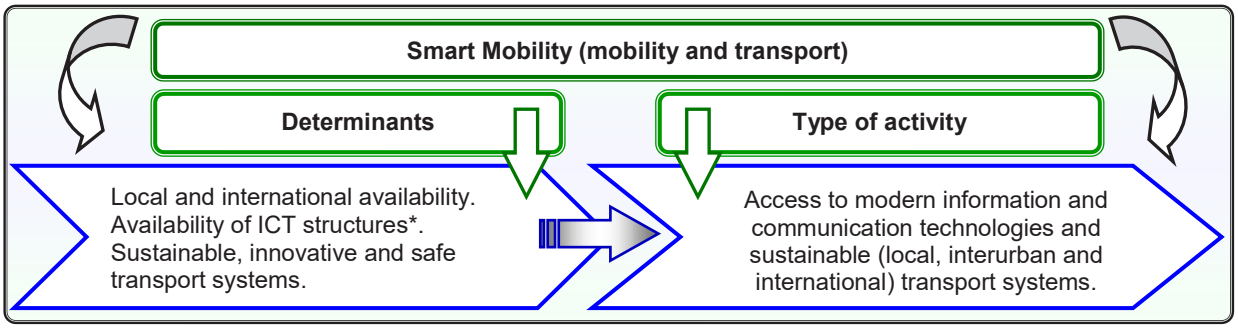


Fig. 1. Features of a typical Smart City.

Source: Frost and Sullivan, 2013.

about Smart Mobility category and its main attributes see fig. 2 and tab. 1.

spond to traffic issues by building more roads; it will instead seek other options. Popular choices include



*** ICT –** Information and Communication Technologies – family of technologies that process, collect and send information in electronic form.

Fig. 2. The Smart Mobility category.

Source: Own work based on: Przybyłowski, 2017.

Tab. 2. Main attributes of Smart Mobility.

SMART MOBILITY	
Aspects of Smart Mobility	**Characteristics**
Flexibility	Multiple modes of transportation allow travellers to choose which ones work best for a given situation
Efficiency	The trip gets the traveller o their destination with minimal disruption and in as little time as possible
Integration	The full route is planned door-to-door, regardless of which modes of transportation are used
Clean Technology	Transportation moves away from pollution-causing vehicles to zero-emission ones
Safety	Fatalities and injuries are drastically reduced
Accessibility	It should be affordable for everyone
Social benefit	It should help to provide a better quality of life

Source: Own work based on: Seimens, 2015; Frost and Sullivan, 2019; *Smart Mobility 2030…*, 2015.

Smart Mobility promises true convenience: using whatever mode of transportation that best suits a traveller in better health, and saved money. The options for implementing Smart Mobility are varied, leaving municipalities lots of room to find solutions tailored for their residents. Smart City does not re-

encouraging more walking, biking, and public transportation use. More novel options include sensor networks that help travellers see and avoid congested streets, and aggregate data that can provide cities with numerous insights (accessed on: https://www.geotab.com/blog/what-is-smart-mobility/).

3. Mobility and transport solutions for Smart Cities

Professional literature of the subject indicate that Smart Mobility initiatives aim to achieve six main objectives, which are: a) reducing pollution, b) reducing traffic congestion, c) increasing people safety, d) reducing noise pollution, e) improving transfer speed, and f) reducing transfer costs. (Bencardino, Greco, 2014; Lawrence et al., 2006).

The Smart Mobility ecosystem involves all actors and stakeholders present on the urban stage: the citizens, who need to move for personal needs, work, leisure and recreation; the private sector companies, which require efficient transportation of goods and products; the policy makers, who struggle to control citizens' satisfaction, environmental pollution; the smart objects, which can sense and interact with people and the environment (European Union 2011; International Rail Transport Committee (CIT), 2007).

Smart Mobility ecosystem needs to be supported by resilient and effective physical and digital infrastructures and proper e-governance tools in order to plan, monitor and improve the transportation services and its quality of service (European Union 2011; International Rail Transport Committee (CIT), 2007). Below are presented some examples of solutions used in smart cities around the world.:

- Amsterdam (capital of the Netherlands) – about 90% of households have bicycles and city has an advanced system of automated services for the public use of shared bicycles. In addition, it has put forward a project to ban gasoline and diesel cars by the year 2025 and thus become Europe's first zero-emissions city (IESE Business School, 2019).
- Madrid (the capital of Spain) stands out in the dimensions of mobility and transportation and in international outreach. It is committed to the development of a sustainable city. The platform MiNT (Madrid Inteligente or "Smart Madrid") lets residents use their smartphones to inform the council of any incident in the management and quality of urban public services, such as a sidewalk in poor condition or a faulty light in a streetlamp, to make the city more sustainable. The city also has the citizen participation platform Decide Madrid ("Madrid Decides"), launched to contribute to the direct democracy in the city's management. The platform allows residents to decide on a wide range of issues related to the city and has served as a model for other cities (IESE Business School, 2019).
- Barcelona (Spain) has about 1,6 million inhabitants and is noteworthy for its growing population of industrial designers and its prominent use of smartphones, and it is a pioneer in traffic management using big data. City is carrying out the C MobILE project, within the framework of cooperative intelligent transport systems, to increase awareness of the use of the road network. The navigation system can issue an alert if an ambulance, the police or a fire engine is coming, if the traffic lights are about to turn red or if there is a pedestrian on the sidewalk who is going to cross (IESE Business School, 2019). Barcelona has also a bike-sharing system – Viu Bicing, which is estimated to save one death and 2,5 million euros every year. The system costs users only 47 euros a year. Users pass a plastic card with magnetic strip in front of a Viu Bicing reader at a bike rack to borrow a bike. If the bike is returned within 30 minutes to another rack, the user pays nothing more. The system works in partnership with the city, and bike racks are located all over, making it easy for users to reach one (accessed on: https://www.geotab.com/blog/what-is-smart-mobility/).
- Columbus (Ohio, USA) has begun to collect traffic data to identify and address safety issues before they become issues e.g., identifying collision hotspots on the city's streets and to detect potential signal issues. The city is on its way to becoming the first Smart City in the United States thanks to a grant from the U.S. Department of Transportation, and analyzing this data will become the city's backbone for all of its future Smart City projects (accessed on: https:///www.geotab.com/blog/reduce-traffic-congestion/).
- Kansas City (Kansas, USA) has a free streetcar carrying up to 6,200 passengers a day in a major business district. The success of the program is largely contributed to all the real-time traffic feedback – not just for where exactly the streetcar is at all times but also the traffic around the downtown area, kiosks that show available parking spaces, etc. It also helps with ridership that the streetcar has free Wi-Fi. This 2,2-mile "smart district" corridor even has street lights that dim when there are no pedestrians walking beneath. Real-time traffic feedback also makes concepts like "congestion pricing" a little easier to sell to consumers who're used to using roads for free. Instead of the typical toll for express lanes, this would change the pricing structure based on peak traffic times and for high-occupancy or exempt vehicles, with the goal of discouraging single-passenger drivers to be on the road at peak travel times (accessed on: https://www.geotab.com/blog/reduce-traffic-congestion/).

- Las Vegas (Nevada, USA) – the city is using V2I[2] technology to not only track how many vehicles go through a given intersection at different times but how many pedestrians are crossing streets and even jaywalking, so the city can reroute vehicle traffic at times of high pedestrian traffic, and so on. The city can also get alerts when a pedestrian is in a roadway when the light is about to change so they can delay the light if needed, increasing the safety of the streets as well (accessed on: https://www.geotab.com/blog/reduce-traffic-congestion/).
- London (the capital of the United Kingdom) – city's innovation with regard to transportation has led it to install the Heathrow pods, capsules that work as a means of transit to connect with Heathrow Airport, one of the busiest on the planet. Its investment in public transport is pursuing one of Europe's biggest construction projects (the Crossrail project), which will add 10 new train lines to the city to connect with 30 already existing stations toward the end of 2019 (IESE Business School, 2019).
- Los Angeles (California, USA) is taking vehicle and pedestrian traffic data and making it open to the public, which means housing authorities and residential developers can better pinpoint commutes, and where housing should be developed to help reduce traffic coming into already congested neighborhoods (accessed on: https://www.geotab.com/blog/what-is-smart-mobility/).
- Minneapolis–Saint Paul (the "Twin Cities" of Minnesota, USA) – can use aggregated data from connected vehicles to automatically identify potholes and other poor road conditions. The data can be integrated with government management so that public works or maintenance workers can automate dispatching and work orders (accessed on: https://www.geotab.com/blog/reduce-traffic-congestion/).
- Seoul (the capital of South Korea) – has a Seoul's "Owl Bus", which is a public transportation system that operates locally between midnight and 5 am, offering a safe and affordable way to travel. Launched in 2013 after officials carried out surveys through a call centre and city blog, the initiative draws upon big data to identify which routes would serve commuting needs best. Owl Bus has lowered transportation costs while providing greater convenience to nearly 8 000 passengers daily. On average, the buses come every 25 to 35 minutes and cost passengers around a quarter of what a typical taxi ride would. The main beneficiaries are those living on the socioeconomic margins who need to commute during the bus system's service hours. Information systems connected inside the vehicles such as the Bus Management System, the Bus Information Unit and Bus Information Tool enable comprehensive control of the bus operations and efficient adjustment of intervals, while providing users and drivers with real-time operation information. Owl Bus now operates on a quasi-public basis, with the city managing the routes and revenues as private companies run the buses (accessed on: http://english.seoul.go.kr/seoul-to-operate-four-custom-year-end-owl-bus-routes-in-gangnam-and-hongdae/)
- Singapore (the Republic of Singaporean; an island city-state in Southeast Asia) – has a fiberoptic network the length and width of the island and up to three mobiles for every two residents, and it has robot hospitals (with human staff and robots), autonomous taxis (with no driver), and vertical gardens and farms that regulate the temperature by absorbing and dispersing heat while collecting rainwater. In this city, the authorities have a commitment to innovation (IESE Business School, 2019).

Singapore has Driverless Mass Rapid Transit (MRT). A growing number of residents (over 5,6 million people) and vehicle population (almost 1 million motor vehicles), have brought Singapore's Land Transportation Authority (LTA) and the Intelligent Transportation Society Singapore (ITSS) together to create an intelligent transport system to improve commuters' travel. Singapore's Smart Mobility 2030 strategic plan is an example of a smart plan that focuses mainly on transportation. The project aims to be informative, interactive, assistive, and to use green mobility. The LTA and ITSS have outlined three key strategies to achieve their goals (accessed on: https://www.geotab.com/blog/what-is-smart-mobility/):

- to implement innovative and sustainable smart mobility solutions,
- to develop and adopt intelligent transport system standards,
- to establish close partnerships and co-creation.
- Songdo Business District in Incheon (South Korea) – was built on 1 500 acres of land reclaimed from the Yellow Sea to house about 300,000 people and attract international businesses and schools. The city has ambitious goals: to be environmentally-friendly (over 100 building are LEED-certified),

[2] Vehicle-to-infrastructure (V2I) is when one vehicle is able to send and receive information. In V2I, the infrastructure can include physical things such as traffic signals and weather alert systems. The vehicle can send data out while simultaneously the infrastructure can send important data back.

bike-friendly, and car-free. The district is also connected via its subway system to the transportation systems of Seoul and Incheon. Buses are also already in use, and the developers promise to have one stop within twelve minutes of every neighbourhood. In addition, an extensive biking network is being built and EV charging stations are already in use. This smart city, though, is more than just Smart Mobility accessed on: https://www.geotab.com/blog/what-is-smart-mobility/):

- pneumatic chutes collect and handle waste underground, eliminating garbage trucks on the roads,
- televisions in residences are being wired so residents can access municipal administration,
- lights and residence temperature can be controlled from either a central panel in the home or apartment or from a smartphone,
- a single control centre in the district monitors three hundred interactive security cameras that include emergency call systems.

4. Case study Szczecin

Szczecin in terms of occupied area (30 055 ha[3]) is ranked third in the country, after Warszawa (51 724 ha) and Kraków (32 685 ha). In terms of population, which is 403,274 inhabitants, it is in seventh place, after Warszawa (1,769,529 inhabitants), Kraków (769,498 inhabitants), Łódź (687,702 inhabitants), Wrocław (639,258 inhabitants), Poznań (537,643 inhabitants) and Gdańsk (464,829 inhabitants)[4].

The city has the lowest population density among the Polish metropolises. Such a state of affairs has a significant impact on its functioning. On the one hand, it improves the quality of life, and on the other hand, it requires appropriate organisation of transport and urban infrastructure (Urząd Miasta Szczecin, 2019).

The urban structure of the city is characterised by a bipolar layout of city-forming centres. The centre on the left bank of the Oder River is characterised by a concentration of services of general urban, regional, national and international importance and is the largest concentration of jobs, while the right bank hosts a centre of local and suburban importance, directed at the immediate surroundings of the city (Urząd Miasta Szczecin, 2019). The development of mutual relations between these centres determines the quantity and quality of communication links through the area separating the main parts of the city (Międzyodrze), covering the areas between the eastern (Regalica) and western Oder streams, having a rich hydrographic system and intensive economic development. "The role and significance of Międzyodrze in the city structure is determined by the existing deep-water port with a system of quays and development areas, bridge crossings on the Oder and Regalica, railway areas, including the Central Port marshalling yard, depression and protection areas. The insufficient use of the city's waterfront location is correlated with the neglected coastal and water areas of Międzyodrze'" (Urząd Miasta Szczecin, 2011).

The diagram below shows the population density of the city against the background of its four administratively separated districts (Fig. 3).

The „smart" activities undertaken so far in Szczecin have focused mainly on rationalisation of spatial management, revitalisation, safety, investment (adequate to the needs and expectations of the society), economic development, low-carbon and energy efficiency, integrated city management, monitoring, striving for sustainable mobility and participation of the inhabitants themselves. (Krawczyk, 2016).

The projects implemented under the Smart City concept included, among others, the Dynamic Passenger Information System, which included (Krawczyk, 2016):

- fifteen passenger information boards and passenger information via text message, Bluetooth and website,
- fleet management systems, vehicle video monitoring, passenger stream counting, periodic electronic ticketing and communication network optimization.

This area also included: central collecting of information on traffic flows, traffic light control, depending on the current traffic situation and events in real time, improving the capacity of the city road communication system, complemented by intelligent street lighting (LED), allowing for the management of individual lamps and reducing energy consumption by up to 70% (Krawczyk, 2016).

In the area of public safety, video monitoring, supported by automatic image analytics, has been introduced to ensure, among other things, automation of the detection of undesirable effects. The investments are also being made in the construction of photovoltaic farms and the production of electricity and heat using biogas generated in the sewage treatment process (Krawczyk, 2016).

Szczecin is involved in the development of sustainable transport by investing, among other things, in electromobility. The city purchased sixteen hybrid

[3] As of 1.01.2008, pursuant to the Ordinance of the CM, the area of the city of Szczecin decreased by 24.91 ha.

[4] Data of the Central Statistical Office from December 31, 2018.

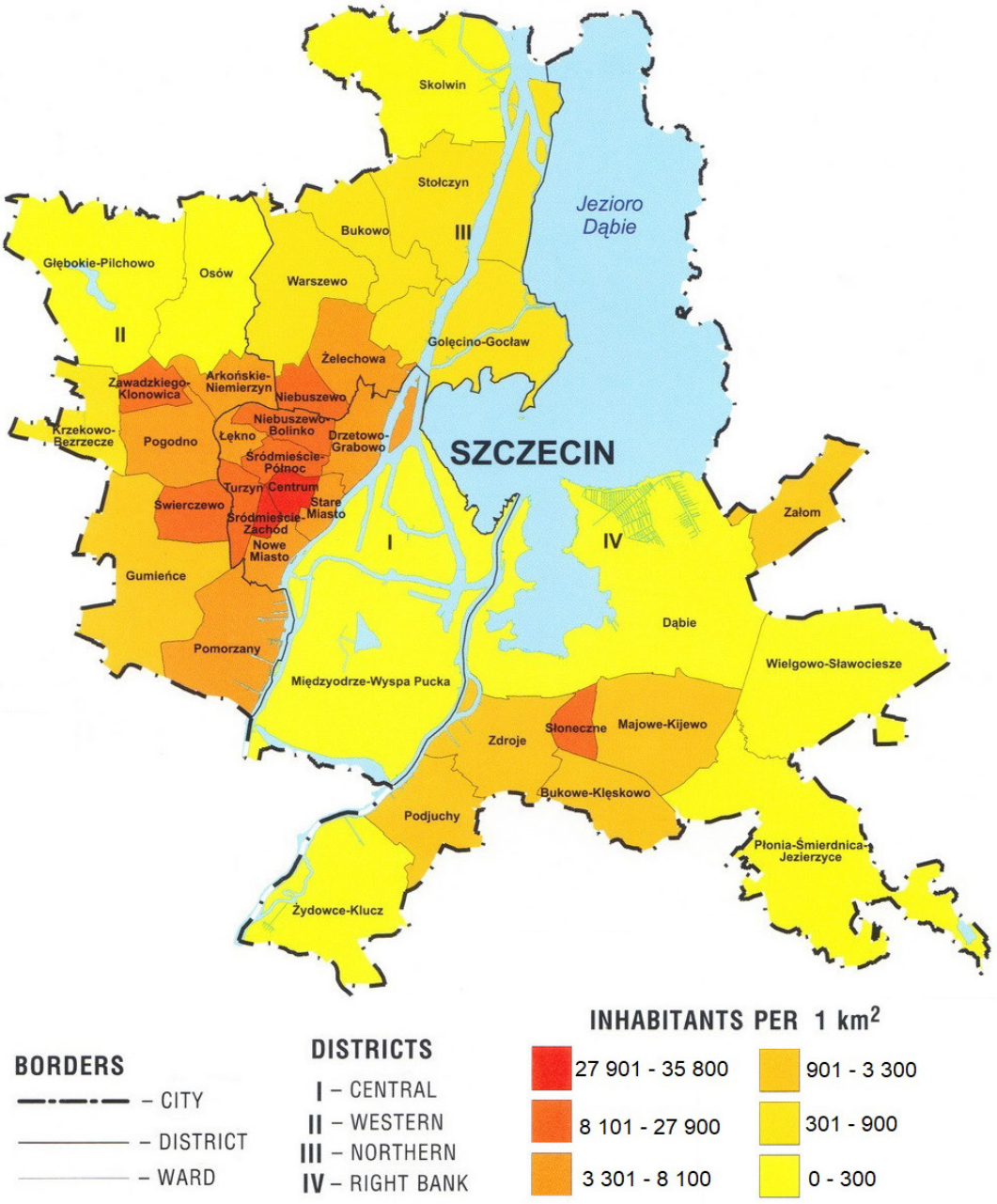


Fig. 3. Main districts of Szczecin.

Source: https://szczecin.fotopolska.eu/1209287,foto.html [7.04.2018].

buses, twenty low-emission Solaris buses and allocates further funds for the purchase of modern tram rolling stock, construction and reconstruction of the tram network (Urząd Miasta Szczecin, 2019).

The city is involved in the implementation of the Szczecin Metropolitan Area Association's investment – Szczecin Metropolitan Railway. Within the framework of the ongoing project entitled "Construction of Szczecin Metropolitan Railway with the use of existing sections of railway lines No. 406, 273, 351" in 2018, an agreement on co-financing of the project and an agreement on cooperation with the Szczecin Metropolitan Area was signed. (Urząd Miasta Szczecin, 2019).

What is more, the city's parking system – Park & Ride – enables people using private means of transport to park their vehicles in free of charge parking lots and use public means of transport. Parking lots are public facilities, open 24 hours a day, unguarded (however, the parking time cannot exceed 24 hours at a time), intended for parking motor vehicles with a permissible total weight of up to 3.5 tons. Parking lots are additionally equipped with a sign informing about the number of available parking spaces,

a stationary ticket machine, a sign informing about the nearest tram and bus line courses and a city bike station (accessed on: https://www.zditm.szczecin.pl).

The public transport system is complemented by the Szczecin City Bicycle (Bike _S)[5]. Bike_S provides over 700 bikes available at 87 stations. In 2018, nearly 490,000 city bike rentals were recorded. The entity responsible for the proper implementation of the Szczecin City Bicycle project is Nieruchomości i Opłaty Lokalne Sp. z o.o. (Urząd Miasta Szczecin, 2019).

Apart from solutions aimed at reducing the importance of individual car communication, actions are also taken to improve it, e.g. turbine and half-turbine roundabouts[6] or yellow boxes (accessed on: https://gs24.pl/), which are designed to ensure that users can take advantage of car communications more efficiently and less collisionally.

The examples provided above show that Szczecin[7], being one of the first Polish local governments to introduce Smart City elements in its area, can boast of already implemented innovative solutions in the area of communication and sustainable transport. The city authorities, focusing on satisfying the needs of the residents, introduce technological solutions used in the largest Smart Cities in the world. They implement intelligent and innovative measures aimed at improving the quality of life of Szczecin's inhabitants, increasing their awareness and participation, increasing the effectiveness of using available resources, as well as stimulating sustainable development of the city in all its areas.

Conclusions

The city is a complex social and technical system. The degree of complexity depends on many factors, such as the size of the occupied area, the condition of the technical infrastructure or demography.

The density and condition of civilization, social and technical infrastructure have a decisive influence on the living and working conditions in a given city. Undoubtedly, the location, equipment and possibilities of public and individual transport determine significantly the ease of access to public administration, education, health care, culture, recreation or place of residence.

A city can become smart only if a true interconnection between its infrastructures (physical, ICT, social, business) can be made (Harrison et al., 2010): in such a case, ICT represents a powerful way to ensure the access to public services and a dynamic driver for the "development of innovative approaches to particular social challenges and to the establishment of new businesses and business models" (Komninos et al., 2013). Moreover, ICT infrastructures, smart devices and personal sensors available to citizens foster the adoption of ICT intensive solutions and services (e.g., transportation management, traffic control, environmental monitoring, etc.) as well as to develop the so-called embedded intelligence of the city (Hernández-Muñoz et al., 2011).

Some examples related to transport management in a Smart City are (Pop, Proștean, 2018):

[5] Bike_S is an unmanned city bike rental service consisting of 87 stations and 702 bikes. It has been operating in Szczecin since August 2014. The stations are located every few hundred meters in the center of Szczecin and in the whole part of the left bank as well as on the right bank. Bike_S bikes enable easy access to any area of Szczecin at any time. Bike_S is a modern and ecological supplement to urban transport. It operates 24 hours a day in spring, summer and autumn. Source: https://bikes-srm.pl/bikes-jak-to-dziala/ [01.09.2014]

[6] Selected roundabouts will include segregated lanes with their individual relations. The right lane (outer lane) will only be used to turn right. Central lanes for left turns or rides straight ahead and internal lanes (left) only for straight ahead ride along the circles. Before entering roundabouts, it will not be indicated which lane to take depending on the chosen exit from the crossroads. That is why such roundabouts are called semi-turbine, not turbine roundabouts. This temporary solution will be tested in the city for 3-6 months. Source: https://wszczecinie.pl/aktualnosci, rewolucyjne_zmiany_na_najwiekszych_rondach_koniec_z_krazeniem_po_prawym_pasie,id-32372.html [22.07.2019]

[7] In European Smart City Project initiated in 2007, scientists from Vienna University of Technology, Delft University of Technology and the University of Ljubljana created a system for analysing Smart City indicators. Out of approximately 1,600 European cities, 70 meeting three criteria were selected: a population of between 100,000 and 500,000, with at least one university and an impact area of less than 1.5 million (to exclude cities dominated by large neighbours). The survey defined „city smartness indicators" in terms of governance, economy, mobility, environment, population and living conditions. In 2015, the Vienna team analysed 90 larger centres, ranging from 300,000 to 1 million inhabitants. Given the large discrepancy in the characteristics of these cities, the ranking according to the integrated indicator was abandoned, leaving the mechanism of comparing the indicators of selected cities – indicators among one another and in comparison with the average indicators for the examined 90 cities. Bydgoszcz, Gdańsk, Katowice, Kraków, Lublin, Łódź, Poznań, Szczecin and Wrocław were assessed in Poland. These cities were ranked below the survey averages, the closest to the averages were Bydgoszcz, Gdańsk and Katowice in terms of living conditions and environment, Kraków, Lublin and Poznań in terms of living conditions and mobility (Kraków and Poznań above the average for living conditions), Szczecin in terms of environment and management, and Wrocław in terms of mobility and population.

- implementation of a system that can announce in real-time the timing for public transport in each station;
- implementation of green transportation systems such as: public bike sharing systems, charging stations for electric and hybrid vehicles;
- implementation of intelligent parking systems;
- implementation of intelligent traffic lights systems;
- implementation of public lighting using alternative energies and intelligent sensors.

The practice of creating Smart Cities indicates that the key role of this complex, long-term process is played (in the material sphere) by urban and spatial infrastructure planning. Moreover, skillful use of the social and intellectual capital of the inhabitants, the level of organisation and preparation of the substantive institution, spatial and financial accessibility of these elements for the inhabitants and entrepreneurs are of utmost significance.

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