SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2022
ORGANIZATION AND MANAGEMENT SERIES NO. 167

SUSTAINABLE MOBILITY WITHIN GREEN SMART CITIES – A CHALLENGE FOR LOCAL GOVERNMENTS. CASE STUDY OF TRI-CITY

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Purpose: Verification of the status, potential and directions of development and identification of challenges for Tri-City local governments.
Design/methodology/approach: The case study of the Tri-City, based on the analysis of the literature on the green smart city concept and the documents of the municipalities of the Tri-City, secondary sources in the form of research communications of a similar scope. Author will first deal with the determinants of the green smart city concept, and within that the determinants of smart mobility.
Findings: The green smart city concept in urban space management for local authorities it is primarily a mobility policy, and within it, two main areas of action. The first is a infrastructure policy, the second is to shaping the transport behaviour of city residents. Infrastructural decisions are directly dependent on the local authorities, while the transport behaviour of the inhabitants can be influenced by the local authorities by shaping the creative class.
Social implications: The management of urban space in terms of sustainable mobility policy should lead to a change in mobility behaviour of the agglomeration's residents. One of the aims of the local authorities should be to define and selection of influence tools on the creative class of Tri-City, which through its mobility behaviour will change the mobility patterns of other residents. The decisions of the local government in the area of infrastructure solutions, the network of public transport and raising environmental awareness of the Tri-City residents, a change in communication behaviour of the Tri-City community should be occurred. This change should be leaded in the direction of resignation from travelling by car in favour of solutions that are more conducive to sustainable development.
Originality/value: The article presents the strategic objectives and directions of activities of the local governments of Tri-City, comparing them with the concept of green smart city. It indicates that the element that connects all areas of this concept is the policy of sustainable mobility of the residents of the city, which should be implemented through investment in infrastructure and building the creative class, which is a role model for ecological behaviour of the residents of Tri-City.

Keywords: smart mobility, green smart city, Tri-City.

Category of the paper: Case study.

1. Introduction

According to the policy of sustainable development, the management of urban spaces by local governments should aim to reduce the negative effects on the environment and create comfortable living conditions for the local community. For urban spaces, sustainable development means fitting into the green smart city concept, which includes the municipality as an organisation and the processes within it (smart economy, smart governance), the population and residents (smart people) the environment (smart environment), as well as the environmental behaviours of residents (smart living, smart mobility). The Tri-City case study based on the analysis of the literature on the green smart city concept and the documents of the Tri-City municipalities, secondary sources, in the form of research communications of similar scope, will first treat the determinants of the green smart city concept, and – within it – the determinants of smart mobility, and then indicate the status, development potential and challenges for Tri-City local governments in this regard.

2. Green smart city – the development direction of city space management

The direction of environmental activities at various levels of the economy, especially local, is conditioned by the deteriorating state of the environment and the need to reduce or avoid harmful changes. Public expectations concerning the activities of local governments are driven by increased social sensitivity to the quality of the environment and, consequently, are reflected in attitudes. Such attitudes bring the management of urban spaces closer to the smart city concept. The smart city concept is rooted in sustainable development and the sharing economy contributing to the creation of an innovative city. An innovative city is more effective in meeting the quality of life needs of its residents; however, the ability to apply smart city concepts to local government policies depends on the city's financial potential (Łaźniewska et al., 2021).

The smart city concept is a concept focused on smart management of space and community, however, no longer sufficient in terms of caring for the environment. A current requirement of urban space management is an environmental approach, taking into account first the perception of the effects of decisions and policy objectives through the prism of the impact on the state of the city’s natural environment. The areas of activities that characterize the smart city transformation process towards a green smart city should also include those aimed at the energy and environmental efficiency of existing buildings, the introduction of renewable energy sources on a municipal scale, and the introduction of smart mobility plans. Indeed, these areas of activity are the most effective way to reconcile the following objectives (Casini, 2017):

- environmental (reduction of energy consumption and emissions),
- economic (reduction of management costs for citizens and public administration, development of businesses and increase in employment levels),
- social (improving well-being and quality of services).

So, green smart city is the highest level of green development and management of urban spaces, one that is most open to new solutions and cooperation. A parallel issue is to improve the skills and environmental competences of the city's residents – further training in the use of infrastructure, transport, tourism, natural environment, education, research and business cooperation, among others (Łaźniewska et al., 2021). Thus, taking into account the challenges for local governments in the field of smart mobility, urban space management in the green smart city concept means, first of all, investing in transport and municipal infrastructure, and secondly, it means reducing the number of trips residents make by environmentally unfriendly modes of individual transport, i.e. cars. Measures to encourage users to change their transport preferences and behaviours (mobility management policies) should, by definition, define the city's overall vision for promoting sustainable transport and encourage residents to use cars less frequently in favour of sustainable modes of transport (Przybyłowski, 2017), thus creating the desired urban mobility model. Urban mobility models are constantly changing. In particular, the high dynamics of transformation is characteristic of agglomeration areas. Mobility is shaped by multiple factors – in particular, by the media and by imitating the behaviours of individuals and social groups, which requires a broad approach to urban functions. A variety of activities are carried out in metropolitan areas to carry out higher urban functions, such as administration, culture, art, science and education. The implementation of these functions falls within the concept of the smart city and creates conditions for the development of the creative class (scientists, engineers, artists, designers and architects, programmers, opinion makers, legal professions, hi-tech sectors, health care financial services industry and management professionals). The creative class, due to its status and social exposure, is a driving force of local and regional development, as it has the opinion-forming potential, so the creative class can participate in the creation of urban mobility behaviours patterns embedded in the concept of green smart city, as its members (Krawczyk, Kos, Tomanek, 2020):

- have a stable financial situation, hence they will be less negative about restrictive measures in line with the green smart city paradigm, e.g. limiting access of older cars (or diesel cars) to the city centre,
- because of their international contacts (e.g., working for a global enterprise) and greater propensity to travel, they are eager to draw on foreign models in the context of solving local transport problems – such as congestion,
- are aware of the negative impact of transport on the surroundings (including the natural environment) and are able to change their own transport habits,

- feel no apprehension when dealing with modern technology and adapt new solutions faster than the rest of society,
- are open-minded and tolerant, which also manifests itself in the acceptance of the transport-related behaviours of others who, for example, use bicycles to commute to work.

Mobility management policy is also the local government's fulfilment of statutory, mandatory actions under legal acts. One such piece of legislation setting the course for changing the urban spaces towards a green smart city is the Act of 11 January 2018 on electromobility and alternative fuels (Dz.U. 2018, poz. 317). The law imposes, among other things, the obligation to create charging sites in newly built multi-family and public buildings, development rules and conditions and obligations for the deployment of alternative fuel infrastructure for transport, rules for the functioning of clean transport zones in cities, information obligations for alternative fuels (Zawieska, 2019). In addition, the law imposes obligations on state authorities and local government units regarding the number of battery electric vehicles in the fleet of vehicles used by these units, the number of zero-emission buses in the fleet of vehicles used in public transport, creating a framework for planning activities leading to minimum conditions that fall under the green smart city concept.

3. Towards green smart city - Tri-City case

The Tri-City is a polycentric metropolitan area. It is located in the Pomeranian Province of Poland, on the shores of the Gdańsk Bay and the Puck Bay. To the south, the urban spaces of the Tri-City is defined by the landforms of the Kashubian Proglacial Stream Valley and the Tri-City Landscape Park. Such a location is, on the one hand, from the point of view of the green smart city concept, advantageous, as it creates conditions for fairly free access to environmental resources, which, by the way, is inscribed in the consciousness of residents who commonly enjoy leisure activities in coastal areas, but on the other hand, it creates a constraint by setting and limiting the directions of urban expansion. The total area occupied by the urban centre thus defined as of 2021 was about 414 km² and was inhabited by approx. 749,800 residents – Gdańsk 470,633, Gdynia 244,104, Sopot 35,049 (GUS, 2022). Due to the awareness of local government authorities, not only of the main urban centres, but also of the municipalities drawn to the Tri-City forming the Gdańsk-Gdynia-Sopot Metropolitan Area, a strategy for the Gdańsk-Gdynia-Sopot Metropolitan Area was developed in 2015, in which the most important determinants of spatial development and management were considered (Strategia…, 2015):

- the metropolitan area is a polycentric and bipolar area with a linear development axis along the main transport axis,
- deconcentration and dispersion of settlements are present within the metropolitan area, involving an exodus of residents from the metropolitan core and other cities,
- the public transport system of the metropolitan area is based on railway connections (SKM, PKP Przewozy Regionalne, PKM), which clearly improve transport accessibility of the metropolitan core and regional centres,
- the metropolitan area is characterised by one of the Poland's largest, very diverse potential for tourism, sports and leisure; the most important assets include its coastal location, cultural offer, historical monuments, cultural diversity, and natural and spa qualities,
- the quality of the environment plays a key role in the development of the metropolitan area from the point of view of securing high living standards for its residents – poor air quality (especially as a result of low emissions, resulting in exceeding the permissible level of particulate matter content, among others) is a threat,
- thanks to the potential of the Metropolitan Area, functional-spatial relationships are formed, manifested in regular or occasional commuting and the use of metropolitan educational, commercial, cultural, leisure and medical offerings.

Based on the conditions indicated above, the strategy defines a strategic goal in the form of: "The goal of Strategy 2030 is to create mechanisms to strengthen the cohesion of the Metropolitan area through coordination of activities, intersectoral cooperation and obtaining compromise solutions for the better development of each of the entities that make up the Metropolitan area," and includes specific objectives for the various areas that are part of the green smart city concept (Table 1).

Looking at the development objectives of the Gdańsk-Gdynia-Sopot Metropolitan Area, it can be clearly identified that the main area for improving the quality of life in the city and developing into a green smart city is the issue of transport – both public passenger and individual, as well as cargo, which is a result of the coastal location, which makes it necessary to bring them in and out of ports. The importance of this area is reinforced by two facts. The first is that "in general, transport accounts for a quarter of Europe's greenhouse gas emissions and is considered a major cause of urban air pollution" (Rasiński, 2018), while the second is that the quality of transport is determined by mobility management policies (including infrastructure), which is the responsibility of the state or local governments.

Table 1.
Specific strategic objectives for the development of the Gdańsk-Gdynia-Sopot Metropolitan Area

Area	Sub-area	Purpose
Society	Education	Development and improvement of the quality of education
		Matching higher and vocational education with labour market needs
	Residents	Increased cultural participation and improved social skills
		Support for families and reduction of migration outflows
		Attracting and supporting new residents
Innovative and competitive economy	Promotion and investment	Creation of infrastructure for investment and economic promotion, including industrial production
		Supporting local businesses in the global market
		Supporting network links within key clusters (including the shipbuilding cluster, transport-freight forwarding-logistics and ICT) as well as regional smart specialisations
	Innovation and entrepreneurship	Promotion of innovation and entrepreneurship
		Increasing the effectiveness of research and development activities through internationalisation and commercialisation of research results
		Supporting the metropolitan labour market
		Development of tourism and leisure industries (including promotion of internal tourism in the metropolitan area)
Sustainable space	Transport	Strengthening the function of an international transport hub, including through the development of seaports
		Improving internal transport accessibility and improving the public transport network
		Improving external transport accessibility
		Improving management and prioritisation of metropolitan public transport, multimodal and active mobility
	Spatial planning	Improving land use efficiency based on a polycentric settlement system
		Creating industrial and service zones
	Environment	Protecting the environment and reducing environmental risks
		Improving the efficiency of water, sewage and waste management.
		Developing renewable energy and increasing energy efficiency

Source: Strategia Obszaru Metropolitalnego Gdańsk-Gdynia-Sopot do roku 2030. Retrieved from: https://www.metropoliagdansk.pl/upload/files/Strategia%20OMGGS%202030(2).pdf, 10.05.2022.

Strengthening the function of Gdańsk-Gdynia-Sopot Metropolitan Area as an international transport hub, including through the development of seaports is implemented and results from the fact that seaports located in Gdańsk and Gdynia handle passenger and cargo traffic. A ferry service is operated to from Gdańsk to Nynäshamn and from Gdynia to Karlskrona. By far the larger operator is the Gdynia-based Stena Line, offering 14 trips per week, while Polferries from Gdańsk is only 7 sailings per week. Both ferries are passenger and car ferries, and both also handle cargo traffic including container traffic on semi-trailers, which puts more strain on road infrastructure. Both are located in the system of the primary transport network of national and international importance and are integrated into a system that, through sea and land connections, is an integral part of the European transport network. A number of transport links leading through the ports of Gdańsk and Gdynia are particularly important for the European Union's transport routes. These include (Grzybowski, 2010):

- trans-European roads (TEN roads):
  - A1 highway (Gdańsk/Gdynia – Łódź – Katowice) with branches,
  - Grudziądz-Poznań, Toruń-Warsaw and Łódź-Wrocław roads,
- trans-European railways (TEN railways),
  - Gdańsk/Gdynia – Warsaw – Katowice – Zebrzydowice railway main line, with a Warsaw – Dorohusk branch line,
  - Gdańsk/Gdynia – Bydgoszcz – Katowice railway main line with Inowrocław – Poznań, Zduńska Wola – Wrocław branch lines,
  - Gdańsk/Gdynia – Elblag – Braniewo – Kaliningrad railway line.

It is clear that port transport service creates infrastructure challenges, both in terms of rail and road infrastructure. Railway infrastructure viewed through the prism of the city creates a problem of land use intensity, "dividing the city" and creating problems at the interface with road infrastructure. However, from the point of view of the city's residents, the most important thing is the road infrastructure, which is simultaneously used for individual transport. From this point of view, it should be said that Gdańsk (New Port, Northern Port and DCT) has a much better connection with the main road traffic direction, that is, east and south with the connection of the Major Henryk Sucharski Road (DK 89) with the S7 national road, in the direction to Elbląg and then east and south and west to the S6 and then A1 south and west DK 22. The important thing is that the ports of Gdańsk can be served in a way that has little impact on city centre traffic. A certain problem is the use of the Sucharski Road by residents for daily commuting to neighbouring communities located south of the city.

In Gdynia, on the other hand, the main element of road infrastructure is the "Eugeniusz Kwiatkowski Road," which is a municipal connector to Morska Street (which is part of the Tri-City's urban traffic axis) and the S6 road, which was built in the 1970s as a ring road for the Tri-City, and is now practically part of it. This results in increased car traffic of Tri-City residents giving up on the main urban road transport axis DW 468 (Gdańsk Central Station – Gdynia Chylonia intersection with S6). The development of the importance of Gdańsk-Gdynia-Sopot Metropolitan Area included in the strategic objectives will definitely exacerbate the problems of road communication in Gdynia, since the Kwiatkowski Road (built in the mid-1970s), which is in dire need of repair, is at the same time the main connection between the city centre and its districts that are some of the city's main dormitory districts (Obłuże, Pogórze, Oksywie, Kossakowo). The challenge for the city is to build two transport solutions to handle the transport of the Port of Gdynia. The first is railways, including the modernisation of existing railway lines 131, 201 and 202 through the Tri-City to Słupsk and the construction of a connection to the Solidarity Transport Hub Poland. Railway investments in the Port of Gdynia area will contribute in the future to connecting it to the network being built as part of the Solidarity Transport Hub Poland (including a node in the vicinity of the Solidarity Port). Goods arriving on ships will be able to be transshipped in the port of Gdynia onto rails, then reach Gdańsk, and there via the Solidarity Transport Hub Poland railway line (the so-called "spoke"

No. 1), i.e. CMK-North, reach the Solidarity Port and the intermodal transshipment terminal located in its vicinity (Pomorski Urząd Wojewódzki).

The second is the so-called Red Road. The new road connecting the Kwiatkowski Estacada, which is overloaded by port transit, with the Tri-City Ring Road and on to the A1 highway (Figure 1) is an opportunity not only for the port's development, but above all to allow residents free passage on the most important artery leading to the city's northern districts. The road has needed costly repairs several times in recent years, and representatives of the Ministry of Infrastructure have regularly received signals from Gdynia about the increasingly necessary Red Road. For many years, the local government of Gdynia has been applying for funds from the State Treasury (Gdynia moje miasto) and it seems that recently, thanks to an agreement signed in April 2022, planning work can begin and construction has a chance to start (Pomorski Urząd Wojewódzki). Such a solution is in line with the investment already underway involving the construction of the Metropolitan Ring Road through the extension of the S7 expressway (Straszyn – Chwaszczyno) and the construction of the so-called "Kashubian Road", (Gdynia Wielki Kack – Bożepole Wielkie). This will improve the situation of the metropolitan cities by taking transit traffic out of the Tri-City ring road. The planned completion date for the "Kashubian Road" is the summer of 2022 (trojmiasto.pl), and the S7 road extension is the second quarter of 2025 (Serwis Rzeczypospolitej Polskiej)

Figure 1. The course of the Metropolitan Ring Road – "Kashubian Road" and the Red Road in Gdynia.

Source: Co na drogach Retrieved from: https://conadrogach.pl/drogi-ekspresowe/mapa-samochodowa/, 10.05.2022; Gdynia moje miasto. Retrieved from https://www.gdynia.pl/co-nowego,2774/znamy-przebieg-drogi-czerwonej,553460, 27.05.2022.

The aforementioned investments are aimed at relieving the Tri-City Ring Road, as well as the traffic axis of the Tri-City agglomeration, namely – provincial road DW 468. This road, connecting all cities, constitutes a parallel infrastructure system to the Rapid Urban Railway (SKM) network, providing passenger transport in Gdańsk, Gdynia and Sopot, as well as inter-city communication, fitting in with the second objective of the Gdańsk-Gdynia-Sopot Metropolitan Area strategy – "Improving internal transport accessibility and improving the public transport network." The use of this road by individual car users generates problems of emissions, noise and congestion, understood as the mutual obstruction of traffic by vehicles,

which is a consequence of the objective relationship between the speed of movement and the volume of flow, under conditions when the capacity utilisation rate of the transport system is approaching its limits. The specific mechanisms associated with the formation of congestion in the transport network are exacerbated in sections characterised by intermittent traffic flows, such as those located in dense urban networks. There are seven primary sources of interference leading to congestion in the road network, namely (Żochowska, Karoń, 2012):

- limited capacity of network elements – e.g., number of roadways, number of lanes,
- traffic incidents – collisions, accidents and vehicle crashes,
- road works – often leading to traffic reorganisation,
- traffic control devices – improperly configured traffic control programs and incorrect selection of traffic control systems,
- mass events – leading to an unusual increase in traffic near the places where these events take place,
- temporal and spatial irregularity of demand – resulting from the variability of traffic on particular days of the week in specific relations.

The reasons indicated above should induce individual car users to switch to public transport. The nature of urban commute, involving many short-distance journeys, predestines it for the popularisation of alternative means of transport. Behavioural changes and the emergence of new travel patterns based on environmentally friendly modes of transport are also needed. Smart residents, an important component in the smart city concept, should be the most receptive to such changes and innovations. In order to achieve the required efficiency, a transformation of urban spatial and energy policies is also needed, implemented together with the idea of a smart and green city (Przybyłowski, 2017).

Encouraging individual car users, especially those who make daily trips to and from work while working in and living in different cities within the Tri-City metropolitan area, is a policy that slows traffic on this road. In March 2021, the speed limit on Gdańsk's main thoroughfare stretching between the city centre and Sopot was lowered from 70 to 50 km/h, despite the fact that this is a 9-kilometer stretch of three-lane Zwycięstwa and Grunwaldzka avenues, and despite the fact that (in a survey conducted by www.trojmiasto.pl) 61% of respondents favoured keeping the higher speed limit. Councilpersons voted in favour of lowering the speed limit and the city management confirmed that increasing traffic safety is a priority in shaping traffic policy in Gdańsk. Therefore, the architects of changes in traffic organisation use tools intended to reduce traffic (trojmiasto.pl).

Within the framework of intercity transport, the basis of the function in the Tri-City is fulfilled by the SKM Rapid Urban Railway, which connects Gdańsk and Wejherowo. The basic section of SKM routes is line 250 Gdańsk City Centre – Rumia, which runs parallel to the "long-distance" line 202 Gdańsk Central Station – Stargard. In addition, SKM operates occasional passenger services on the Gdańsk Central station – Gdańsk Expo Stadium route.

The frequency of trains on the Gdańsk City centre – Gdynia Cisowa section is every 7.5 minutes in the service peak, and every 15 minutes off-peak. Such a network of connections in terms of their frequency meets the expectations of Tri-City residents, especially those whose destinations are located near this transport route, contributing to lower emissions. However, commute within each city represents disconnected systems, as they are based on different solutions. Gdańsk relies on bus and tramway transport to build its transport networks, while Gdynia relies on bus and trolleybus transport and is one of three cities in Poland with trolleybus transport. The others are Tychy and Lublin, with Gdynia's trolleybus service being the oldest in operation, as it was established in 1943, and in terms of the number of fleet in use, it is ranked second, but with the largest network of lines. Gdynia is a city that is constantly upgrading its trolleybus infrastructure and fleet. It is constantly introducing innovative technologies and ensuring the development of environmentally friendly public transport (Rasiński, 2018). An example of such an environmentally friendly solution and at the same time freeing the transport network from the grid is the introduction of battery-equipped trolleybuses into the fleet, serving lines in Sopot and Obłuże (trójmiasto.pl) (Figure 2).

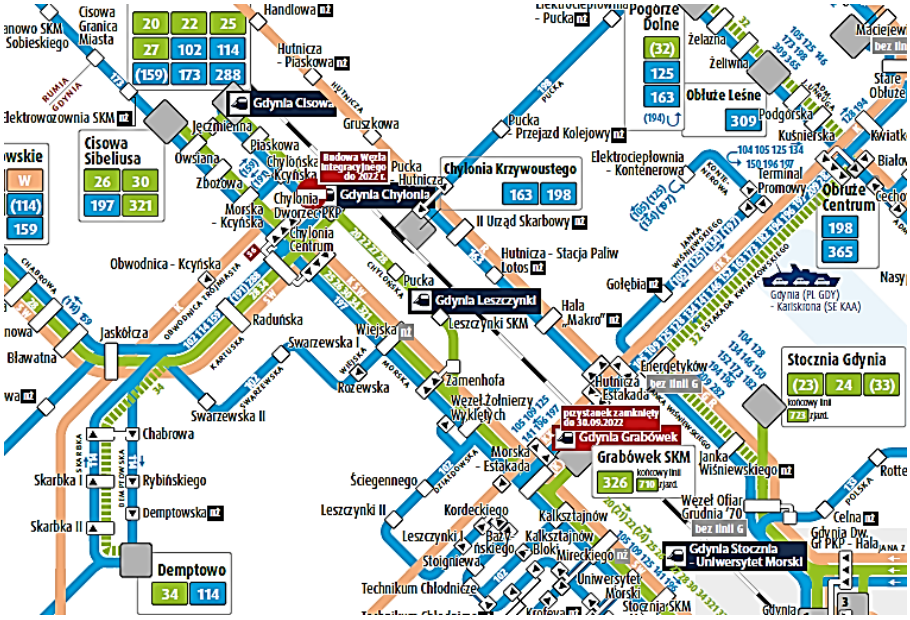

Figure 2. Examples of trolleybus lines outside the overhead grid (as of early May 2022).

Source: Zarząd Komunikacji Miejskiej w Gdyni. Retrieved from: https://zkmgdynia.pl/files/Schematy%20sieci%20MZKZG/SchematMZKZG.pdf, 10.05.2022.

The origins of the Gdańsk tramway network date back to 1873, when the first horse-drawn tramway was introduced from the city centre (Targ Sienny) to its outskirts towards Sopot (Pomorska Street), where a tramway depot was located. The network was electrified very quickly, as early as 1896, the horse-drawn tramway was taken out of service (trojmiasto.pl). Expansion of the tramway network (Figure 3) was carried out with maintenance of the main

axis of intercity communication – parallel to the DW 468 road (connection from City Centre to Pomorska Street by a line in its course or parallel and a parallel line closer to the sea, serving the districts of Zaspa and Przymorze), and in a transverse direction connecting Stogi, Piecki-Migowo, Chelm, Ujeścisko with City Centre, which is to perform a complementary function to the SKM network.

Figure 3. The current layout of the tramway network in Gdańsk.

Source: Wikipedia Retrieved from: https://pl.wikipedia.org/wiki/Tramwaje_w_Gda%C5%84sku, 10.05.2022.

Sopot does not have its own public transport, it is served by the communication facilities of neighbouring cities of Gdańsk and Gdynia. Tri-City residents have already gotten used to the fact that Gdynia and Gdańsk buses are operated in Sopot, but tourists coming to the resort for a holiday do not know how to get around by public transport in Sopot. There is information at bus stops about which bus serves which line and which tickets to use. The information is in available Polish and English, however, despite this in Sopot, tourists have trouble using the public transport (Sopot nasze miasto). The solution to this issue is metropolitan tickets, which are offered to residents as single-use and monthly tickets, while clearly differentiating between network operators. A special case are metropolitan tickets, which in a form particularly dedicated to tourists are 24- or 72-hour tickets (Table 2).

Table 2.
Price list and scope of the network covered by the 24- and 72-hour metropolitan tickets

Specification	Scope included	Regular price ticket	Reduced price ticket
24-hour metropolitan ticket	**Paper and phone, municipal** valid for ZTM Gdańsk and ZKM Gdynia and MZK Wejherowo (applications: GoPay, jakdojade.pl, moBiLET, mPay, SkyCash and zbiletem.pl)	PLN 16	PLN 8
	Paper and telephone rail/municipal for two operators valid on trains of railway operators: SKM and POLREGIO and for: ZTM Gdańsk or ZKM Gdynia or MZK Wejherowo (applications: GoPay, jakdojade.pl, moBiLET, mPay, SkyCash and zbiletem.pl)	PLN 22	PLN 11
	Paper and telephone rail/municipal for all operators valid on trains of railway operators: SKM and POLREGIO and for: ZTM Gdańsk and ZKM Gdynia and MZK Wejherowo (applications: GoPay, jakdojade.pl, moBiLET, mPay, SkyCash and zbiletem.pl)	PLN 25	PLN 12.50
72-hour metropolitan ticket	**Paper and phone, municipal** valid for ZTM Gdańsk and ZKM Gdynia and MZK Wejherowo (applications: GoPay, jakdojade.pl, moBiLET, mPay, SkyCash and zbiletem.pl)	PLN 32	PLN 16
	Paper and telephone rail/municipal for all operators valid on trains of railway operators: SKM and POLREGIO and for: ZTM Gdańsk and ZKM Gdynia and MZK Wejherowo (applications: GoPay, jakdojade.pl, moBiLET, mPay, SkyCash and zbiletem.pl)	PLN 50	PLN 25

Source: Metropolitalny Związek Komunikacyjny Zatoki Gdańskiej. Retrieved from: https://mzkzg.org/bilety-jednorazowe-i-czasowe, 24.05.2022.

The transport and fare solutions indicated above are designed to encourage tourists and residents of the Tri-City, as well as neighbouring municipalities, to use public transport. This is also reinforced by cities' conscious policies on the use of environmentally friendly means of personal transport by residents such as bicycles, scooters, etc. The intersection of individual and public motorised transport (cars, buses, tramways) and individual environmentally friendly transport (bicycles, scooters) raises the risk of traffic accidents. To prevent this, infrastructure in the form of bicycle paths is being expanded and measures are being taken on road infrastructure. To this end, among other things, speed bumps are being installed, TEMPO 30 zones are being designated, or traffic light system upgrades are being implemented. "This is our response (as stated by Magdalena Kiljan, a spokesperson for the Gdańsk Roads and Greenery Management Board) to the increasing number of requests and proposals from residents of Gdańsk who care about making the street, sidewalk and bicycle path in their immediate vicinity safe" (trojmiasto.pl). In addition, one can point to the creation of facilities for users of environmental means of individual transport in the form of building ground crossings, an example of which are the crossings with traffic lights at the Upland Gate and the Gdańsk Medical University just located along DW 468 (Puls Gdańska).

The infrastructure solutions indicated above at the intersection of traffic routes improve traffic safety with personal transport devices and traffic support devices, however, three elements treated in parallel are necessary. Firstly, the already mentioned infrastructure, secondly, legal framework, and thirdly, the ability to use the personal transport provided. The network of bicycle paths in the Tri-City in 2021 was approx. 293 km – Gdańsk approx. 203 km, Gdynia 68 km, Sopot 22 km (GUS) – Figure 4.

Figure 4. Map of bicycle paths of the Tri-City agglomeration.

Source: Trojmiasto.pl Retrieved from: https://rowery.trojmiasto.pl/Mapa-drog-rowerowych-Portalu-Trojmiasto-pl-n89661.html, 24.05.2022.

Until recently, the regulations of the Road Traffic Law (Ustawa z dnia 20 czerwca 1997) treating the bicycle as the only means of individual transport were sufficient, but the development and continued spread of, for example, scooters required regulation. As a result, on May 20, 2021, an amendment to the Road Traffic Law and other laws came into force, which introduced concepts into the law (Ustawa z dnia 30 marca 2021 r.):

- an electric scooter as an electrically powered, two-axle vehicle, with handlebars, without a seat or pedals, structurally designed to be driven solely by the rider on the vehicle,
- personal transport equipment (PTE) as an electrically powered vehicle, excluding an electric scooter, without a seat and pedals, structurally designed to be used exclusively by the driver on the vehicle,
- a traffic support device (TSD) as a device or sports and recreational equipment designed to move a person in a standing position, powered by muscle power.

Regulating the use of bicycles, scooters, a personal transport device, a traffic support device has put the traffic issue in order, however, it is also necessary to create opportunities to use these means for that part of the urban community that cannot afford to purchase their own means. Here, city bicycle and scooter rental systems play an important role. On the streets of Gdańsk, Gdynia and Sopot, electric scooters from several companies can be spotted standing every day. It is worth noting that Quick scooters were introduced to the Tri-City by a local company from Gdynia. The service area of all operators is very similar (Puls Gdańska). Tri-City authorities have invested in the city's bicycle-sharing system. In 2019, MEVO, the city's unmanned bicycle rental system, was established. In 2021, the system was terminated by malfunctions related to, among other things, the app and the delivery of an insufficient number of bicycles, however, the idea itself, which met with great approval from the Tri-City community, will be reintroduced. In February 2022, a contract was signed with the new operator of the MEVO system, *CityBike Global*. According to the plan, 4099 bicycles are to be made available in late spring of 2023, 3099 of which will be electric, and the remaining thousand will be traditional bicycles to be used within the boundaries of the Tri-City Metropolitan Area (Trojmiasto.pl).

In April 2022, the Gdynia City Council voted a resolution on the principles of providing a targeted subsidy for the purchase of an electric bicycle. Starting in 2019, residents and local businesses can rent cargo bicycles for free as part of the city's rental service, and a subsidy for the purchase of such a bicycle is in place starting in 2020. Also, some officials, as part of their duties during field trips, use this very means of transport. Interested residents who would like to use an electric bicycle for daily transport will be able to buy one, receiving up to a 50% subsidy. According to the provisions of the resolution, natural persons residing in Gdynia will be able to apply for the subsidy – each resident of Gdynia may use it once. The subsidy is available in an amount equivalent to 50% of the purchase value of the bicycle, but no more than PLN 2500. (Gdynia moje miasto).

Reinforcing the behaviours of urban residents toward the use of environmentally friendly modes of transport – both public transport and individual transport is aimed at changing transport-related behaviours. The basis for effective action and the challenge of pursuing local governments is to recognise the current state and develop incentive policies. In the case of the Tri-Cities, transport-related behaviours were studied in 2020. According to this survey, according to respondents' declarations, 81% of them say they have a personal car in the household (83% of men and 79% of women), in addition, 86% of respondents say they have a bicycle in the household. The distribution of declarations of ownership of a motorcycle or moped is interesting, as a total of 9% of respondents declare ownership of a motorcycle or moped in the household, while the gender distribution shows that it is almost 8% of men and 9% of women. Ownership of a scooter in the household was reported by 25% of respondents (23% of men and 27% of women). In terms of using a personal car on a daily basis, 85% of respondents say they do so. For 74% of respondents, the main motivation for their daily

commute is work, study (school, university). When a trip consists of only 1 stage (such trips account for 60% of typical daily trips, according to the survey), the most popular mode of transport is the passenger car indicated by 64% of respondents, followed by walking 16% and bicycling 12%. For a trip consisting of 2 stages, respondents pointed to public transport modes of bus/tramway/trolleybus as the most popular mode of commute (37%), followed by passenger car (20%) and train (19%). It is worth noting that 22% of respondents do not use a personal car (24% of women and 20% of men). In contrast, 53% of respondents use a personal car because they believe it allows them to travel faster than other means of transport (48% of women and 57% of men), and furthermore, 42% say that when travelling by personal car they can choose their own route and time of travel. In terms of elements that could induce the residents of the Metropolitan Area to travel sustainably (by public transport, bicycle, on foot, shared modes of transport), the most frequently indicated elements were higher frequency of public transport lines (58% of responses), combining schedules of different modes of transport (51% of responses) and shorter travel time by public transport (50% of responses) – each of these elements was indicated by more than 50% of respondents (MRC Consulting).

4. Conclusions and discussion

A framework for the environmental management of urban spaces, in line with Green Deal objectives, is a part of the green smart city concept. This concept, assuming the reduction of negative environmental impacts, poses challenges to local governments, which, depending on the existing conditions and development aspirations of municipalities, sometimes require reconciling objectives which, at first glance, seem contradictory – as is the case with the Tri-City agglomeration. The Tri-City agglomeration's aspirations in the strategy to be an important transport hub, based on the ports of Gdańsk and Gdynia, create challenges in terms of having rail and road infrastructure suitable for the planned passenger and cargo traffic. Gdańsk is in a far better position than Gdynia, as it already has the infrastructure to handle the existing potential of its ports. In the area of road infrastructure, the only certain problem is the congestion that occurs during the commute to work and home of Gdańsk residents living in the southern districts of the agglomeration, as these sections are used for this type of travel. In Gdynia, on the other hand, large investments are required to secure the commute capacity to and from the port, located right in the city centre. The challenge, therefore, is the construction, including the provision of funds for it, of the so-called "Red Road", relieving the "Kwiatkowski Estacada", which needs a major repair and handles the traffic of the dormitory districts of Gdynia. The Red Road, along with the necessary expansion of the 201 and 202 railway infrastructure, represents the biggest challenge in terms of both financing, planning and implementation. Planning work is fortunately already underway, but completion is still a long

way off. Some help in solving the problems of transport service at the Port of Gdynia will be the commissioning, in late summer or early autumn of this year, of the so-called "Kashubian Road", which will allow to take vehicular transit traffic out of the city's northern districts.

All cities of the Tri-City agglomeration, within the framework of their urban spaces, subscribing to the concept of the green smart city, must introduce measures aimed at changing the communication behaviours of residents in the direction of reducing travel by cars in favour of the use of public transport and individual, environmental means of transport such as bicycles, scooters, etc. Thus, the challenge is to build appropriate infrastructural solutions (bicycle paths – here the situation is relatively good), systems to encourage their use (city bicycle – after the unsuccessful first attempt, work is underway to restore the bicycle rental system) or subsidies for the purchase of electric bicycles, and to introduce convenient solutions within the transport network. Tri-City has a convenient transport solution (Rapid Urban Rail, Pomeranian Metropolitan Railway) connecting the cities of the agglomeration, so solutions to slow down traffic on the main road axis DW 468 extending the time of travel by car should cause a shift of passenger traffic to this means of transport. However, such measures are insufficient, and it is necessary to build public awareness of pressing environmental issues. So the challenge in this area is to define and create environmentally friendly behaviours among the creative class. This part of the urban community, by the fact that the rest of the population imitates their behaviours, should become part of smart mobility connecting all areas of the green smart city.

References

1. Casini, M. (2017). Green Technology for Smart Cities. *IOP Conference Series: Earth and Environmental Science, no. 83 012014*, pp. 1-10.
2. *Co na drogach.* Retrieved from: https://conadrogach.pl/drogi-ekspresowe/mapa-samochodowa/, 10.05.2022.
3. *Gdynia moje miasto*. Retrieved from: https://www.gdynia.pl/co-nowego,2774/droga-czerwona-ma-powstac-za-cztery-lata,563354. 26.05.2022.
4. *Gdynia moje miasto*. Retrieved from: https://www.gdynia.pl/co-nowego,2774/znamy-przebieg-drogi-czerwonej,553460. 27.05.2022.
5. *Gdynia moje miasto*. Retrieved from: https://www.gdynia.pl/co-nowego,2774/dotacja-na-e-rowery-przeglosowana,565172, 4.06.2022.
6. *Główny Urząd Statystyczny*. Retrieved from: https://bdl.stat.gov.pl/bdl/dane/podgrup/tablica, 24.05.2022.
7. Grzybowski, M. (2010). Porty Gdańsk i Gdynia w systemie logistycznym Polski. *Prace Naukowe Politechniki Warszawskiej, Vol. 76*, pp. 43-45.

8. GUS - Główny Urząd Statystyczny. Retrieved from: https://bdl.stat.gov.pl/bdl/dane/teryt, 10.05.2022.
9. Krawczyk, G., Kos, B., Tomanek, R. (2020). Kierunki zmian modelu mobilności na podstawie badań zachowań komunikacyjnych klasy kreatywnej w polskich metropoliach. *Transport miejski i regionalny, 4*, pp. 3-8.
10. Łaźniewska, E., Janicka, I., Górecki, T. (2021). Green Smart City as a New Paradigm of Local Development. *Problems of Sustainable Development, 16(2)*, pp. 125-136.
11. Metropolitalny Związek Komunikacyjny Zatoki Gdańskiej. Retrieved from: https://mzkzg.org/bilety-jednorazowe-i-czasowe, 24.05.2022.
12. MRC Consulting Tomasz Czuba (2020). *Zachowania transportowe mieszkańców OMGGS*. Retrieved from: https://www.metropoliagdansk.pl/upload/files/Raport%20-%20Zwyczaje%20transportowe%20mieszka%C5%84c%C3%B3w%20OMGGS%2030_11_2020(1)(1).pdf, 4.06.2022.
13. *Oficjalny portal miasta Gdańska*. Retrieved from: https://www.gdansk.pl/wiadomosci/Znajdz-drogi-rowerowe-w-miescie-Odbierz-nowa-mape-rowerowa-Gdanska,a,59317, 24.05.2022.
14. *Pomorski Urząd Wojewódzki.* Retrieved from: https://www.gdansk.uw.gov.pl/5864-droga-czerwona-do-portu-gdynia-umowa-podpisana, 27.05.2022.
15. Przybyłowski, A. (2017). Miasto przyszłości w aspekcie równoważenia mobilności. *Studia KPZK, No. 177,* pp. 173-181.
16. *Puls Gdańska*. Retrieved from: https://pulsgdanska.pl/artykul/hulajnogi-elektryczne/1168282, 4.06.2022.
17. *Puls Gdańska*. Retrieved from: https://pulsgdanska.pl/artykul/kolejne-przejscie-dla/1227860, 24.05.2022.
18. Rasiński, T. (2018). Trolejbus jako ekologiczny środek transportu miejskiego. *Autobusy Vol. 12,* p. 216. Retrieved from: http://ojs.inw-spatium.pl/index.php/Autobusy/article/view/500/443.
19. *Serwis Rzeczypospolitej Polskiej*. Retrieved from: https://www.gov.pl/web/infrastruktura/obwodnica-metropolii-trojmiejskiej-w-realizacji, 27.05.2022.
20. *Sopot nasze miasto*. Retrieved from: https://sopot.naszemiasto.pl/sopot-turysci-nie-wiedza-jak-poruszac-sie-po-kurorcie-myla/ar/c4-1513665, 10.05.2022.
21. *Strategia Obszaru Metropolitalnego Gdańsk-Gdynia-Sopot do roku 2030*. Retrieved from: https://www.metropoliagdansk.pl/upload/files/Strategia%20OMGGS%202030(2).pdf, 10.05.2022.
22. *Trojmiasto.pl*. Retrieved from: https://historia.trojmiasto.pl/Jak-tramwaje-opanowaly-przedwojenny-Gdansk-n98862.html, 10.05.2022.
23. *Trojmiasto.pl*. Retrieved from: https://rowery.trojmiasto.pl/Mapa-drog-rowerowych-Portalu-Trojmiasto-pl-n89661.html, 24.05.2022.

24. *Trojmiasto.pl.* Retrieved from: https://www.trojmiasto.pl/wiadomosci/Trasa-Kaszubska-pierwszy-odcinek-ma-pozwolenie-na-uzytkowanie-n165009.html?id_zdjecia=567166&type=2#fb_id:p0:567166,pozycja:1, 10.05.2022.
25. *Trojmiasto.pl.* Retrieved from: https://www.trojmiasto.pl/wiadomosci/Trolejbusy-zamiast-autobusow-na-trasie-z-Gdyni-do-Sopotu-n152662.html, 10.05.2022.
26. *Trojmiasto.pl.* Retrieved from: https://www.trojmiasto.pl/wiadomosci/Trolejbusy-po-blisko-50-latach-znow-dojada-na-Pogorze-n145370i.html, 10.05.2022.
27. *Trojmiasto.pl*. Retrieved from: https://www.trojmiasto.pl/wiadomosci/Gdansk-Nizsza-predkosc-na-al-Zwyciestwa-i-Grunwaldzkiej-n153440.html#tri, 24.05.2022.
28. *Trojmiasto.pl.* Retrieved from: https://www.trojmiasto.pl/wiadomosci/Umowa-na-Mevo-2-0-podpisana-Rowerami-pojedziemy-wiosna-2023-r-n164054.html#tri, 4.06.2022.
29. *Ustawa z dnia 11 stycznia 2018 roku o elektro mobilności i paliwach alternatywnych*. Dz.U. 2018, poz. 317 (2018).
30. *Ustawa z dnia 20 czerwca 1997 Prawo o ruchu drogowym,* tj. Dz.U. poz. 988 (2022).
31. *Ustawa z dnia 30 marca 2021 r. o zmianie ustawy – Prawo o ruchu drogowym oraz niektórych innych ustaw.* Dz.U. poz. 720 (2021).
32. *Wikipedia.* Retrieved from: https://pl.wikipedia.org/wiki/Tramwaje_w_Gda%C5%84sku, 10.05.2022.
33. Zawieska, J. (2019). Rozwój rynku elektromobilności w Polsce. In: J. Gajewski, W. Paprocki, J. Pieriegud (Eds.), *Elektromobilność w Polsce na tle tendencji europejskich i globalnych Publikacja Europejskiego Kongresu Finansowego* (pp. 10-11). Warszawa: CeDeWu Sp. Z o.o.; Centrum Myśli Strategicznych.
34. Żochowska, R., Karoń, G. (2012). Przegląd literatury na temat zjawiska kongestii i zakłóceń ruchu w systemie transportowym miasta w aspekcie modelowania podróży. *Zeszyty Naukowo-Techniczne SITK RP, Oddział w Krakowie, Vol. 2(98),* pp. 252-256.