INFORMATION IN THE CITY TRAFFIC MANAGEMENT SYSTEM. THE ANALYSIS OF THE USE OF INFORMATION SOURCES AND THE ASSESSMENT IN TERMS OF THEIR USEFULNESS FOR CITY ROUTES USERS

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ABSTRACT. Solving problems connected with the flow of cargo and people in cities demands taking a system approach and integrating a number of activities. One of effective methods of improving traffic, and what is even more important, the one possible to be promptly introduced, is to implement Intelligent Transport Systems. It makes it possible to significantly enrich information resources for managing the city traffic. Nonetheless, to achieve satisfactory results, one has to consider information needs of public transport users and provide them with convenient access to information to enable them to plan their journeys more effectively. This article presents the results of research conducted on two urbanized areas, namely the Poznan conurbation and the Upper Silesian Industrial Region. The research aim was to determine which information sources city routes users use and how they assess their usefulness.

Key words: city traffic management, city transport, local public transport, city logistics.

INTRODUCTION

The competitiveness of modern cities and their development dynamics depend more and more on the progress of knowledge and innovation. This progress has resulted in the quality of city transport systems, which has been included in "The National Transport Policy for 2006-2025" ["Polityka Transportowa Państwa na lata 2006-2025" 2005]. Modern transport systems face many problems. Apart from being overloaded, they do not correspond with specific features of cities and their residents' transport needs. Furthermore, they negatively impact on the level of environmental sustainability. All the aforementioned as well as transport inefficiency (traffic congestion); decrease the life quality of city residents, instead of improving it. The inefficiency of transport systems results in the first place in long city journeys time and a time loss, which it entails. Furthermore, public transport efficiency is reduced, while the danger of collisions and accidents is on the increase. This translates into higher costs of journey and external costs that the natural environment incurs. Functioning in the conditions of congestion, modern transport systems users not only have to be exceptionally patient, but, first of all, they have to be able to manage their time in a flexible manner. It refers to both journeys made with own means of transport and with public transport.

Solving the problems connected with the flow of cargo and people in cities needs taking a comprehensive and system approach, as increasing the quality of roads and their traffic capacity has physical limitations determined by road infrastructure whose development is in turn limited by the

architecture of a given city, not to even mention budget constraints. One of main tasks included in the National Transport Policy for 2006-2025 is "promoting innovative technical solutions, e.g. by encouraging the development of traffic management systems which prioritize means of public transport in traffic, by using traffic control systems for public transport vehicles with the application of satellite navigation, by developing dynamic passenger information systems, etc." ["Polityka Transportowa Państwa na lata 2006-2025" 2005]. Therefore, an effective method to make the flow of cargo and people in cities more efficient is Intelligent Transport Systems (ITS) with one of their basic components common for all the others, namely information. This article is devoted to solutions, which aim to provide city transport system users with information in the real time. The user is understood here as a person controlling a mechanical vehicle (carrying cargo or people) and a passenger in means of public transport. This study aims to analyse how city routes users use individual available sources of information and to evaluate how useful such sources are. The research was conducted on two urbanized areas, namely the Poznań conurbation and the Upper Silesian Industrial Region. The research results will be useful in developing city traffic management systems based on dynamic and current access to information, taking into consideration transport systems users' information needs. At present, many Polish conurbations are developing such systems, while the other ones only face a necessity of their implementation.
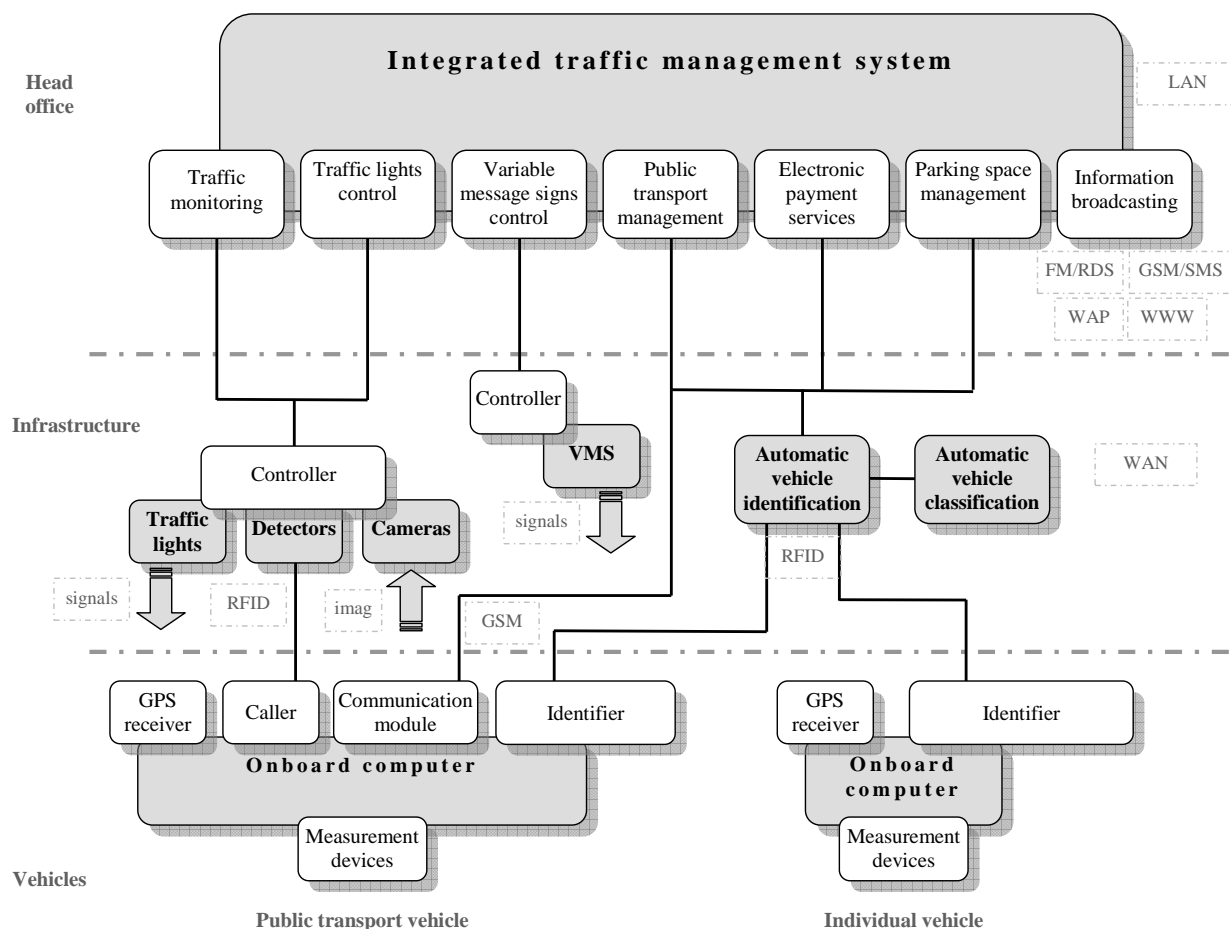
CITY TRAFFIC MANAGEMENT SYSTEM

Intelligent Transport Systems have been developed from the synergy of existing technological solutions. They respond to increasing problems of modern transport systems, including first of all continuous traffic growth, air pollution, noise and users' safety being at risk. "ITS serve both individual and public transport. ITS are mainly implemented to: improve safety and comfort of journeys, quality of information and its availability, increase mobility, and make city transport more efficient. ITS also aim to reduce the number of road accidents, congestion level and costs it entails (e.g. time loss, fuel consumption, environmental pollution). In addition, the objective of ITS is to improve the functioning of city logistics system, and, as a result, to increase city competitiveness in the long-term" [Sienkiewicz-Małyjurek, Szymczak 2008]. City traffic management systems are one of ITS components.

The last decade has seen a dynamically growing number of systems in place which aid traffic management in cities. New applications have been created, which control activities, facilitate transport and flow of information among services operating in this area, which has contributed to considerable integration of activities. A city management system is a set of tools and techniques used for such activities as [Szymczak 2008]:

- extensive permanent monitoring of road traffic, including both intensity of traffic and its structure in terms of its direction and type, with a special focus on city public transport vehicles;

- traffic lights control in a dynamic mode on the basis of information from traffic monitoring;

- control of information transmitted on road signs and variable message signs (VMS) - the transmission of information is made on the basis of information from traffic monitoring;

- registering random incidents (vehicle breakdowns, accidents) and traffic violations both for the purpose of reorganizing temporary traffic and preparing the evidence.

Basic components of the integrated traffic management system include the traffic monitoring system, traffic lights control system, variable message signs control system, and the city public transport management system. The system may be also extended by additional subsystems and applications connected with them, including automatic traffic information over the RDS radio tuner, through the Short Message Service and on the Internet. Information is a component common for all modes of the city traffic management system. The structure of the integrated traffic management system is shown in Figure 1.

Source: Szymczak 2008

Fig. 1. The structure of the integrated city traffic management system
Rys. 1. Struktura systemu zintegrowanego zarządzania ruchem miejskim

TRANSPORT INFORMATION SYSTEMS

Transport information systems make one of ITS components. They are used to gather and analyse data from many sources, and then to transfer such data to transport system users in the real time. Examples of such systems include Trafficmaster, ADVANCE, FASTTRAC, VICS, and ATIS. They cover city road networks, motorways, city ring roads, dual carriageways, railway routes, waterways and airports. The data gathered and analysed is presented on the Internet, can be sent by the radio or mobile communications as well transmitted to every mobile receiving device. It is used by local authorities, residents, tourists and any other interested person. Transport Information Systems consist of permanent elements presented on Figure 2.
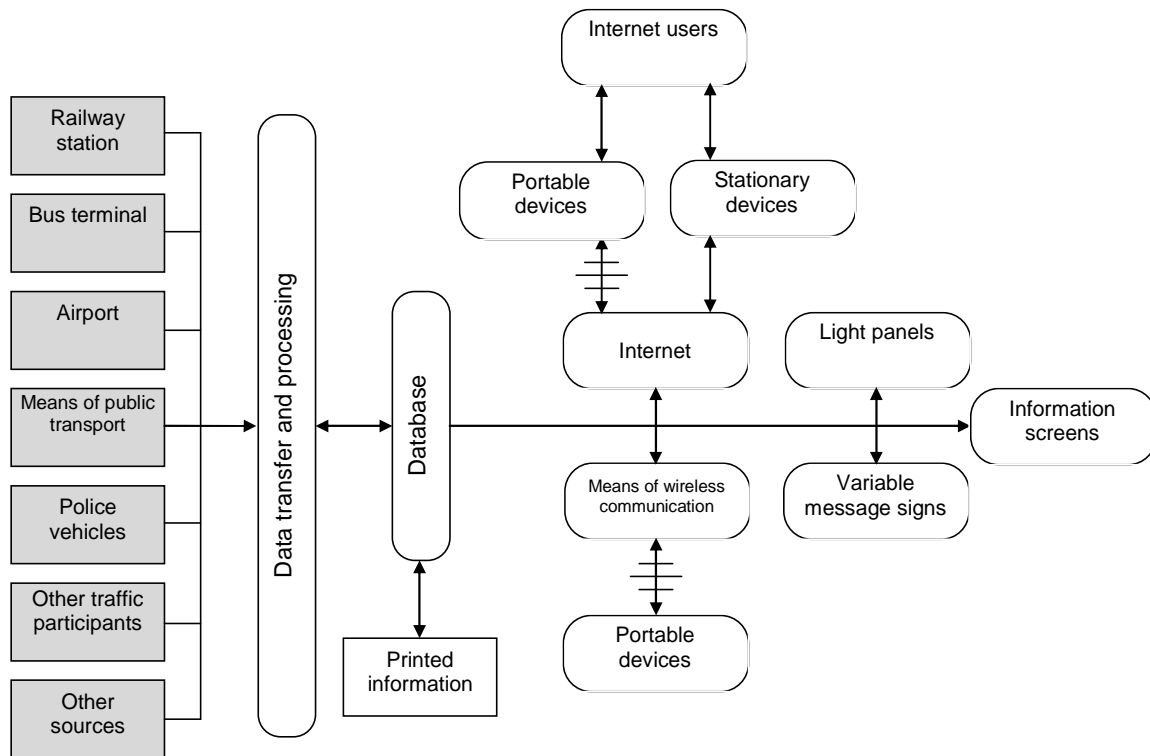
Source: Own study on the basis of Zongqi, Zhihong 2008

Fig. 2. The structure of the transport information system
Rys. 2. Struktura systemu informacyjnego transportu

Transport systems users can use the information from the transport information system to plan their journeys in terms of the choice of transport and route, and also to modify an earlier chosen route to avoid or limit various dangers during their journey. For passengers using roads with their own means of transport, the most useful information concerns the traffic congestion level, traffic incidents, recommended diversions, changes in traffic organization, free parking spaces, etc. Public transport users have similar information needs, except that they are additionally interested in the access to transport services information, public transport arrivals and departures, delays, and changes of routes, etc. Commercial car and lorry drivers have yet other needs. They need information about burden limitations, axle load, allowed vehicle dimensions (e.g. height of flyovers), restrictions for lorries, car parks for lorries, petrol stations with high pressure petrol pumps, etc. Such individual needs have been also considered by satellite navigation maps producers and producers of the first devices designed specially for lorry drivers [GPS dla trakerów 2009].

There are many methods of distributing information about the current traffic situation. The most popular is the mass media, with a prevailing role of radio transfer which may be supplemented by text information provided in an additional channel in RDS TP/TA (Radio Data System - Traffic Programme / Traffic Announcement) in the analogue radio broadcasting in the VHF band or transmitted within digital radio broadcasting DAB (Digital Audio Broadcasting). Also the Short Message System and Multimedia Messaging System frequently serve the purpose of distributing information. DAB and MMS enable sending pictures such as situation drawings of changes in traffic organization or schematic diversion plans.

Another source of information, though currently useful mainly before starting a journey, is internet technologies (The possibility of using internet resources and services during a journey may soon become widely available. The Internet use is already possible in some luxury passenger cars such as a new Audi A8 (the function is placed on the driver's central console, it is available wireless for

passengers) and in modern means of public transport through mobile Wi-Fi hot spots. Such a service has been offered since 1 September 2010 in the newest buses operated by Wiraż-Bus - a public carrier of Swarzędz, a municipality located near Poznań [Ewing 2010; http://wiraz-bus.cba.pl]). City halls, road directorates, and independent companies run internet services.

Information about city traffic is of dynamic nature, which is why they should be promptly transferred. "Information gathering, analyzing and transferring should take from 5 seconds to 1 minute" [Zongqi, Zhihong 2008]. S. Kenyon and G. Lyons identified three types of passenger-targeting information [Lyons 2006]:

- − Unimodal Traveller Information (UTI) - the simplest and most frequent form of informing passengers, e.g. information boards, road atlases, internet maps; it has a wide spectrum of use, but is relevant only to a specific scope of information;

- − Multimodal Traveller Information (MTI) - information about more than one mode of transport, made available on the basis of access to a range of information sources;

- − Integrated Multimodal Information (IMMI) - enables to compare passengers' needs with current traffic conditions; it uses a number of data sources and makes it possible to prepare various content compilations.

Transport information systems facilitate smooth flow of cargo and people in a dense network of roads on urbanized areas. IMMI presents the highest information value for passengers. This kind of information transfer can be personalised for a specific group of users, and even for one defined user, which in addition increases the usefulness of this information channel.

The are many services in the world, where city routes users can find necessary information. The use of such information depends first of all on individual needs and its potential users. Research conducted in Great Britain among transport systems users show that basic information which passengers seek includes information about traffic limitations and a possibility of planning one's route. The results of this research are presented in Table 1.

Table 1. Basic types of information, which passengers seek in information services
Tabela 1. Podstawowe rodzaje informacji, poszukiwanych przez pasażerów w serwisach informacyjnych

Type of information	Number of responses (in %)
Road traffic limitations during a journey	87
Possibility of planning a journey	80
Potential time of a journey	73
Total cost of a journey	66
Possibilities of purchasing a ticket	56
Transport costs depending on means	54
Reasons for selecting means of transport	43

Source: Lyons 2006

In cities worldwide there are information portals, which are very frequently really advanced, where it is possible to obtain information useful both for drivers and public transport users, city residents and tourists.

RESEARCH RESULTS

In December 2009 and January 2010, the authors conducted surveys among public transport users and passenger car drivers. The research was carried out on two urbanized areas, namely the Poznań conurbation and the Upper Silesian Industrial Region. The research aim was to determine which information sources city routes users use and how they assess their usefulness. All surveys were responded to in the presence of a survey conducting person ready to explain any respondents' doubts so as to prevent any negative impact of such on the final results. Only a small number of surveys was filled by a survey conducting person via a telephone conversation with a respondent. The surveys were anonymous. Table 2 and 3 compile filled surveys subject to the analysis.

Table 2. Surveys compilation - the Poznań conurbation
Tabela 2. Zestawienie wyników ankiet w aglomeracji poznańskiej

| Age	Public transport users		Drivers		
	Women	Men	Women	Men	
under 25	15	10	14	17	
26-40	14	14	13	15	
41-60	16	12	12	16	
above 60	14	11	9	13	Total
	59	**47**	**48**	**61**	**215**

Source: own study

Table 3. Surveys compilation - the Upper Silesian Industrial Region
Tabela 3. Zestawienie wyników ankiet w Górnośląskim Okręgu Przemysłowym

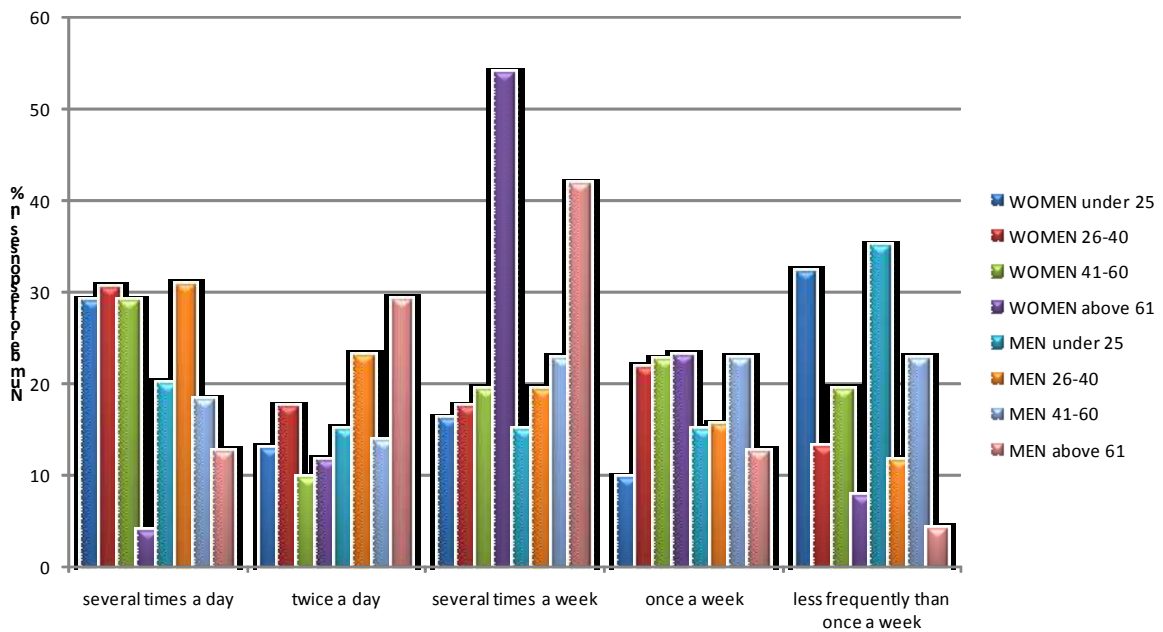| Age	Public transport users		Drivers		
	Women	Men	Women	Men	
under 25	16	10	15	24	
26-40	10	12	13	18	
41-60	15	10	12	19	
above 60	12	13	8	14	Total
	53	**45**	**48**	**75**	**221**

Source: own study

The analysis of the research results indicates that no differences exist in terms of the frequency of using public transport, its assessment or using information sources about journey conditions among public transport users in both analyzed areas, i.e. the Poznań conurbation and the Upper Silesian Industrial Region. The results lead to a conclusion that there are also no differences as far as respondents' sex and education are concerned. Different behaviours and opinions are only observed while considering respondents' age.

The diagnosis of the Polish transport system lists the following main trends: a fall in public transport share (by about 20-25%) in the local transport in most cities due to an increase of individual transport share to 60-70% in that transport and higher users' expectations as to individual transport subsystems (such as comfort, reliability, safety, journey time, journey certainty, low costs, etc.) ["Polityka Transportowa Państwa na lata 2006-2025" 2005]. Such trends have been confirmed in the conducted research, which shows that 54.8% drivers use their car for transport purposes every day (see Figure 3). It is mainly drivers under 25 (62.7% in this age band). On the contrary, a car as an everyday means of transport is the least used by respondents aged 41-60 (16.7% of women and 20.2% of men). A lower frequency has been observed in the case of public transport use (see Figure 4). As little as 22.2% of users use public transport several times a day, while 25.6% - several times a week. It is respondents aged above 61 (47.8%) and 41-60 (18.8%) that use this transport most often.
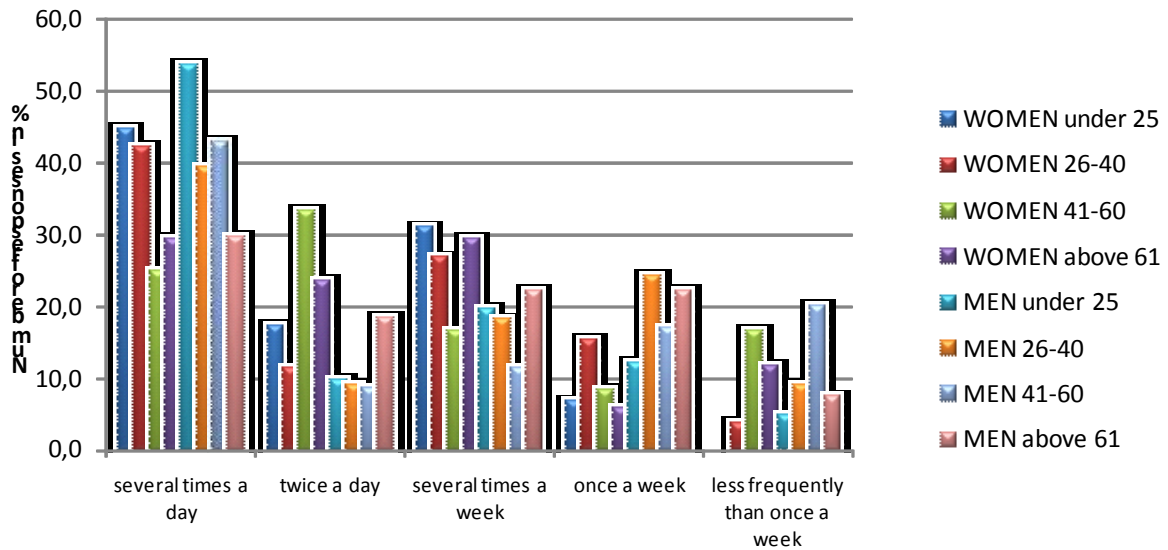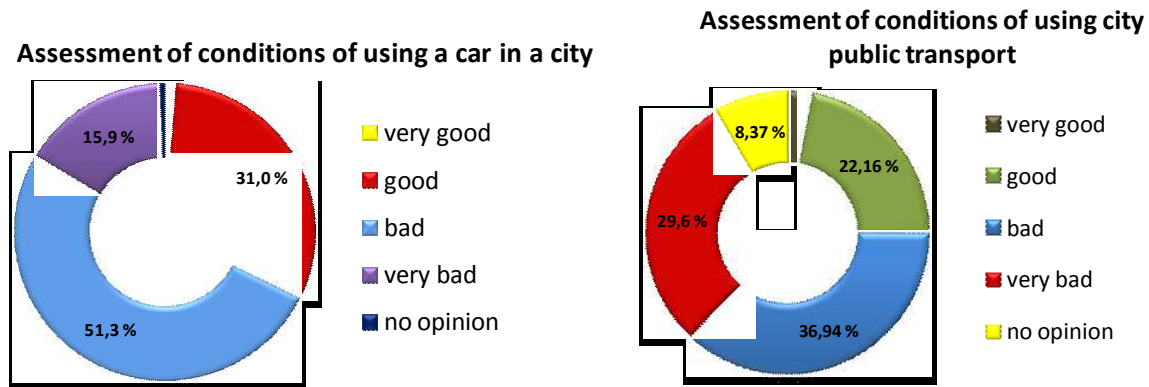
Source: own study

Fig. 3. Frequency of using a car for transport purposes in a city.
Rys. 3. Częstotliwość korzystania z samochodu w celach transportowych w mieście

Source: own study

Fig. 4. Frequency of using public transport.
Rys. 4. Częstotliwość korzystania z transportu publicznego

The analysis of drivers' opinions shows that 67.1% of them negatively assess (score assessment 1 and 2) conditions of using a car in a city. Likewise, 66.5% public transport users give the negative assessment of their journey conditions. The results of opinion research are shown in Figure 5.

Assessment of conditions of using a car in a city

Assessment of conditions of using city public transport

Source: own study

Fig. 5. The assessment of using a car and public transport in a city
Rys. 5. Ocena warunków korzystania z samochodu i transportu publicznego w mieście

Main tasks listed in "The National Transport Policy for 2006-2025" include developing of the application of modern technical and organizational solutions is such areas as dynamic drivers information systems and passenger information systems. The analysis of assessments given as to the usefulness of information sources while using a car as a means of transport indicates that drivers most frequently use:

− road information boards (63.4% responses),

− GPS with maps (58.2%),

− the radio (55.6%),

− road atlases and maps (50.9%),

− CB radio (43.5%).

The least used source of information is SMS and MMS. It was clearly indicated by respondents - 46.1% of them have never used such services. This fact is due to the low popularity of road SMS and MMS in Poland (It can be stated that in Poland systems informing drivers about current traffic intensity through SMS and MMS have only started to develop. An important stage of this development is the Auto Świat Finder service that has been activated recently by one of popular car magazines. When a driver sends an appropriately formulated text message (PLN 2.44), a multimedia message is sent back with information about traffic incidents and a small map depicting driving conditions of roads subject to question (what needs to be given by a driver is a city name, a street name or a road number) ["Nie daj się zakorkować" 2010]). This situation may not change soon as 35.3% of respondents marked this information channel as the least efficient in terms of its usefulness (score assessment 1 and 2). The press and television were most frequently assessed as poor sources of information (56.5% and 43.9% respectively). These sources turn useful mainly before setting off and, compared with the radio or CB radio they lose in terms of providing up-to-date information. The compilation of usefulness assessments of individual information sources for drivers is displayed in Figure 6. It is mainly younger respondents that use modern technological solutions. Their major source of information is internet maps and CB radio (46.1% and 53.8% respectively). The situation looks different in the over 40 age band - here respondents use first of all traditional road atlases and maps (74.5%) and road information boards (69.9%). What strikes attention is that in every age band the same assessments were given for GPS systems (score assessments from 3 to 5) as a modern technology and the radio as a traditional source of information (56.5% and 51.2% respectively).

To obtain a more in-depth view of the results, the analysis was made of information sources selected for a particular purpose of information, which is shown in Figure 7. It indicates the radio as
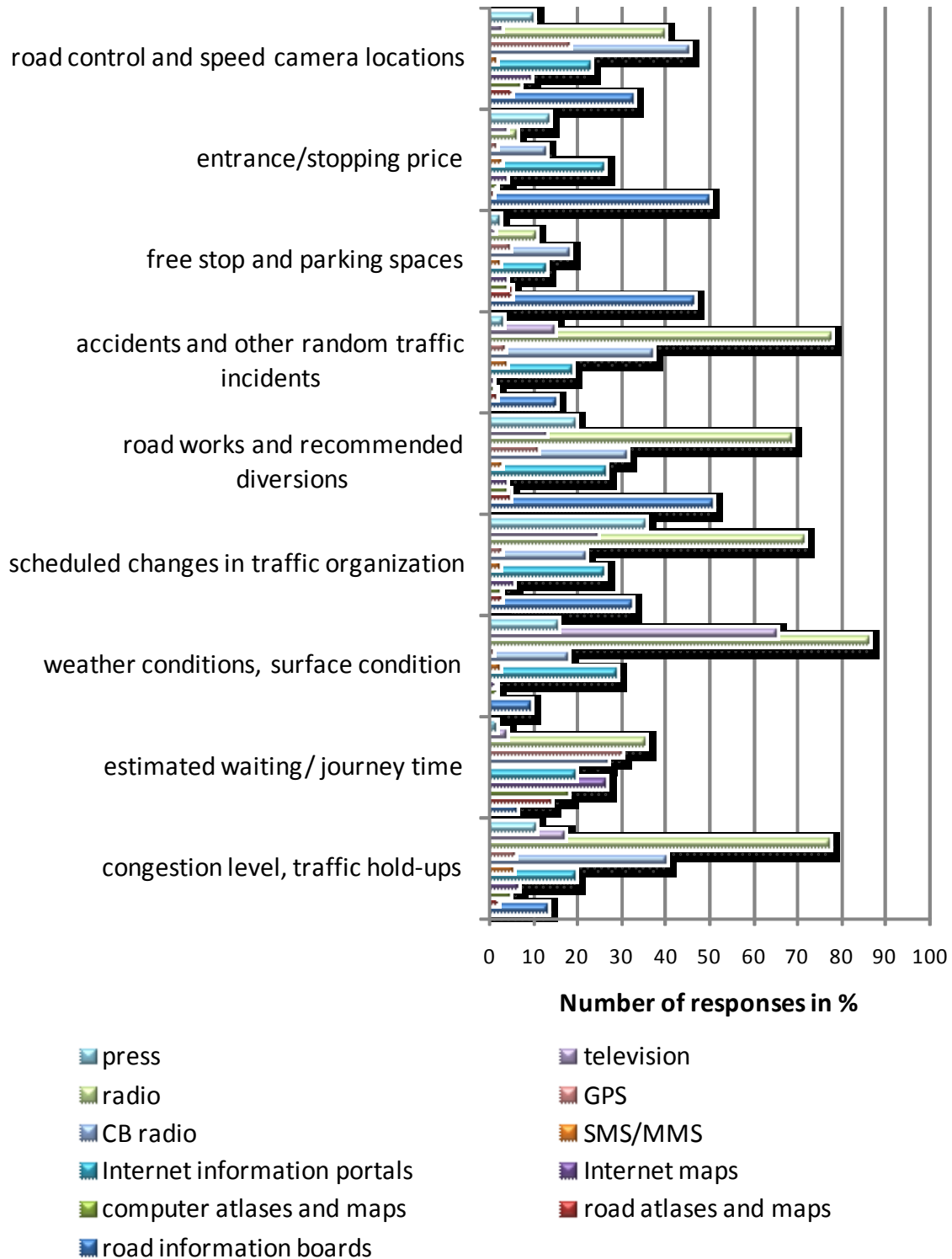
a still very important source of information for vehicle drivers. It is the most frequently used form when drivers need information about accidents and other random traffic incidents (77.6% responses), the congestion level (77.1%), scheduled changes in road traffic organization (71.1%), road works and recommended diversions (68.6%), and weather conditions (86.2%). The comfort of use while driving and up-to-date information constitute a decisive factor for selecting the radio as a source of information.

Number of responses in %
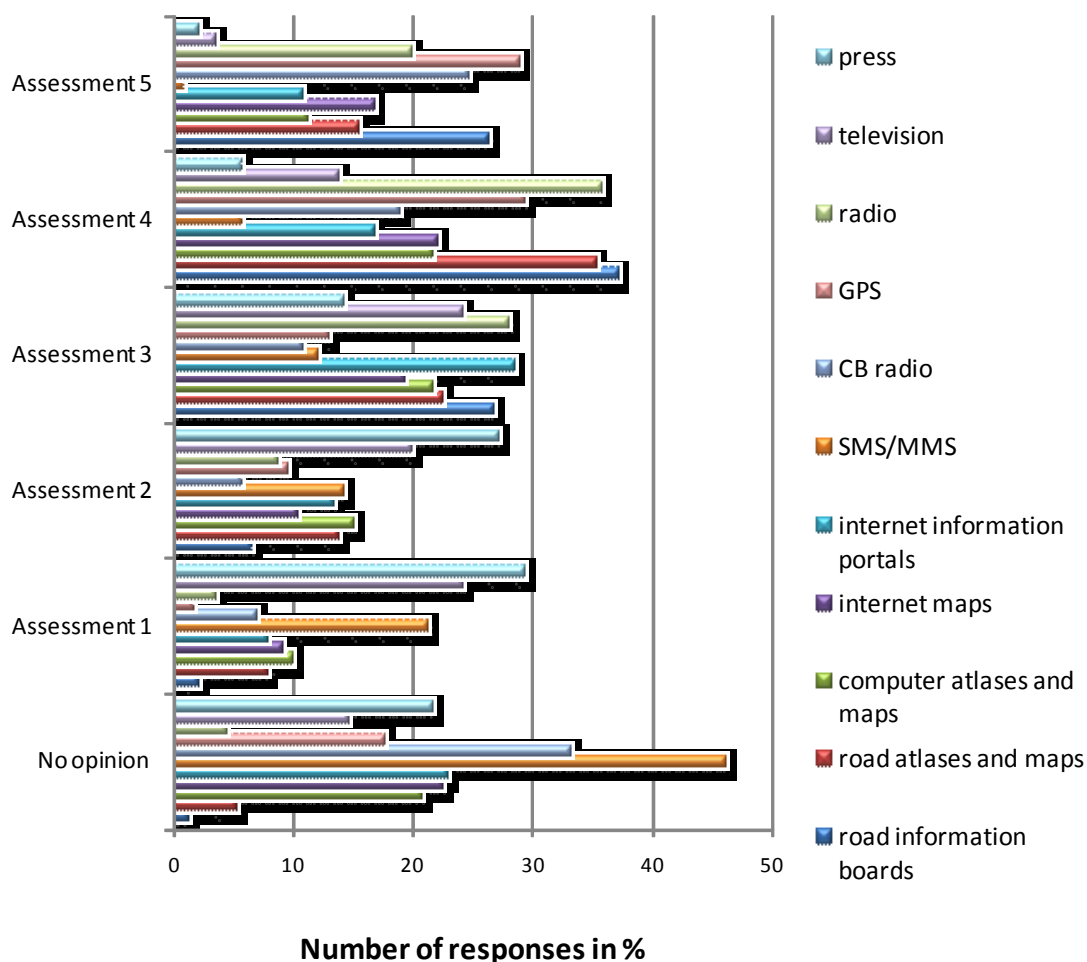
Source: own study

Fig. 6. Assessment of information sources in terms of their usefulness for drivers (5- the highest score, 1- the lowest score).
Rys. 6. Ocena źródeł informacji w odniesieniu do ich użyteczności dla kierowców (5- najwyższa ocena, 1- najniższa)

Number of responses in %

- press
- radio
- CB radio
- Internet information portals
- computer atlases and maps
- road information boards
- television
- GPS
- SMS/MMS
- Internet maps
- road atlases and maps

Source: own study

Fig. 7. Sources of information used by drivers for information purposes
Rys. 7. Źródła informacji używane przez kierowców w celach informacyjnych

City public transport users use different sources of information. In their opinion, the most useful ones (marked with the highest score) include:

– information at public transport stops (75.9% of responses),

– the Internet (62.1%),

− electronic timetable (44.8%).

On the contrary, the least useful sources of information given by respondents (marked with the lowest score) are:

− the radio (54.7%),

− the television (52.7%),

− the press (54.2%).

The compilation of usefulness assessments of individual information sources for public transport users is displayed in Figure 8. Again no differences have been identified as to the usefulness of information sources regarding the sex. As in the case of private car drivers, younger respondents use modern technological solutions more often. Such a phenomenon has been shown in the assessment of information sources usefulness. The electronic timetable has been positively assessed (score assessments 3 to 5) by 86.3% respondents under 25, 48.9% of respondents aged 26-40, 37.7% of respondents aged 41-60, and by only 5.9% of respondents above 61. The use of the Internet as an information source indicates even more significant differences with regard to the age of public transport users. This source of information was positively assessed by 80.4% of respondents under 25, 81.6% at the age 26-40, 71.7% at the age 41-60 and as little as 10.1% of respondents over 61.
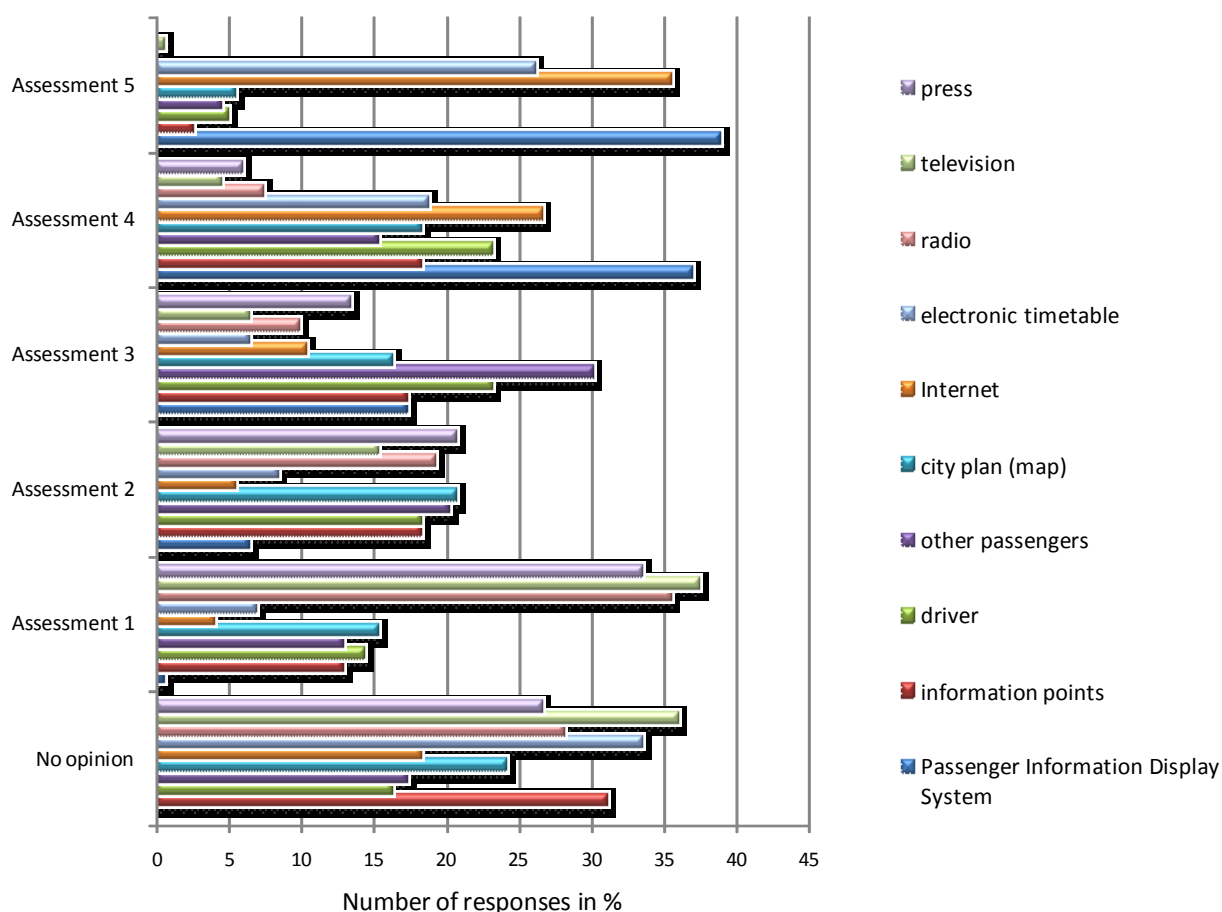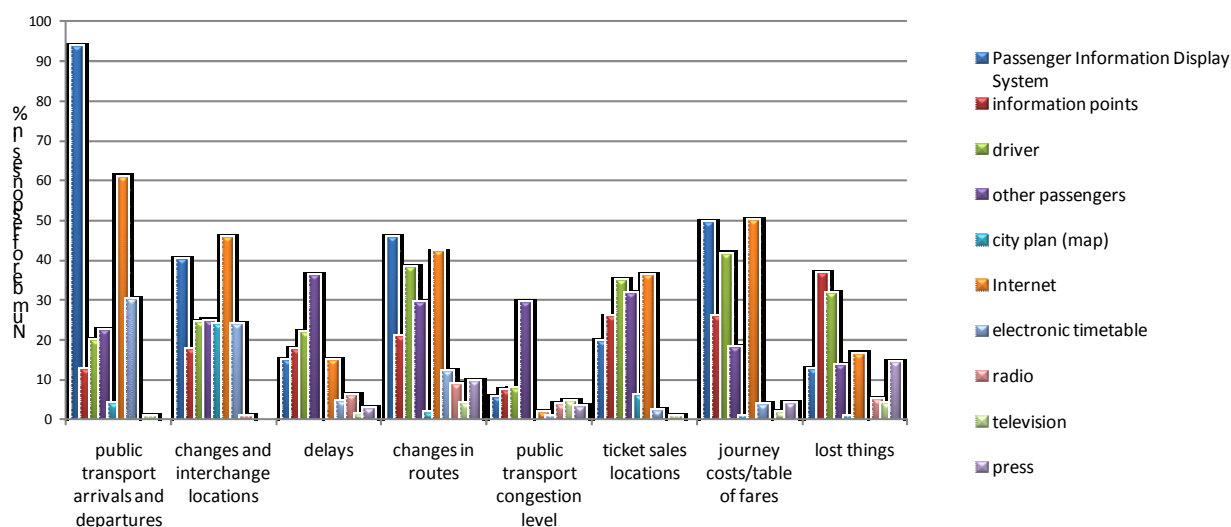

Source: own study

Fig. 8. Assessment of information sources in terms of their usefulness for public transport users (5- the highest score, 1- the lowest score).
Rys. 8. Ocena źródeł informacji w odniesieniu do ich użyteczności dla użytkowników transportu publicznego (5- najwyższa ocena, 1- najniższa)

Public transport users most often seek information about public transport arrivals and departures, change possibilities, interchange locations, delays in public transport services, changes in routes, congestion level and journey costs, etc. On both analyzed urban areas public transport users can choose from a variety of passenger information sources. To obtain information about public transport arrivals and departures, users most often select the Passenger Information Display System (93.6% of responses) and the Internet (accounts for 60.6% of responses). Likewise, in the case of information about changes in routes - the most frequently used information sources include the Passenger Information Display System, and the Internet (45.3% and 41.9% respectively), while with regard to changes - it is 39.9% and 45.3% of responses respectively, and journey costs - 49.3% and 49.8% respectively. Figure 9 compiles assessments of individual information sources in terms of their usefulness for public transport users.

Source: own study

Fig. 9. Sources of information used by public transport users with regard to their information needs
Rys. 9. Źródła informacji używane przez użytkowników transportu publicznego w związku z ich potrzebami informacyjnymi

CONCLUSIONS

Drawing on the considerations given in this study, secondary sources and analyses of empirical research results it may be concluded that:

– analysing the role of information in the city traffic management it should be stated that from the view of a transport system user, whom access to information enables to make a conscious choice as to available journey possibilities, not only does it have an essential role in the current planning of traffic and its control to shorten journey time and increase traffic safety, but is of strategic importance in establishing a sustainable transport system, which will make it possible to implement the best division of tasks between the public and individual transport taking into consideration residents' mobility on the one hand and the environmental burden from the other hand;

– for the information to serve its purpose, it has to be up-to-date and be as much available as possible both before and during a journey, bearing in mind its easiness to be obtained by transport system users; it demands the communication of transport information systems with mass media, the Internet and local information and communication technologies systems which

use in the first place wireless connections (e.g. mobile communications, Wi-Fi hot spots) given hugely popular personal mobile devices;

– the obtained research results indicate that transport system users in cities use a number of sources: car users most often use the CB radio, traditional road maps and atlases, the radio, GPS, road information boards, while public transport users use first of all the Passenger Information Display System, the Internet and growing in popularity electronic timetables;

– different behaviours and opinions of transport system users regarding the frequency of use and the assessment of individual information sources are only visible while considering respondents' age - a place of residence, sex, and education are virtually of no importance here;

– the analysis of transport system users' information needs compared with the detailed analysis of information mostly sought after in information portals allows to identify residents and visitors' transport needs, which constitutes relevant information to better traffic management in cities and, in the long term, to planning transport system development;

– as not all respondents were aware of some information sources being available and a method of access to some information channels, it is important to state that of great importance is informing the society by mass media about new information and communication technologies and initiatives concerning services for car drivers and public transport users.

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INFORMACJA W SYSTEMIE ZARZĄDZANIA RUCHEM MIEJSKIM. ANALIZA WYKORZYSTANIA I OCENA PRZYDATNOŚCI ŹRÓDEŁ INFORMACJI DLA PORUSZAJĄCYCH SIĘ PO MIEŚCIE

STRESZCZENIE. Rozwiązywanie problemów, jakie wiążą się z przepływami ładunków i osób w miastach wymaga podejścia systemowego oraz zintegrowania wielu działań. Jednym ze skutecznych sposobów usprawnienia ruchu, a co ważniejsze możliwym do szybkiego wdrożenia jest implementacja Inteligentnych Systemów Transportowych, co pozwala na znaczne wzbogacenie zasobów informacji dla zarządzania ruchem miejskim. Aby jednak efekt był zadowalający należy uwzględnić potrzeby informacyjne kierowców i pasażerów środków transportu zbiorowego oraz zapewnić im dogodny dostęp do informacji, aby mogli lepiej planować swoje podróże. Artykuł zawiera wyniki badań, jakie przeprowadzone były na dwóch obszarach zurbanizowanych - w aglomeracji poznańskiej oraz na terenie Górnośląskiego Okręgu Przemysłowego. Celem badania było określenie, z jakich źródeł informacji korzystają poruszający się po mieście oraz jak oceniają przydatność tych źródeł.

Słowa kluczowe: zarządzanie ruchem miejskim, transport miejski, lokalny transport zbiorowy, logistyka miejska

INFORMATION IM VERWALTUNGSSYSTEM DES STADT-VERKEHRS. ANALYSE DER BENUTZUNG UND BEWERTUNG DER NÜTZLICHKEIT DER INFORMATIONSQUELLEN FÜR STADT-VERKEHRSTEILNEHMER

ZUSAMMENFASSUNG. Die Lösung von Problemen, die mit dem innerstädtischen Personen- und Güterverkehr verbunden sind, verlangen nach einer planmäßigen Behandlung und Integration von vielen Wirkungen. Eine der wirksamsten Weise der Stadtverkehrsverbesserung, die möglich zum schnellen Einführung ist, ist die Implementation von Intelligenten Transportsystemen, was erlaubt, bedeutend die Informationen für das Verwaltungssystem des Stadtverkehrs zu bereichern. Damit der Effekt zufriedenstellend ist, soll man Informationsbedürfnisse von Fahrern und Passagieren von Transportmitteln des öffentlichen Verkehrs berücksichtigen und ihnen bequemen Informationszugang sichern, damit Sie besser ihre Reisen planen könnten. Der Artikel umfasst Ergebnisse von Untersuchungen, die man auf zwei urbanisierten Gebieten -in der Poznań - Agglomeration und im Oberschlesischen Industriegebiet durchgeführt hat. Das Ziel von Untersuchungen war die Bestimmung, welche Informationsquellen die Verkehrsteilnehmer benutzen und wie die Nützlichkeit von diesen Quellen bewerten.

Codewörter: Verwaltung des Stadtverkehrs, Stadtverkehr, öffentlicher Verkehr, Stadtlogistik

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