Examples of innovative transport solutions complying with the “smart mobility” concept criteria

Introduction

Nowadays, over half of population lives in cities – in 2007, ca 50% of the populace inhabited urban areas, and according to forecasts this percentage will increase to 60% [13]. The increasing process of urbanisation and the disturbing co-occurrent process of chaotic metropolitan growth causing developmental dispersion lead to the phenomenon known as “urban sprawl”. Changes in spatial development influence a change in residents’ travel behaviours, resulting in a rising demand for the use of cars in travel, intrinsically accompanied by traffic congestion and harmful emissions, including CO$_2$. On account of globalisation processes, the demand for long distance transit, including different means of transport, passenger as well as freight, is increasing. Simultaneously, due to non-uniform travel behaviours, both in terms of the city travel and outbound travel, there is a need to provide information on communication systems’ functioning and increase transport accessibility. Urban transportation planning stands before a challenge to ease the negative effects of urbanisation and mobility, including lowering the energy usage and improving the environmental condition, but also to supply an integration of transport networks, to provide information on their operation, and to improve destination availability (also in a regional approach).

Cities developed according to the “smart city” concept should rise to the challenge. In agreement with this concept, urban development planning should take into account various spheres of city life (economy, human and social resources, engagement of the public sector, mobility, natural resources, quality of life) and utilise IT innovations [2]. One of the “smart city” pillars is the notion of “smart mobility”, referring to a more efficient transport system management through the use of solutions enabling real time access to information on the performance of the network, as well as strategies which lead to attaining sustainable mobility. These strategies cover [2]:

- increasing the transport accessibility level (by various means in a local, a regional and an international scale),
- stimulating an increase in the use of public transport, especially in terms of business travel (by providing an adequate infrastructure, improving the quality of services),
- supplying information on the network status (especially using Internet tools),
- improving road safety.

“Smart mobility” also takes into consideration new trends in urban mobility, pertaining to the reduction in...
the number of private vehicles, improvement of multimodal travel conditions, encouragement to use active mobility means (cycling, walking) and modern solutions, e.g. smart cards. Hereunder, two examples of innovative transport solutions will be presented, implementation of which is related to meeting the postulates of the "smart mobility" concept – Demand Responsive Transit Service and carsharing system (aka car clubs).

**Demand Responsive Transit Service – a service tailored to customers’ needs**

The conventional bus transit works within defined rules, covers only fixed routes and according to a rigid timetable. However, in suburban areas, regular line buses are often empty, low utilisation of such services is due to long routes, low run frequency, and low passenger turnout. In such cases, it is justifiable to organise a more flexible form of transport than a traditional bus, in such a manner, that passengers’ transit needs are satisfied and that they are given access to chosen destinations, while meeting the economic efficiency criteria. An innovative solution complying with these requirements, which are simultaneously among the postulates of “smart mobility”, is the service called Demand Responsive Transit Service. Its characteristics are flexible routes and timetables, and the use of small or medium size vehicles, which run on combined routes which link bus stops according to passengers’ needs [7, p.71]. Organising this form of transport in a low population density area contributes to maintaining or even increasing the share of public transport in non-pedestrian traffic.

A standard service-delivery procedure consists of stages illustrated in fig. 1, where [4]:

- clients call the dispatcher’s office to place and order which is then relayed to the system,
- the system determines an optimal route (orders are being combined to transport the highest possible number of passengers, and the software marks out a route that may be altered according to new orders, while the area of operation stays the same),
- the system selects a vehicle, fitted with proper communication devices enabling contact with the dispatcher’s office (a mobile phone, on-board computer, a chip card reader),
- the chosen route is sent to the vehicle along with a timetable,
- customer service occurs – customers proceed to the indicated spot, where they await the arrival of the vehicle.

This type of transport is in operation, amongst others, in: Italy (Florence, Genoa), Sweden (Stockholm,), Finland (Keski-Usimaa), Belgium (Limburg, Flanders), and since 2007 also in Poland – Krakow [7, p. 71]. In Krakow, Tele-Bus service was launched by MPK Cracow on July 14 2007. Initially, it operated in Rybitwy, Przewoz and Pod-wierzbie districts and the northern part of Biezanow district. These are suburban areas, where a regular transit was hardly justifiable economically. Implementing the service ensured rationalisation of public transport expenses, improved its performance, and provided residents with an easy access to transport hubs covering regular lines to the city centre. In March 2009, upon residents’ request, the
area was expanded by Plaszow district. The current range, see fig. 2, is three times bigger than the original zone.

Fig. 1. Procedure of service-delivery [4].

The Krakow model of the service does not have regular timetables and routes, and is characterised by flexible routes and fixed bus stops, places where vehicles may turn round and spots where they may end a course and await a new order. Passengers may order a transit within working hours between two optionally selected bus stops [10]. Tele-bus is using two Jelcz 081MB Vero midi buses powered by eco fuel.

Fig.2. Current area of Tele-Bus service operation.
Source: MPK SA in Krakow.

A special dispatcher’s office works as the system management and control centre taking customers’ orders, planning routes, timetables to be passed on to the drivers. The office is equipped with Softeco Sismat S.p.A.
software, which enables the use of versatile routes and timetables while maintaining full control over the number of vehicles and routes simultaneously.

To use the service, customers have to register in the system, by providing their personal and contact details in order to receive an individual number necessary to execute the order [10]. While making a reservation, one has to define the starting point, the destination, and time of the departure or the arrival. The dispatcher confirms order acceptance and supplies the number of the vehicle to be boarded. The service is available seven days a week and a transit may be booked every day during the dispatcher’s office working hours, either in advance or impromptu. Last minute booking is available on the day of the journey (not later than 30 minutes before the departure) or on other days of the current week. Booking in advance refers to days in following weeks. In this case, customers are required to call the office again on Saturday or Sunday preceding the week of the service, in order to obtain detailed information on the bus’ arrival at the required stop. It is possible for people who are at the bus stop and did not book the transit to get on board, but only if there are untaken seats and their destination correlates with the current route. Fares are equal to those for other lines operating in Krakow, and bus passes and tickets for regular lines operating within the area serviced by Tele-Bus remain valid.

According to MPK S.A. database, in the first half of February 2014, the service had 2,201 registered users, whereas an average number of passengers amounted to 1075 in 2007, 1652 in 2008, 1,461 in 2009, 1,845 in 2010, 2,238 in 2011, 3,270 in 2012, and 3,003 in 2013, which indicates a gradual growth; in 2012 a triple increase in comparison to the first year of operation. Tele-Bus was the most popular in October 2012 – the average number of passengers amounted to 3,720.

**Carsharing – access to a car without the necessity of ownership**

Carsharing relies on use of vehicles owned by the city, a private company, an institution, or a group of people, each of which reserves car access time. Vehicles are picked up and dropped off at special car parks, localised in different areas of the city. System users benefit by e.g. splitting fixed costs (amortisation, insurance) among the group of users and enjoying guaranteed access to the car without the need to own it [7, p.215]. This solution directly reflects “smart mobility” postulates – its implementation results in a more efficient use of the existing resources, especially in reference to urban areas. Pay-as-you-drive system further motivates towards less frequent use of cars and choosing eco-friendly means of transport, helps reducing the number of private cars, leads to a decreased energy consumption and reduction of noise and local pollution [7, p.215]. Thanks to the implementation of new technologies, carsharing is an easy and user-friendly solution.

The service is organised by private entities (companies working only as the system operators, car manufacturers, traditional car rental agencies) or local governments and organisations for the purpose of
providing an alternative to a private car usage [6]. Carsharing may also be implemented in a peer-to-peer model [14], where the owner of a car provides it for others for short periods of time. The owner may earn by leasing the vehicle during the time they are not using it, while the lessee has access to vehicles close to their place of residence and pays only for the time of their actual use. In response to the peer-to-peer users’ needs, private entities provide access to websites which work as a data exchange, reservation and payment processing platform.

Table. 1. Number of carsharing users and available cars; 2012.

<table>
<thead>
<tr>
<th>Continent</th>
<th>Number of users</th>
<th>Number of available cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asia</td>
<td>160 500</td>
<td>6 155</td>
</tr>
<tr>
<td>Australia</td>
<td>25 500</td>
<td>1 080</td>
</tr>
<tr>
<td>Europe</td>
<td>691 943</td>
<td>20 464</td>
</tr>
<tr>
<td>North America</td>
<td>908 584</td>
<td>15 795</td>
</tr>
<tr>
<td>South America</td>
<td>1 500</td>
<td>60</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1 788 027</strong></td>
<td><strong>43 554</strong></td>
</tr>
</tbody>
</table>

Source: [8].

In 2011, carsharing functioned in over 600 cities all over the world, and in 2012 the biggest market share, in terms of the amount of users, was held by North American (51%) and European operators (39%), whereas the share of Asian countries, Australia and South America amounted to 9%, 1% and less than 1% respectively [8] (table 1). In 2013, first carsharing systems were launched in Poland by private commercial entities – Easymotion in Poznan and GoGet.pl in Wroclaw.

In order to use the service, users have to register on a website, by phone or at a customer service points, depending on the selected operator. The client receives a user number and often a special chip card which works as a key to all vehicles owned by the operator issuing the card. Vehicle booking is performed on-line, by phone (call, text) or special applications on mobile devices. During the booking procedure, the user should state the term of the lease, the preferred collection location and the type of the vehicle. After the order is placed and confirmed, the vehicle is transferred to the location within the time specified in the order. The vehicle is collected from a particular location and normally is returned to the same place.

A model example of the system would be Cambio, in operation in several German and Belgian cities, launched in Bremen and initially operated as a club consisting of 30 eco-oriented members sharing 3 cars [3]. Since then, the system has greatly developed and transformed into a prosperous, full-scale enterprise. Bremen authorities entered into cooperation with the operator, and Cambio became an element of the sustainable development of the city and an eco-friendly transport strategy. The operator also collaborates with the public transport operator in the scope of offering common pass and carsharing fares. Several Cambio car parks are situated near public transport stops and public bicycle stands, thus creating public mobility stations (mobil.punkt) integrating various transport systems (fig. 5).
Depending on the size of a given station, Cambio system offers two car access options: either by a card reader placed behind the car's windscreen, or by collection of car keys from a special safe located at the car park. To gain access to a car, the user has to (depending on the situation):

- hold the card over the reader embedded in the safe and enter their PIN – the computer verifies reservation data and gives access to the keys,
- or hold the card over the reader placed behind the windscreen – after the on-board computer verifies the reservation data, it opens the door; the keys are inside the vehicle in a special compartment and are available after entering the PIN.

In order to return the vehicle, the user needs to (depending on the option):

- lock the car and place the keys in the safe – the safe computer automatically sends information about the journey to the central computer,
- or leave the keys in a special safe – the on-board computer processes travel data and sends them to the central computer – and lock the car using the card.

In both cases, the central computer generates the bill, which is sent to the users once a month. Most operators charge customers based on the following elements: time of use and/or mileage, subscription, registration fee, security deposit, extra charges, for instance for a delayed return, parking in an incorrect spot etc. The operators provide vehicles of different makes, sizes and parameters to meet the client’s needs (small urban cars, convertibles, minivans, vans etc.). Vehicles often run on traditional fuels (gasoline, diesel), but many systems offer electric or hybrid cars. The number of vehicles and car parks differs from one operator to another. For instance, Bremen Cambio offers 200 cars and over 50 stations, whereas Paris Autolib', based solely on electric cars, has 3,000 cars and 4,000 charging/collection points [9]. On average, there are 1.92 vehicles per carsharing station, and 1.31 per station in case of smaller operators owning up to 20 vehicles.
Studies show [15], that the system is mostly used for shopping or reaching several destinations within a single day, but also for business or recreational trips. Carsharing is beneficial for companies thanks to the reduction in maintenance and parking costs, the flexibility of the service arising from the easy reservation mode and the possibility of use of different types of vehicles. Business clients are characterised by a higher demand on travel during the day – consequently the operational effectiveness of a car rises to 45% [6]. Using the service leads to a reduction in the amount of owned cars – according to the data provided by Cambio - one carsharing vehicle may replace approximately 4 to 10 private vehicles (which results in a car travel mileage drop of 7 million kilometres) [3]. In Australia, a single GoGet car helps to replace 9 private vehicles and is on average shared by 23 customers [11]. A research on City CarShare users in Berkley carried out by the University of California shows that 30% of participating households sold their car while the others delayed the purchase of a new vehicle [8]. The system user is able to reduce the carbon footprint by 290kg of CO$_2$ annually in comparison to a car owner, also because of a higher public transport use frequency [12]. In Bremen, the Cambio system contributes to the drop in CO$_2$ emissions amounting to 1900 t annually [5].

**Conclusions**

Cities and metropolises embodying the “smart city” concept, and “smart mobility” as its element, encourage residents to change their lifestyles and modify transport behaviours towards more ecologic by providing proper infrastructure, increasing the quality of services, integrating transport systems and offering new forms of mobility. One of the characteristics of this process would be the use of latest technological advances in IT and technical innovations. Both of the solutions described in the paper are well-inked in this particular approach. Their implementation leads to the reduction in private car use in favour of more eco-
friendly means of transport and better accessibility. City dwellers have access to a wider array of transport modes, and thanks to their flexible organisation, they use them according to their needs. Simple reservation system and mode of operation is possible thanks to the implementation of IT technologies and other technological innovations.

Since September 2013, the Department of Transport Networks at Cracow University of Technology has been a partner in a project co-funded from the funds of the European Union initiative CIVITAS CAPITAL, whose aim is to promote good practices in the scope of innovative solutions for public transport, including actions presented in the article, developed within the CIVITAS initiative. A network of CIVITAS cities is being developed in Poland (CIVINET Poland) – a network of centres implementing CIVITAS projects and ready to share their experience and cities willing to take advantage of this experience. CIVINET is a platform for sharing information; it provides opportunities to participate in workshops and meetings not only with Polish, but also experts from other European countries. Furthermore, Polish network of CIVITAS cities is designed to popularise any and all efficient or innovative action assisting cities in attaining a sustainable system of transport.

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Abstract

The article presents “smart mobility” guidelines and examples of innovative transport solutions materialising the approach - Demand Responsive Transit Service and carsharing. Implementing the presented services in urban areas results in the reduction of private car use in favour of environmentally friendly means of transport and improved transport accessibility. City residents gain access to a wider array of means of transport, and are able to use them according to their needs, thanks to the flexible model of organisation. The simple system of reservation and operation is possible thanks to implementation of IT systems and technological innovations, which are simultaneously the markers of „smart mobility”.

Przykłady innowacyjnych rozwiązań transportowych spełniających postulaty koncepcji „smart mobility”

Streszczenie

Artykuł prezentuje założenia koncepcji „smart mobility” oraz przykłady innowacyjnych rozwiązań transportowych urzeczywistniających to podejście – przewozy autobusowe na żądanie oraz system carsharing. Wdrażanie zaprezentowanych usług w obszarach miejskich prowadzi do ograniczania
użytkowania samochodów prywatnych na rzecz środków bardziej przyjaznych środowisku oraz do poprawy dostępności transportowej. Mieszkańcy miast mają dostęp do zwiększonego wachlarza środków lokomocji, a dzięki możliwości elastycznej ich organizacji, korzystają z nich w zależności od zapotrzebowania. Łatwość rezerwacji usług i użytkowania zapewniona jest dzięki zastosowaniu techniki informacyjnych i innowacji technologicznych, będących jednocześnie jednymi z wyznaczników „smart mobility”.

References


