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The Determination of Potential Locations for Hotel and Service Facilities in relation to the Transport System – the Logistic Approach

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The existing space distribution of hotel and service facilities in different places in the world is mainly the result of natural organic growth. Such facilities were built in areas of actual and/or potential demand, provided adequate financial resources and land were available. Additionally, an important factor was also the availability of technical infrastructure, including, in particular, transport. Sometimes those facilities were built without any detailed spatial analysis of their locations. It can be concluded that planning of hotel and service facilities lacked clear and accurate methods as well as analytic tools. The main reason was the lack of relevant databases.
Along the development of Information and Communication Technologies (ICT), information tools started to be used in nearly every area. It should be noted that the development of the hotel and service base can be significantly promoted while using modern ICT solutions. In their article, the authors, among others, propose to use trip planning tools backed by Big Data. A trip planner can be used to collect data that help to determine the location of hotel and service facilities (e.g. hotels, guest houses, motels, leisure, recreation and restaurant facilities). The article presents the case study from the Upper Silesia conurbation, Poland. The use of Big Data allows to select locations of investment corresponding to actual tourist travel needs, especially that every year tourism becomes an increasingly important sector of the national economy in many countries.

Keywords: spatial planning, logistic approach, trip planner, journey, travelling, Big Data, tourism, terrorism, natural disaster.

1. INTRODUCTION

The transport system developed in a specific area has a significant influence on the socio-economic growth [1]. The accessibility of transport infrastructure not only helps to service passengers [2], but also enables to deliver goods more efficiently [3, 4]. The logistic approach requires a number of activities that are integrated in space and time. It is related to the implementation of specific long-term (strategic) and short-term (tactical or operational) plans [5]. The logistics transferred from companies to the urban setting has created an opportunity for better planning which supports the development of a given area [6]. The crucial role of information flow still remains valid as an essential element of the proper functioning of a company or, as it is in this case, the city (conurbation) [7].

The technological advancement allows to collect data from different fields of life. In the case of transport applications, such data can be delivered directly to customers - people travelling, or in an aggregate form information may facilitate the process of urban planning (through direct transfer of information [8] or using additional tools, e.g. simulation software [9]). The use of mobile applications supports trip planning, including trips within a city (commuting to work or education etc.). Other types of travelling include leisure (or optional) trips.

Tourist traffic mainly involves trips made by travellers outside their usual place of dwell. Additionally, in recent years, trips are made on increasingly long distances. A tourist arrives at an area of his/her interest (destination), and as such the area is usually unknown. Most often, trips of this type are made by plane, train, including high-speed trains, passenger cars and sometimes bikes. A leisure trip may involve one or more of modes of transport. The number of modes used in the travel chain is determined by the distance and purpose of travelling. A tourist moves from his/her home to the accommodation facility (e.g. hotel) also using intermediate hubs (co-modality nodes, bus stations, railway stations and airports). Although departure from a tourist area is similar and usually involves the same mode of transport, various other options can be considered on the way back (alternative hubs, e.g. other airports, other modes of transport). Other options may also be considered on the route to the destination due to, inter alia, unforeseen reasons (technical problems, weather conditions, and others, such as strikes and riots). A sample tourist traffic chart (chain) is presented in figure 1.

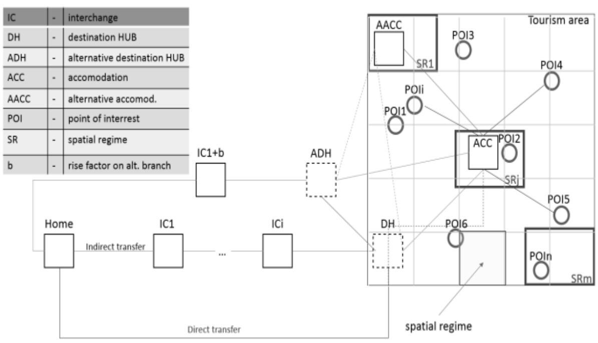


Fig. 1. Simple journey space structure
Source: own research

According to Figure 1, it is essential that the tourist preferably selects a place to stay for a night which is beneficial from the point of view of the location of his/her Points of Interest (POI) in a tourist area. Other factors related to the location of their accommodation are also important, e.g. price per night, quality of accommodation, access to the transport system, availability of beds etc. Safety of travel and stay in a given area (discussed further in article) are also taken into account. Therefore, accommodation conditions may vary in time and space depending on selection criteria. This multi-criteria selection process pertaining to the target tourist area is presented in figure 1. A tourist area presented has been additionally divided into homogeneous spatial regime. Such division enables to define parameters for selecting of accommodation in the entire area examined. Additionally, it allows to apply discrete optimization methods while using computer-aided selection of the destination. Algorithms of intelligent and decision-making systems in transport are also relevant. For example, in case of an environmental/natural disaster, riots or a terrorist attack, quick evacuation from that location is secured by adjusting traffic conditions in a given area.

In the case of the issue discussed in this article, the basic research problem is the development of the hotel and service base in a given area while taking into consideration various aspects concerning transport network and security and other conditions. The problem should be extended to a related issue of determining locations for other points associated with the tourist traffic, such as transport infrastructure (transfer points), restaurants and recreation facilities. Considering geopolitical changes in the 21st c., we should take into account tourist traffic safety analyses, as well as demographic, economic and social changes that have taken place in societies which are relevant to the tourist traffic structure. These issues are inherently related to the location of airports, train stations and bus stops and main routes.

2. THE PROPOSED METHOD AND DATA SOURCES

The manner in which a tourist reaches his/her destination is crucial for the analysis of the research problem. Results of the analysis, in combination with the structure of the local road network (transport), help to determine the future location of hotel and service facilities. Usually, while selecting a place to stay, a tourist plans his/her trips to and from the accommodation facility, as well as within the area. According to American research, nearly 100% of people plan in advance their trips, of whom about 40%-56% use IT trip planning systems [30]. The planning of international trips by tourists is shown in figure 2, whereas local trip planning at the destination is presented in figure 3.

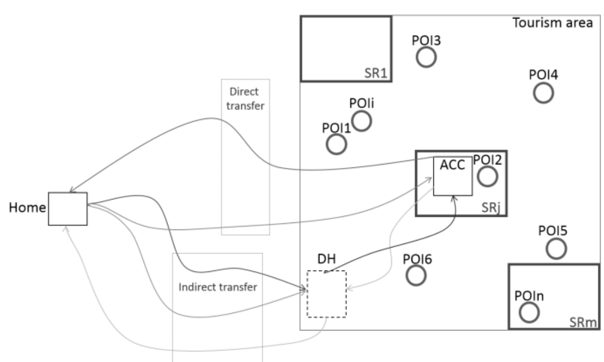


Fig. 2. Journey global planning – strategy level
Source: own research

A tourist visits a certain area of interest (area analysed) for a specific reason (goal). The implementation of that goal requires him/her to achieve POI in the area. A tourist who is not familiar with the local transport system may resort to a trip planner, navigation tools, social media, tourist websites, hotel and ticket reservation systems etc. Thus, a large number of trips to POI may be registered and their parameters determined, especially with the use of trip planners and ticket reservation systems, tourist information systems, hotel booking systems, as well as bank systems, social media etc.

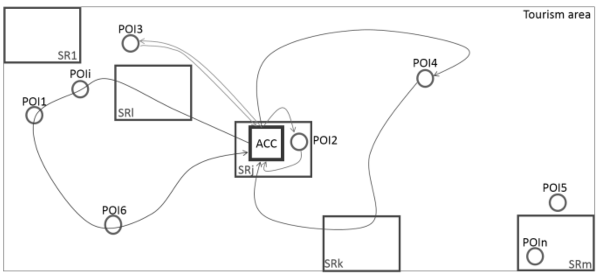


Fig. 3. Local level of trip planning (operational level)
Source: own research based on local and strategy level approach [10]

In recent years, we have observed a significant increase in the number of trip planners developed [11, 12, 13, 31, 32]. Frequently, trip planners have numerous limitations, including those functionally linked with the selected area, or they can be limited by the number of travelling modes. The inclusion of more than one mode of travelling allows the user to review available options in a city, such as public transport, bike-sharing and car-sharing, Park & Ride etc. [14]. By adding options that indicate reasons of travelling to the trip planner (purpose of travel), we increase the number of data that can later facilitate planning. In such a situation, it is possible to define precise parameters of the trip planned and it creates the possibility to register pent-up demand for accommodation. The suppressed demand includes trips planned to a given area, which are abandoned for various reasons. While using these functionalities, it is possible to observe the suppressed demand as regards tourist traffic. The use of such trip planners for international trips necessitates to integrate planners or to develop a global trip planner for a wide area. Trip planners are becoming more popular and their use is still growing [15]. The approach can be valuable provided urban trip planner is developed (as alternative to other systems of route planning). At the same time, the full implementation of this approach can be achieved through standardization and harmonization of data according to global ITS standards [16]. Some doubts regarding the scale of the trip planner are justified only in relation to vehicles already used on roads. The majority of new vehicles are fitted with on-board navigation systems. In such a case, a mandatory functionality of downloading data from queries travellers send, including those in private cars, can significantly increase the volume of data to be used in the proposed method. At the moment, it is still difficult to implement the method technology-wise (remote transmission and processing capacity of on-board computers).

Therefore, a trip planner may archive queries regarding trips in relation to the purpose of tourist trip or similar factors. Archiving is possible thanks to the planning mechanism which stores all queries in a server side. This also applies to responses of the algorithm incorporated in a planner. No response (in the form of a specified route) is synonymous with a partial registration of suppressed demand for tourist trips [17].

With the introduction of the functionality which indicates the purpose of travel, it is possible to filter database queries and obtain information about expected needs (demand) of the tourist traffic and its purposes, including sports, recreation and leisure. The verification of queries sent to the trip planner as regards the external and local tourist traffic is possible through additional smart algorithms (i.e. machine learning) or directly through a process of multi-stage reasoning. Trips which started in a walking distance to stops of public transport from hotels and guest houses (identified in the web) are treated as an external tourist traffic, which is important from the point of view of issues discussed in the article.

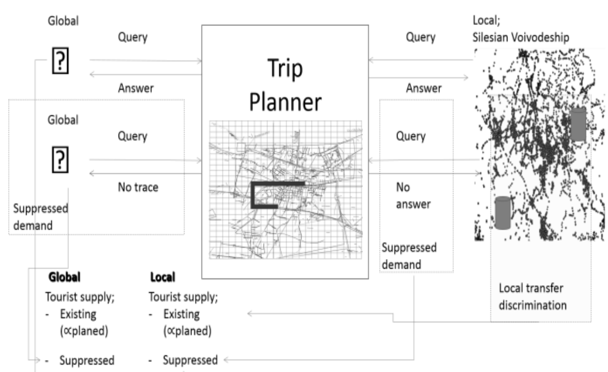


Fig. 4. Trip planner and tourist trip structure
Source: own research

Figure 4 shows the structure of queries sent to the advanced trip planner as regards global and local tourist traffic. The first filtration of the two types of tourist traffic can be based on the hotel domain or the IP address from which the query is sent to determine a route. The latter is based on the analysis of trip origins - beyond locations of hotels and tourist facilities. Trips planned according to responses from the planner (correct path designation) should be treated as highly likelihood. Trips for which no response is given (e.g. lack of means of transport at specified time and place) are treated as a pent-up demand for tourist services. Thus, it is possible to determine the demand for tourist services:

- globally,
- locally,
- globally for pent-up demand, and
- locally for supressed demand.

Finally, the probability of a trip can be verified at selected cross sections of the transport network while using ticket booking systems, hotel booking, other ICT systems, etc. In the case of an individual transport network cross section the following can determined:

$$P_i^{Ex} = \frac{ET_i}{PT_R} \cdot \lambda_g \qquad (1)$$

where:

P_i^{Ex}	-	likelihood index of desired trip in cross section *i* of the transport network [-],
ET	-	number of trips observed in cross section *i* [-],
PT	-	number of trips planned using trip planners on route R
λ	-	scale parameter, percentage of trips made in a cross section using a trip planner, which revises probability to 1, based on global transport research - g

The number of trips observed *ET* in cross section *i* can be examined using ITS systems. They include detection loops, count of vehicles and people in those vehicles, counting people using public transport etc. The accuracy of these measurement systems has been steadily improving. For example, in public transport the occupancy rate is approximately 95-98% for occupancy meters and 99.9% for city card systems [29]. The number of planned trips is calculated based on data from the trip planner or planners. Lambda is relatively most difficult to determine. At the moment, it is mainly based on transport studies. On the basis of studies implemented by the authors, in the Upper Silesian conurbation [18], the value of the parameter for the population of 2 million people is 0.066 (ca. 7%) [-] taking into account trip planners only (for young people this parameter is 0.0971 (ca. 10%) [19]. The value increases significantly if we include car-based navigation systems. Then the parameter exceeds 0.45. According to American research on transport behaviour, the value can theoretically vary between 0.42 and 0.56 [-] [30].

In order to define parameters regarding current demand for hotels and services, the area analysed should be divided with a fixed grid into spatial regime (Figure 5). The smaller the area of a single regime, the more accurate the analysis using the methodology presented. Districts are created to assign tourist traffic parameters, such as safety (e.g. number of crimes), the number of modes of transport handling tourist traffic, tourist facilities, e.g. hotels, museums, art galleries, restaurants, educational establishments with sports halls, car parks etc.

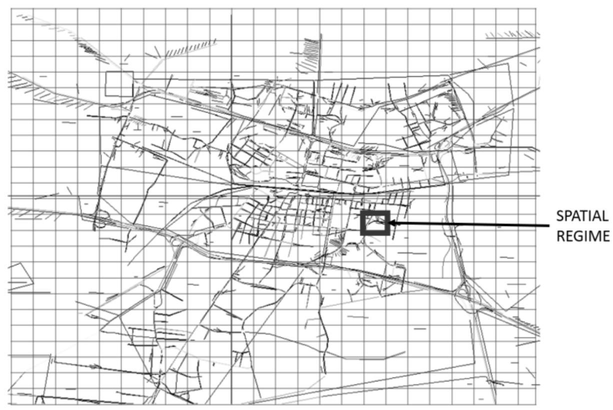


Fig. 5. Spatial regimes, Upper Silesian conurbation (Poland)
Source: own research

In the case of trips planned within the area analysed, we know the starting point and destination of a trip as well as intermediate POI. Information about queries and additional traffic data enable us to define a set of matrices for spatial districts:

$$[a_{kl}^{S}] =< [a_{kl}^{A}], [a_{kl}^{T}], [a_{kl}^{B}], [a_{kl}^{C}], \quad (2)$$

where:

$\left[a_{kl}^{S}\right]$	-	matrix of total load in district
$\left[a_{kl}^{A}\right]$	-	matrix of air transport traffic
$\left[a_{kl}^{T}\right]$	-	matrix of rail transport
$\left[a_{kl}^{B}\right]$	-	matrix of bus transport
$\left[a_{kl}^{C}\right]$	-	matrix of individual car transport

In this approach, not only start and destination districts are determined, but also all regimes within the analysis area along the route. Therefore, value a_{kl}^{*} is characteristic for each spatial regime within the area analysed as regards the following:

- location of restaurants,
- location of transfer points,
- location of recreation facilities,
- location of shops,
- location of accommodation of high transport accessibility,
- any other parameters in databases e.g. OpenStreetMap (OSM) etc.

Thus, we define a potential demand for various services in the area concerned, and each element of the above mentioned matrices (2) is the incremented regarding traffic to the destination is registered in a given area. Consequently, matrix S determines multimodal characteristics of each district and other matrices define characteristics of other modes. Elements of the matrix having the largest number of registered trips point to those spatial districts that are predisposed for the development of multimodal or specialised transfer hubs for specific modes of transport. This translates into possibilities for developing of the hotel and service base in those locations. The whole process of district delimitation is based on data regarding trip destinations. Therefore, while using sophisticated trip planners and other reservation systems (tickets, hotel rooms), it is possible to have relatively accurate designation of locations suitable for airports, subway stations, railway stations etc.

Studies covered by the article used a tool for parsing large database. The main screen is presented in figure 6.

The tool can be used to determine potential locations of hotels and services in selected spatial districts also in terms of their transport accessibility within the transport network. The location is determined by choosing of a specific regime and further planning of hotel and service facilities depends on such parameters as road network, local spatial development, availability of land for investment etc. An example of the analysis supporting the development of hotel facilities is presented in figure 7.

Figure 7 shows the transport accessibility area within 800 m from transport nodes in the Upper Silesia conurbation with public transport stops. Such a map may help to determine locations for

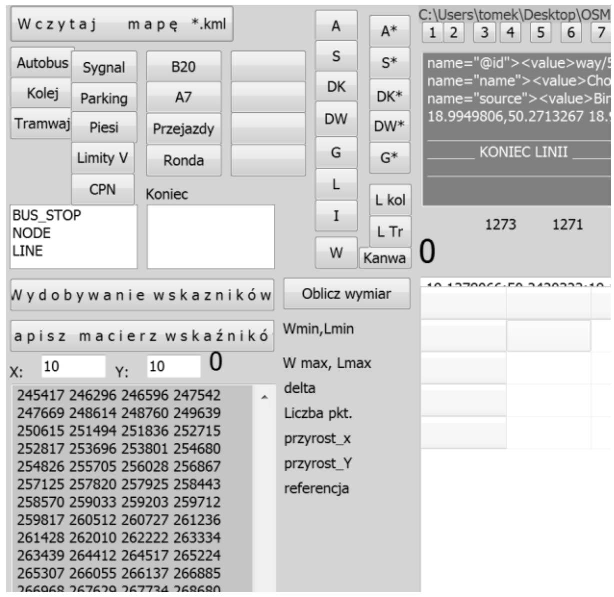


Fig. 6. OSM data parser (in Polish ver.)
Source: own research

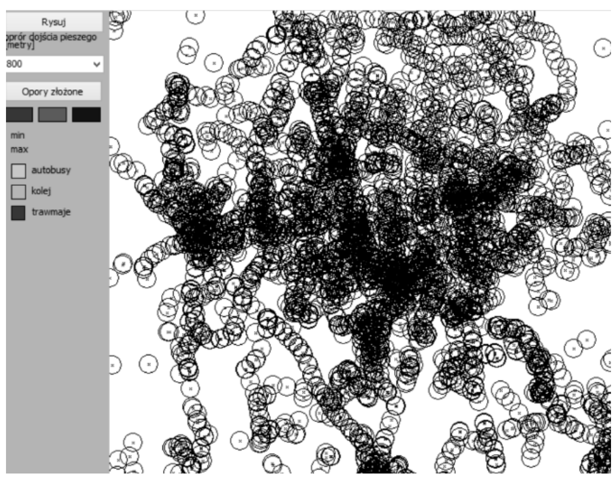


Fig. 7. OSM hotel, hostel, motel parser in aspect of transport accessibility (service point distribution, accessibility less then 800 m)
Source: own research based on OSM data ©

the investor who is interested in providing services to the incoming tourist traffic which uses air, rail or bus transport It includes tourists who use mainly public transport and taxis. The procedure matches data available with the susceptibility of the district to have a specific tourist facility developed. Susceptibility is defined by criteria selected for spatial regimes in relation to a target customer from the point of view of the investor who pursues specific goals in the tourist industry. For this purpose, we can use OSM data. While using the parser, it is possible to collect and analyse OSM data as regards various tourist needs (Figure 8).

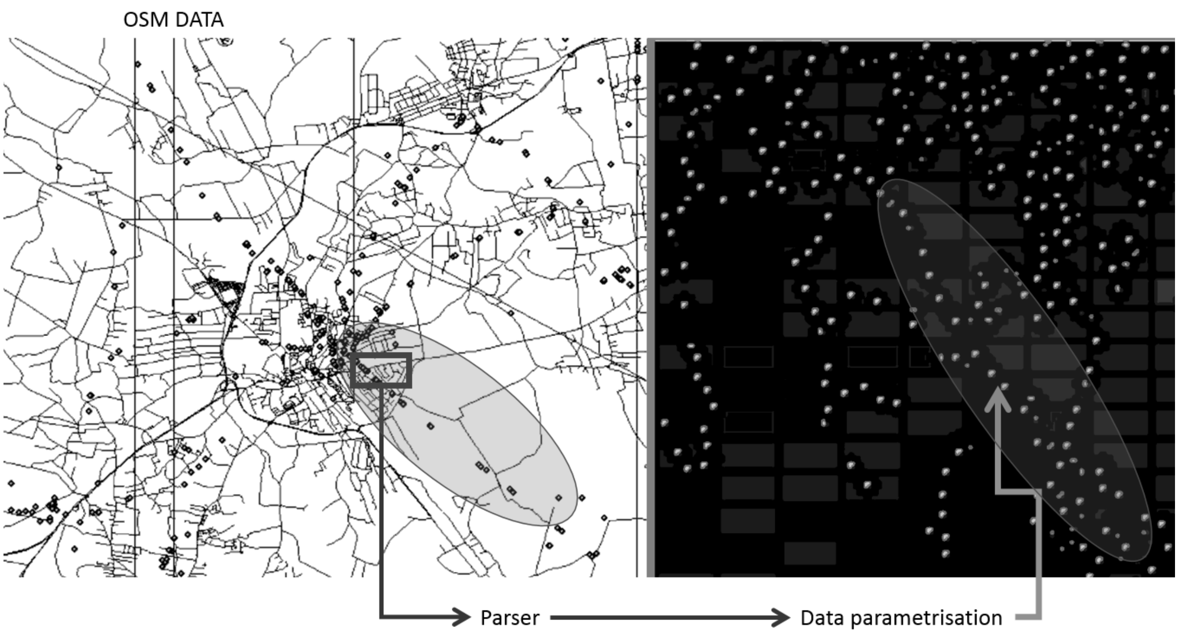


Fig. 8. OSM data parser, public transport parametrisation
Source: own research based on OSM data ©

The parser in figure 8 scans OSM database files and counts characteristic elements in each of spatial regimes. On this basis, it develops tables listing spatial regimes as regards values that are important from the point of view of tourist traffic (decision-making variables). For example, in the spatial regimes, the tool can sum up the number of restaurants, water reservoir, police stations, museums, and sport and leisure facilities. The investor, or the city, while pursuing their logistic approach to the development of hotel services, decides which criteria are selected for the analysis in the context of the target market segment. For example, if we have an extremely small number of golf courses in the area concerned, the investor counting on high demand from prospective customers in this market segment should take into account existing locations of golf courses in the entire area. In this respect, the calculation methodology has a very specific and precise application. Another example is shown in figure 9. The figure shows OSM data from the search in a residential area of around 5 million inhabitants (most populated territorial unit in Poland). For each spatial district, calculations cover the total number of public transport stops, including bus, train and tram. A colour is used to mark spatial regimes in the map, which have a certain number of public transport stops (depending on area delimitation). It might be debatable in districts of a sparse transport network. This naturally favours tourists who do not have individual means of transport.

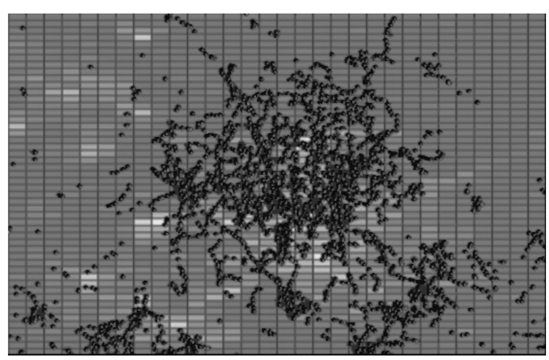


Fig. 9. Public transport points distribution and overall characteristic for tourism
Source: own research based on OSM data ©

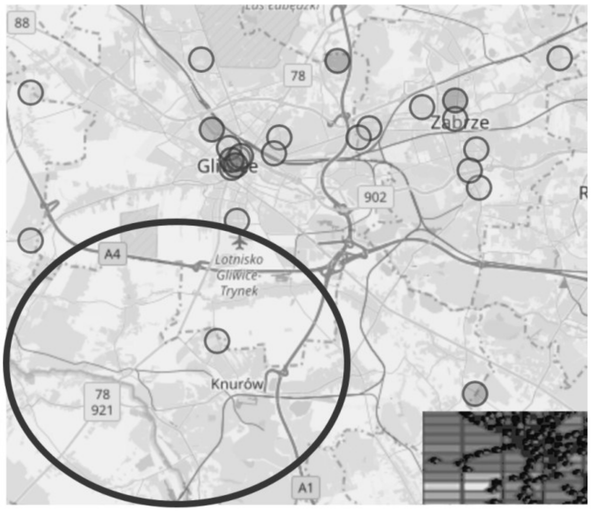


Fig. 10. Public transport point for tourism and hotel localization (selected example)
Source: own research and Overpass Service query based on OpenStreetMap © (https://overpass-turbo.eu/)

Light green is used to indicate regimes best suited for accommodation facilities (few hotels and several stops) designated for people coming to the area without their own means of transport which actually translates into the vast majority of all trips in that tourist traffic (Figure 10). Therefore, each spatial regime can be described using the following figures:

- trips to destination which attract tourists to the area,
- trips from origin which make tourists leave the area,
- locations where tourists start their trips within the area (origin point),
- destinations chosen by tourists in the area,
- intermediate points on the route.

Additionally, each trip (and also each intermediary point) has certain markers assigned:

- public transport (PuT), individual cars, electric cars etc.
- travel criterion (quicker, shorter, more environmentally friendly),
- purpose (shopping, other, entertainment),
- trip planners also introduce other criteria as regards the analysis discussed in the article.

Figure 10 shows effects of using the methodology. Calculations helped to establish potential locations for hotels in an area of just one facility of this type.

Each spatial district can be described by a function of general tourist susceptibility of that district:

$$TSF = (DT + ST + SP + EP + IP) / NH \quad (3)$$

where:
Wfs - tourist susceptibility function
DT- number of destination trip points
ST - number of source trip points
SP- number of start points
EP- number of end points
IP- number of intermediate points
NH- number of hotels.

The function can be developed to meet needs of a particular investor who implements their hospitality industry plans.

If it is possible to assign complex weights to each of points, it is also possible to determine the function for each point within the district. For example, it is possible to develop a function taking into account means of transport, trip criteria and purpose:

$$*P = TMw_1 + TCw_2 + TMw_3 \quad (4)$$

where:
*- type of point in transport network (start, end, intermediate)
TM- transport mode,
TC- transport criterion,
TM- transport motivation.

Setting the weight w_1 as significant results in selecting transfer points for tourists, fuel stations etc. during counting. Thus, the weight w_2 differentiates points as regards the nature of travel. For the fastest trips, the process may indicate locations of restaurants. Similarly, the weight w_3 may indicate those districts where various tourists facilities should be located (recreation venues etc.).

Natural locations of tourist accommodation are in districts of the largest concentration of DT ST, EP and SP. One can also consider regimes with a large number of intermediate points (IP) and where so far no hotels are available.

Tourist susceptibility should be extended with characteristic features promoting tourist traffic.

$$TSFX = TSF + NGP + NM + NRO \qquad (5)$$

where:

$TSFX$ - Extended tourist susceptibility of a spatial district,

NGP - number of gastronomic points

NM - number of museums

NRO - number of recreation points etc.

The analysis of the tourist traffic may take into account these values not only to determine districts suitable for tourist and service facilities but also those designated to control tourist traffic (tourist information points). For this purpose, heuristics is used to describe values of individual spatial regimes as regards their tourist attractiveness. Due to the use of heuristics, a trip planner user is guided through the network along the shortest or the fastest path and also along the most attractive tourist routes.

3. CASE STUDY

Considering a specific nature of the method, which to a large extent depends on the availability of data used to examine the possibility of developing tourist facilities, as well as capability of data processing, below presented is an example based on data from the Upper Silesia conurbation. For this particular area, it is assumed that there is a need to analyse possibility locations for hotels and service facilities. The aim is to develop a logistic approach to the problem, which can help to provide more efficient and effective tourist traffic handling throughout the area concerned [20]. A location of a hotel in the new socio-economic space stimulates new supply chains.

Considering the specific nature of the problem, a direct access from planned facilities to the main road network and socio-economic facilities should be taken into consideration. Additionally, the analysis includes museums, public transport network and restaurants. Therefore, criteria for selecting of locations are as follows:

$$CL = ATRN * w_1 + ATH * w_2 + ATFS * w_3 + \mathrm{ATM} * w_4 + \mathrm{APT} * w_5 + \mathrm{AGP} * w_6 \qquad (6)$$

where:

CL - criterion of localization ATRN- access this road network expressed by number of nodes,

ATH - access this hospital expressed by number of medical points

ATFS - access this fire stations expressed by number of fire stations,

ATM - access to museum expressed by the number of places where museums are located,

APT - access this public transport expressed by number of bus, tram and railway stops,

AGP - access this gastronomy expressed by number of places etc.

$w_1..w_6$ - weights of parameters.

According to the example, the function of those criteria can be built in many ways, provided required data exist. Data in this case has been extracted from the OSM map layers (Figure 10 and 12).

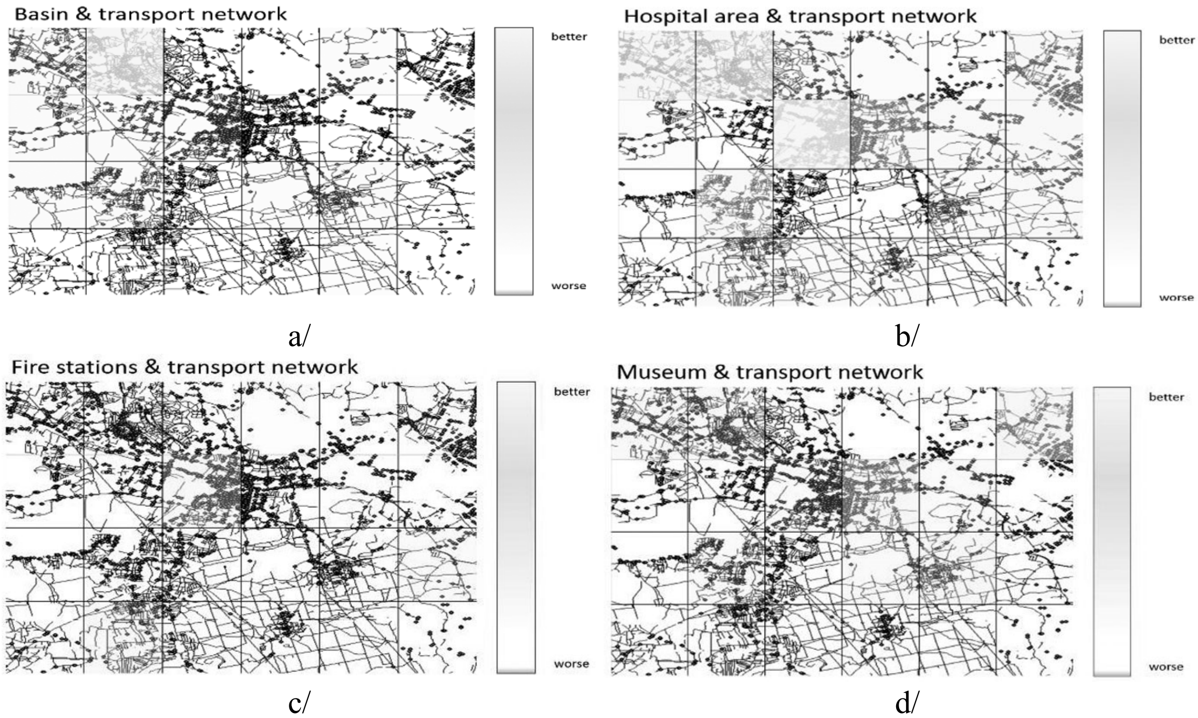


Fig. 10. Example data: road network&(basin, hospitals, fire stations, museum)

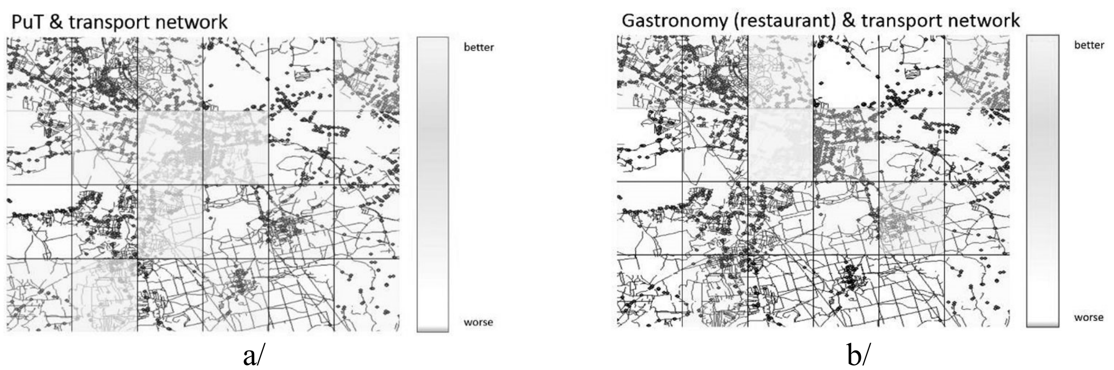


Fig. 11. Example data: road network&(public transport PuT, hospital, fire stations, museum, gastronomy)
Source: own research based on OSM maps ©

The program extracting data from OSM databases, presented in figure 6, automatically takes into account the division into spatial regimes while scanning of OSM files. Calculations used the following weights of parameters (for this specific case weights can be changed): road network (0.15), water reservoirs (0.15), hospitals (0.20), fire station (0.15), museums (0.05), PuT (0.05), and restaurant (0.05). The selecting of the most suitable spatial regime while taking account of preferred criteria is shown in figure 12. For the sanatorium or a rehabilitation facility, the criterion regarding changing of the location for hospitals and transport nodes could have much greater importance and so on.

Figure 12 also shows new regions that can be alternative to locations of the investment in the hotel and tourist base. In order to choose from four spatial regimes selected using the above method, we can also take into account prices of building plots for the investment, available technical infrastructure and the possibility to develop required infrastructure.

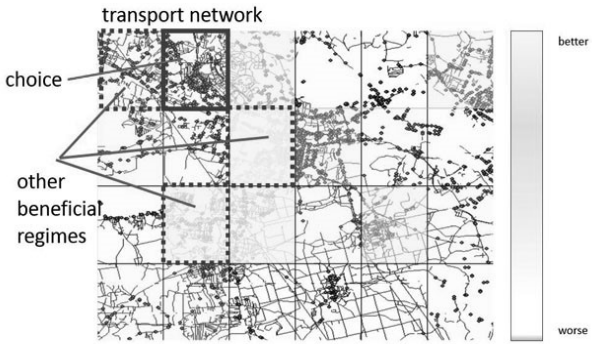


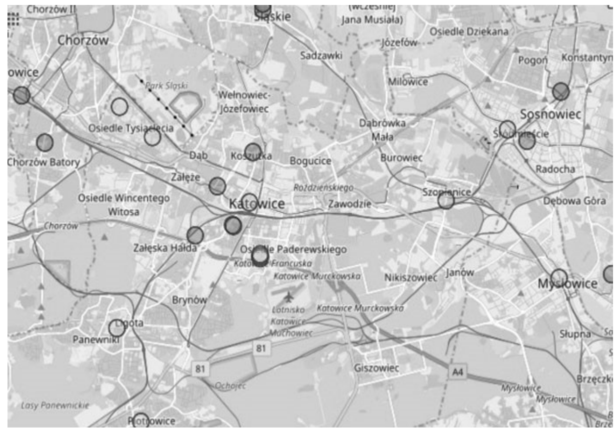
Fig. 12. Example data: road network and chosen regime and his three variants.
Source: own research based on OSM map©

4. TOURISM SAFETY - DISCUSSION

Considering various threats to the tourist traffic in the world, the analysis of locations for tourist facilities should also consider such factors such as time needed for medical, emergency, order and law enforcement and crises management services to respond to various threats. Tourist traffic can be exposed to weather disasters, riots, strike and terrorist attacks, and both of them are relatively frequent. In order to analyse a prospective location for a tourist facility regarding these factors, one can carry out exactly the same analyses as shown above. The difference is in data sources that are used for the purpose. Most frequently it boils down to the extraction of data related to generally understood safety and related issues from OSM or other public data structures (GSM, GIS, Google) [21], [22], [23], [24], [25], [26], [33].

For example, in a crisis situation in areas of an intensive tourist traffic, rescue operations may depend on the location task forces and the coordinating unit. The location of such task forces as the police and sports facilities, schools and concert halls capable of receiving people who did not manage to reach their accommodation or whose lodging was destroyed. Figure 13 shows the distribution of police units in the area analysed and sports facilities where people can be gathered in a crisis situation. Then, people can be evacuated from those sites using the various modes of transport.

a/



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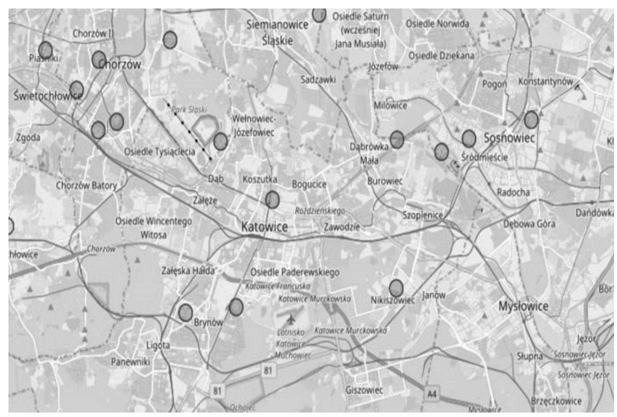

Fig. 13. Important for safety places in analyzed area: a/ police station b/ stadium
Source: and Overpass Service query based on OpenStreetMap (https://overpass-turbo.eu/)

Knowledge about the transport network is crucial for efficient rescue operations (it is obvious and actually used) and the same applies to knowledge about congestion in the transport network. The latter is less obvious especially in terms of congestion which arises in a crisis situation. An example of a tool that analyses the distribution of facilities and parameters of the road network is shown on Figure 14. The distribution of traffic congestion based on measurements in the area concerned should be taken into consideration when rapid evacuation of people from hazardous areas is needed.

It should be noted that the observed relations between the transport network and tourist traffic can often play a crucial role in a crisis situation.

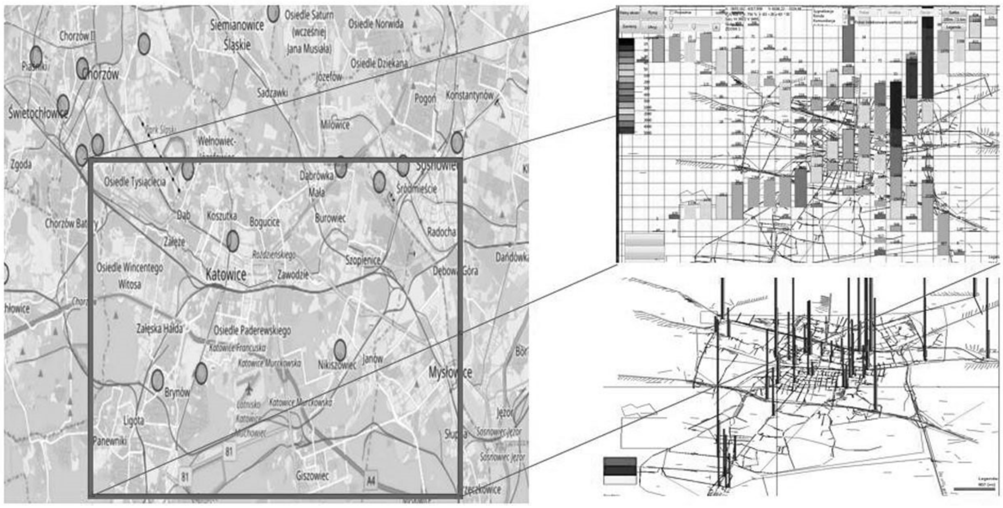

Fig. 14. Safety places and congestion distribution over road transport system
Source: own research and Overpass Service query based on OpenStreetMap (https://overpass-turbo.eu/)

5. CONCLUSIONS

The outline of the methodology for selecting spatial regimes suitable for developing tourist and service facilities requires an access to relevant data and a tool for extracting required information, i.e. parser (in this case software developed by the author). Basic data used to determine locations for tourist facilities can be obtained from open sources such as the OSM. Information about needs of people travelling can be obtained from queries to trip planners, electronic timetables, tourist information, specialised web-based booking services, commercial services, such as banks, GSM etc. All data are grouped into sets which help to determine locations for tourist and service facilities in a specific area of socio-economic system and a specific transport network also in terms of increased safety for travellers.

Trip planning based on specific parameters from mobile applications is frequently used and aims at the unification of its users. According to the authors, the methodology and the structure of large databases, or Big Data, promote a logistic approach not only in terms of traffic flow [27], but also in terms of urban planning (including suburbanisation problems) , which can significantly affect socio-economic phenomena in a given area [28].

A part of the analysis presented in the article applies to tourist traffic safety in relation to congestion requires specialist tools (software) as those developed by the authors, as presented in figure 14. Such data are of different quality than those in, for example, GoogleMaps and Targeo.pl. Ensuring safety for tourist traffic is a broad and valid issue, especially in relation to parameters of transport systems, and it is going to be presented by the authors in further articles.

REFERENCES

[1] Rosik P., Szuster M., *Rozbudowa infrastruktury transportowej a gospodarka regionów. Wydawnictwo Politechniki Poznańskiej*, Poznań 2008.

[2] Starowicz W., *Zarządzanie mobilnością wyzwaniem polskich miast*, Transport Miejski i Regionalny, (2011)/1, pp. 42-47.

[3] Tundys B., *The Impact and Role of Transportation on the Construction and Operations of the Green Supply Chain*, [in:] *Sustainable Transport Development, Innovation and Technology*, collective work ed. by M. Suchanek, Springer Proceedings in Business and Economics, Switzerland, Cham 2017, pp. 15-26.

[4] Naumov V., *Estimating the Vehicles' Number for Servicing a Flow of Requests on Goods Delivery*, Transportation Research Procedia, 27 (2017), pp. 412-419.

[5] Mindur, L. (ed.), *Technologie transportowe*, Wydawnictwo Naukowe Instytutu Technologii Eksploatacji – PIB, Radom 2014.

[6] Jacyna M., Żak J., Jacyna-Gołda I., Merkisz J., Merkisz-Guranowska A., Pielucha J., *Selected aspects of the model of proecological transport*

system, Journal of KONES, Powertrain and Transport, 20 (2013), pp. 193-202.

[7] Szołtysek J., *Podstawy logistyki miejskiej*, Wydawnictwo Akademii Ekonomicznej, Katowice 2007.

[8] Sierpiński G., Staniek M., *Education by access to visual information – methodology of moulding behaviour based on international research project experiences*, [in:] *9th International Conference Of Education, Research And Innovation (ICERI2016), 14-16 November 2016, Seville, Spain ICERI2016 Proceedings*, ed. by: L. Gómez Chova, A. López Martínez, I. Candel Torres, Published by IATED Academy, pp. 6724-6729.

[9] Pijoan A., Kamara-Esteban O., Oribe-Garcia I., Alonso-Vicario A., Borges C.E., *GTPlat: Geosimulation for Assessing the Application of Incentives to Transport Planning*, [in:] Sierpiński G. (ed.), *Advanced Solutions of Transport Systems for Growing Mobility, Advances in Intelligent Systems and Computing*, vol. 631, Cham 2018, pp. 74-89.

[10] Ortúzar J. D., Willumsen L. G., *Modelling transport*, John Wiley & Sons, Ltd, West Sussex, United Kingdom 2011.

[11] Lewczuk K., Żak J., Pyza D., Jacyna-Gołda I., *Vehicle Routing in Urban Area – Environmental and Technological Determinants*, WIT Transactions on The Built Environment, 130 (2013), pp. 373-384.

[12] Esztergár-Kiss D., Csiszár Cs., *Evaluation of multimodal journey planners and definition of service levels*, International Journal of Intelligent Transportation Systems Research, 13 (2015), pp. 154–165.

[13] Borkowski P., *Towards an Optimal Multimodal Travel Planner – Lessons from the European Experience*, [in:] Sierpiński G., *Intelligent Transport Systems and Travel Behavior, Advances in Intelligent Systems and Computing,* vol. 505, Cham 2017, pp. 163-174.

[14] Sierpiński G., *Technologically advanced and responsible travel planning assisted by GT Planner*, [in:] Macioszek E., Sierpiński G. (edd.), *Contemporary Challenges of Transport Systems and Traffic Engineering. Lecture Notes in Network and Systems*, vol. 2, Cham 2017, pp. 65-77.

[15] Maciejewski M., *Dynamic Transport Services*, [in:] Horni A., Nagel K., Axhausen K. W. (edd.), *The Multi-Agent Transport Simulation MATSim*, Ubiquity Press, London 2016, pp. 145-152.

[16] Celiński I., Sierpiński G., Staniek M., *Sustainable development of the transport system through rationalization of transport tasks using a specialised travel planner*, [in:] Dell'Acqua G., Wegman F. (edd.), *Transport Infrastructure and Systems*, CRC Press, Taylor & Francis Group, London 2017, pp. 1071-1079.

[17] Szarata A., *The simulation analysis of suppressed traffic*, Advances in Transportation Studies, 29 (2013), pp. 35-44.

[18] Celiński I., Krawiec S., Macioszek E., Sierpiński G., *The Analysis of Travellers' Behaviour in the Upper Silesian Conurbation*, The Archives of Transport, 24 (2012), pp. 441-461.

[19] Sierpiński G., *Ocena systemu transportowego oraz preferencje osób podróżujących jako wsparcie kształtowania podziału zadań przewozowych – studium przypadku dla konurbacji górnośląskiej*, Prace Naukowe Politechniki Warszawskiej. Seria Transport, 111 (2016), pp. 487-499.

[20] Mindur M., *Logistyka. Nauka – Badania – Rozwój*, Wydawnictwo Naukowe Instytutu Technologii Eksploatacji – PIB, Warszawa–Radom 2017.

[21] Hu T., Yang J., Li X., Gong P., *Mapping Urban Land Use by Using Landsat Images and Open Social Data*, Remote Sensing, 151 (2016)/8, pp. 1-18.

[22] Kijewska K., Małecki K., Iwan S., *Analysis of Data Needs and Having for the Integrated Urban Freight Transport Management System*, Communications in Computer and Information Science, 640 (2016), pp. 135-148.

[23] Valerio, D., *Road Traffic Monitoring from Cellular Network Signaling*, FTW-TR-2009-003, (2009), pp. 1-48.

[24] Chapleau, R., Morency, C., *Dynamic spatial analysis of urban travel survey data using GIS*, [in:] *25th Annual ESRI International User Conference, San Diego, Paper UC1232*, California 2005, pp. 1-14.

[25] Zielstra D., Hochmair H. H., Neis P., *Assessing the Effect of Data Imports on the Completeness of OpenStreetMap – A United States Case Study*, Transactions in GIS, 17 (2013)/3, pp. 315-334.

[26] Camboim S. P., Bravo J. V. M., Sluter C. R., *An Investigation into the Completeness of and the Updates to, OpenStreetMap Data in a Heterogeneous Area in Brazil*, ISPRS International Journal of Geo-Information, (2015)/4, pp. 1366-1388.

[27] Sierpiński G., Macioszek E., Staniek M., Celiński I., *Big Data Concerning Travel Preferences as a Means to Support Decision Making in the Field of Environmentally Friendly Urban Development*, [in:] *Regional Studies Association Winter Conference 2016. New Pressures on Cities and Regions, 24-24 November 2016*, London 2016, pp. 1-11.

[28] Pawłowska B., *Zrównoważony rozwój transportu na tle współczesnych procesów społeczno-gospodarczych*, Wydawnictwo Uniwersytetu Gdańskiego, Gdańsk 2013.

[29] Gajewski D., Szarata A., *Wahania ruchu na ulicach Warszawy*, Logistyka (2010)/4 , CD 2, pp. 1-8 - https://www.czasopismologistyka.pl/artykuly-

naukowe/send/195-artykuly-na-plycie-cd-1/1827-artykul
[30] Ministry of Tourism & Recreation, Tourism Branch, *The Trip-Planning Behaviour of American Travellers And The Causes of Last-Minute Bookings*, Ontario, June 2005.
[31] Małecki K., *The importance of automatic traffic lights time algorithms to reduce the negative impact of transport on the urban environment*, Transportation Research Procedia, 16 (2016), pp. 329-342.
[32] Iwan S., Małecki K., Stalmach D., *Utilization of Mobile Applications for the Improvement of Traffic Management Systems*, [in:] Mikulski J. (edd.), *Telematics - Support for Transport. TST 2014. Communications in Computer and Information Science*, vol 471, Berlin–Heidelberg 2014, pp. 48-58.
[33] Iwan S., Małecki K., *Data Flows in an Integrated Urban Freight Transport Telematic System*, [In:] Mikulski J. (edd.), *Telematics in the Transport Environment. TST 2012. Communications in Computer and Information Science*, vol 329, Berlin–Heidelberg 2012, pp. 79-86.l 329, Berlin–Heidelberg 2012, pp. 79-86.

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