



## OPTIMISATION OF TRANSPORT PROCESSES IN CITY LOGISTICS

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**ABSTRACT.** The problem of the rationalization of the flow of people and goods in urban areas is discussed in the presented paper. Due to the increasing traffic congestion, this is one of the most important problems of the effective city management, especially in line with the principles of the sustainable development. The paper presents local conditionings for urban agglomeration of Poznań, with particular attention paid to difficulties of the distribution of goods in urban areas. The available sources for obtaining the good practice for local authorities are presented, e.g. European projects like SUGAR Project (Sustainable Urban Goods Logistics Achieved by Regional and local policies).

**Key words:** city management, city logistics, sustainable development, distribution of goods in urban areas, flows of people and goods, road infrastructure in cities, SUGAR project.

### INTRODUCTION

The condition of the effective city management by authorities is the very good knowledge of the specific issues connected with city logistics. For they are activities that require such connecting, channelling and controlling of flows of goods and services, necessary for the supply, cleaning and internal functional efficiency of the city, which causes the littlest loss of time and the limitation of the useless transportation of resources as well as the limitation of the emergence of bottlenecks and the congestion. The internally consistent (through good management) logistic system of city areas is such an arrangement, where the management processes of flows of people, goods and information are realized in accordance with principles of the sustainable development [Pawlak 2007] and fulfil the expectations of users of cities on an agreed level.

The following functional subsystems can be recognized within this system [Awasthi, Proth, 2006]:

- control of flows of goods and persons,
- collective and individual communication,
- storage of goods,
- transport of goods as well as media transmission,
- transport and storage of urban wastes.

The public administration acts as one of the main participants or coordinators in each of above-mentioned subsystems and realizes its functions through many institutions and offices. Additionally, the city logistics is a part of the economic policy of every country [Taniguchi, Thompson, 2001].

The issues connected with the proper functioning of the city, the spatial concentration or deconcentration is also related to the spatial planning and the transport planning. The transport is one of basic factors determining the level of the economical development, which is also reflected in the theory of the regional development [Domańska, 2006]. An efficient transport system should be adjusted to the size, nature and spatial diversity of transport requirements in the discussed area and at the same time should be able to fulfil and connect all functions of the city [Tundys, 2008].

The aim of this paper is to diagnose the spatial transport problems of urban areas (based on the agglomeration of Poznan) to propose new solutions, which take into account a wide range of spatial, economic, environmental and logistical determinants.

The paper is of a theoretical and descriptive nature. The most recent specialist literature as well as the own knowledge and practical experiences of the authors were used in the process of the preparation of this paper. The method of the word description, expanded by the formalized mathematical expressions and graphic illustrations of communication routes of the urban agglomeration of Poznan was applied.

## **LOGISTIC RATIONALITY OF THE SUSTAINABLE DEVELOPMENT OF THE CITY**

Each city is a concentration of the human population, environmental resources, different types of anthropogenic creations (including wastes and pollutants), economical operators and the whole range of social behaviours (from congestions up to crimes). The energetic, material, informational and financial flows connect and bind all these factors and create the systems of the logistic nature. They exist and develop always in a neighbourhood, which consists of different objects outside of this system, but having influence on this system and are influenced by it as well. These surroundings consist of collections of objects and relationships among them as well as their properties of economical and technical (infrastructure), social (level of awareness and incomes of inhabitants of urban areas) and ecological (environmental) nature [Pawlak, 2004].

The indicators of the sustainable development of cities, based on the American experiences and adaptations of the World Bank [World Bank, 1994] in the area of transport activities are focused on:

- Reduction of the use of a car per inhabitant,
- Increasing the loading share of the transport unit,
- Increasing the relative average speed of cars,
- Increasing the length of the separated bike paths.

The concentration of transport activities in urban areas (both freight and passengers' ones) causes the strong impact on the life conditions of the inhabitants as well as on functioning of the whole social-economic sphere. Approaching the rational policy of the sustainable development of urban areas, there is often a need for an indicator, which will allow to give some hints how to plan further activities e.g. logistic ones (which are based in big extend on the transport activities). There are a few most typical ones; among them so called the ecological footprint is one of the most often used. It is defined as an area required to satisfy the living needs of one person, the whole group or even the whole city. In terms of logistics of the city agglomeration [Estevan, Sanz, 1996] it allows, for example, to analyze the dimension of the supply of goods to the population. The equation used to calculate the annual ecological footprint for the urban mobility, required in this approach, looks like the following one in these conditions:

$$EF_i = \sum [ [ \sum EC_z EL_z D_{ij} Trip_{ij,z} ] + L_z ]$$

where:

$EF_i$  - the annual ecological footprint made by  $i$  means of transport

$EC_z$  - the energy consumed by the mean of transport  $z$  per km (GJ / km). Energy consumption ( $EC_z$ ) is the energy balance of the whole transport cycle, calculated based on data concerning the energy consumption, manufactured transport units and the level of fulfillment of the loading unit.

$El_z$  - the area of ecological land per GJ of energy of mean of the transport  $z$  (ha / GJ)

$D_{ij}$  - the net distance between the locations  $i$  and  $j$

$Trip_{ij,z}$  - the number of rides carried out during the year between the locations  $i$  and  $j$  using the mean of transport  $z$

$L_z$  - the area of the land equivalent to the space occupied by the infrastructure of the mean of transport  $z$ .

Based on the conducted experiments and the calculations of the ecological footprint of urban areas in various European cities such as Barcelona, the constant (in practice) increase of its value is observed and this means that, there is an increase of the load of the natural environment as a result of the impact of freight transport activities. It can be presumed, that this is clearly resulted from a positive correlation between the increase of the supply of goods and an increase of the wealth of populations living in European cities.

This trend has undoubtedly increased substantially the transport congestion in recent years, causing the increase of the value of the ecological footprint (one of the Authors of this paper (Zbyszko Pawlak) is occupied with wider researches in different polish cities. The results will be presented in the separate paper). Its constantly growing levels are probably connected also with the increase of the frequency of the use of delivery cars and the elongation of transport distances. It is also undoubtedly caused by the changes in the residential structure of the urban areas in the processes of the suburbanization and at the same time in the processes of the allocation of industrial and services investments.

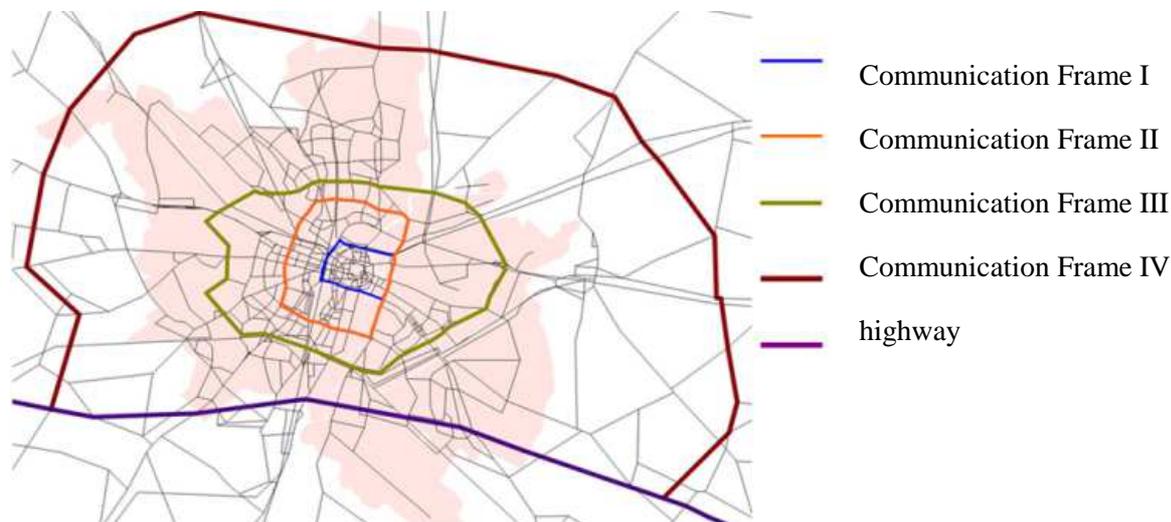
## **REASONS OF PROBLEMS CONNECTED WITH TRANSPORT STREAMS IN THE AGGLOMERATION OF POZNAN**

Poznan is located on the axis of the cities of Berlin - Warsaw - Moscow, within the second Pan-European Transport Corridor linking Western and Eastern Europe. It is an important node connecting the key roads of international and domestic importance, and therefore is defined as a transit city.

The city of Poznan, together with adjacent areas, creates an agglomeration of a total population of approximately 850 000. In recent years, the trend of suburbanization can be observed. Due to that, the quantity of inhabitants of Poznan decreases and at the same time, the quantity of inhabitants of adjacent surroundings of the city increases. Therefore, the city authorities meet new requirements to organize the smooth transfer of people between their home and the place of a work, education, etc. The very important and still underestimated growing problem is associated with the efficient handling of the transport of goods needed to fulfil the needs of the city as well the efficient distribution of goods produced by companies located in this area. To meet these requirements, the new infrastructure investments are now performed or planned for the realization in the near future. Among others, this concerns the road network system, which is currently being developed as a framework layout of the main streets.

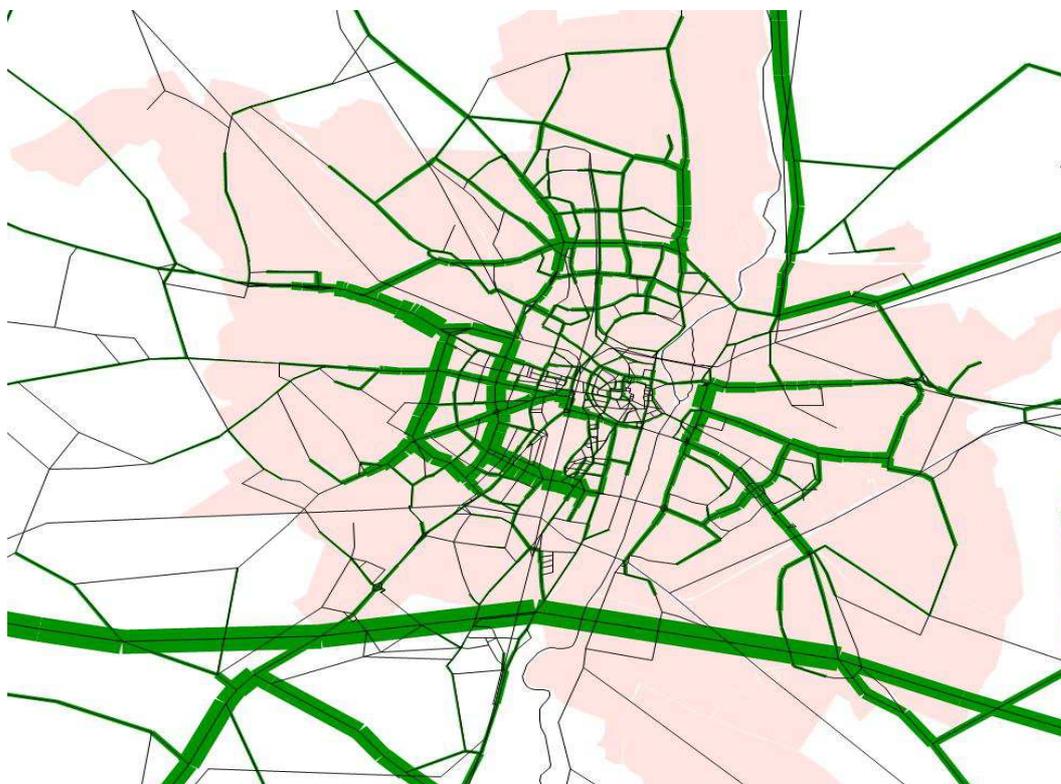
At present, the most occupied parts of the communication system of the city of Poznan are the highway, the south-west and east part of the Communication Frame II, the south-west part of the Communication Frame I, Bukowska and Grunwaldzka streets. These streets are the connections between the west part of the city and Communication Frames I and II (Fig. 1).

The biggest problems in the smooth motion of vehicles mainly concern the streets of the city (Fig. 2) located inside the Communication Frames I and II (the strict centre of the city). Since they have a huge impact on the urban distribution of goods in Poznan, the examples of these obstructions and methods how the city of Poznan tries to overcome the current communication problems are described in this paper.



Source: Administration of the City of Poznan

Fig. 1. Proposed target communication framework of Poznan  
Rys. 1. Propozycja docelowego układu ram komunikacyjnych Poznania



Source: Administration of the City of Poznan

Fig. 2. The load of road network by the delivery transport  
Rys. 2. Obciążenie sieci drogowej ruchem transportu ciężarowego i dostawczego

The fulfillment of the transport needs of the city is one of the most difficult problems. The reason of such a situation is the lack of the consistency between the spatial structure of the city and the transport systems existing and functioning inside this city. The logistics can be very helpful in this situation by the implementation of the suggestions for new localizations of those elements of logistic infrastructure of the city, which influence mostly the inadequacy of above-mentioned structures [Szoltysek, 2007].

The modern city logistics introduces the reduction of the transport motion inside the strict city centre by the use of integrated systems of the transport management. It forces to look for new solutions for the use of the means of transport, which are included in such a system of the transport management in the cities [Lewandowski, 2002].

Currently the most burdensome elements of the process of the distribution of goods in Poznan are loading and unloading operations carried out mainly for small shops, which are located in the centre of the city. It is connected with the specific character of the narrow streets in the historic part of the city and the lack of unloading bays arranged along the main streets having the high traffic load. The carried out loading and unloading operations contribute to the difficulties of both pedestrian and vehicles traffic.

The main transportation problems of Poznan are:

- excessive traffic in relation to the capacity of the road infrastructure, causing the blocking of the transportation system,
- transit freight transport inside the city,
- big amount of transports associated with deliveries to residents and companies located within the city,
- lack of parking places in the centre of the city,
- high emission of fumes generated by the means of transport,
- high level of noise caused by means of transport,
- devastation of city roads by means of transport.

In order to solve these problems, the city authorities introduced a limited-entry zone for lorries, except for delivery cars carrying the supplies to the clients located in the centre of the city. Additionally, the special so called time-windows were been set on some streets during which the delivery trucks can park and unload the goods. However, the introduced limitations did not solve completely the still existing problem, due to the fact, that drivers commonly break the traffic regulations. Furthermore, there is an additional problem with the enforcement of existing traffic rules and consequently the cars, left on the roadway, block the traffic of vehicles and the trams as well as the cars, parking on pavement, block the pedestrian traffic. Moreover, it can be observed quite often how the providers, carrying the boxes of goods, go among the parked vehicles.

One of the reasons of the existing situation is the fact that, several suppliers, which are not coordinated in any way, realize the deliveries to a single shop. Therefore, the location of the shops belonging only to stores chains in the centre of the city would be the better solution, because such chains usually have their own distribution network, based on consolidation centres located in the outskirts of the city. Deliveries are carried out in a coordinated way taking into consideration the minimization of transportation costs and thus the minimizing the quantity of vehicles on roads.

The city logistics is a way of thinking, operating in the field of competing requirements against limited resources of the urban area. Taking into account this assumption, it is necessary to extract the transport problems in a limited urban space. It leads to the considerations related to issues of the optimization of the flow of means of the transport in the existing communication infrastructure of the city. This task demands careful studies on reasons of the congestion in the city area as a whole and also in separated parts of the city. The important feature of the centre of the city is the congestion created due to the no-optimized system of streets and a big street traffic, both having a journey target

in the centre of the city and a transit one. This causes significant problems in the process of the supplying the customers located both in the centre of city as well as in its outskirts. This problem requires the relocation of the transit traffic out of the centre of the city.

Therefore, in order to reduce the delivery traffic in the centre of the city of Poznan, it is purposeful to create a consolidation centre for the city, from which the goods could be delivered by the use of e.g. the freight trams. The goods from different suppliers could be stored in such a city consolidation centre. At present, such solutions are used successfully in some European cities, e.g. in Dresden. The biggest disadvantages of such solutions are the high investment costs associated with the construction of the needed infrastructure, while the advantages are low operating costs and the reduction of the traffic of big trucks in the city centre.

Another problem faced by the local authorities is the lack of the logistic centre, where the goods for the agglomeration of Poznan could be stored. The existing large warehouse centres around Poznan are built only by private investments and therefore the local authorities have no big influence on the coordination of the flows of the goods within them.

The advantage of the coordination of the flows of goods, being handled by the use of the logistics centres as the nodal points, is the possibility to transfer a significant part of their volume by the use of the alternative means of the transport, such as the combined transport. In the case of the city of Poznan, there is a great potential in the area of the railway infrastructure. The transfer of the transport of goods conducted now by the use of the road transport to the railway transport could reduce significantly the quantity of cars entering the centre of the city.

The use of packing automates in the distribution process is another method to reduce a quantity of delivery cars in the centre of the city. At present, one of the courier company operated in Poznan, offers such a service, where the shipments are delivered by the individual clients to these packing automates, from which they are taken once a day. This way of organizing the collection of courier shipments eliminates the unnecessary entrances of courier cars to the centre of the city, parking in the illegal places and therefore blocking the road and the pedestrian traffic.

This short description of the complications associated with the distribution of goods in urban areas shows, that occurring problems are not easy not only to be solved but also to be identified and parameterized. The local plans of activities in this area should be based on real and detailed data concerning the transport of goods in the city area. At present, the local authorities do not possess such data.

## **DIRECTIONS FOR THE IMPROVEMENT OF TRANSPORT SERVICES OF POZNAN IN TERMS OF SUGAR PROJECT**

In Europe, the professionals focus their attention on the city logistics, recognizing its huge influence on the management of the entire traffic in the cities. Realizing how important the city logistics is, Regione Emilia Romana and Fondazione Istituto sui Trasporti e la Logistica (ITL) already in 2007 year started to work on SUGAR project (Sustainable Urban Goods logistics Achieved by Regional and local policies). In 2009, the SUGAR project was successfully incorporated into the subsidized EU project INTERREG 4C, which is scheduled to the end of February 2012.

The main objective of the SUGAR project is to analyze the causes of the inefficient and ineffective management of freight transport in the city, which still affects the city distribution of goods in most European cities. SUGAR project promotes the exchange, the discussion and the transfer of experiences and good practices among the Cities of Good Practice (Bologna, London, Paris, Barcelona) and the Transfer Cities (Poznan, Palma de Mallorca, Crete, Athens, Vratsa, Celje, Usti at Laba), by providing the update of policies and the development of planning of the management of the city transport of goods. Therefore, the identification of good practices within the project SUGAR plays a key role in supporting the planning of the regional policies. The exchange of the knowledge connected with the good practices, acts as a lever to stimulate the development of local activities plans concerning the city logistics.

One of the main objectives of SUGAR project is to initiate and facilitate the development of such plans. It is also the reason, that the creators of these policies are the first beneficiaries as well as the target group of SUGAR project.

Poznan plays a transfer part in the SUGAR project that means it takes over the knowledge of good practices in the management of the transport of goods in the cities, which is already used successfully for years in other agglomerations of European Union and outside it. The task of Poznan city is to develop the action plan aimed at reducing the negative effects of the delivery traffic in the city.

In accordance with the Transport Policy of the City of Poznan, adopted by the City Council still in 1999, the city authorities should decide for the solutions, which reduce the difficulties for inhabitants caused by the transport and improve its efficiency, and thereby aiming to achieve a sustainable transport system in economic, spatial, ecological and social terms. The transportation of goods is one of the elements of the Transport Policy, which sets some goals and directions of the development, such as the release of the residential areas from the traffic caused by the transport of the goods.

Therefore, by the participation in the SUGAR project, the city of Poznan plans to develop the action plan for improving the efficiency of the transport of goods in the city. This plan will be submitted for the approval by the City Council and will be the fifth consecutive program, which details the points of the Transport Policy. The four previous ones are:

- Sustainable Development Program for Public Transport,
- Road Program,
- Parking Policy,
- Bicycle Program.

## **COCNLUSIONS**

The expectations of the rationality of the analyzed solutions (also in the aspect of the sustainable development of the city) will be met only under condition that there will be a linear access (by road) to this area of the city, which is particularly exposed to the intensity of the transport activities. In addition, the efficient use of ring roads and the communication framework should lead to the time savings comparing to the use of traditional presently available network of streets. The communication rings should be connected by short radial sections of city roads, which will form the nodes allowing the efficient access to the centre of the city.

The SUGAR project is the first project of the exchange of the experiences in the area of the transport of goods, in which the Office of City of Poznan participates as a partner (this office manages the logistics of the city). The cooperation within this project should help to find effective solutions to existing transport problems of the city. This is particularly important from the perspective of the challenges, which the city agglomeration of Poznan will face, including the organization of EURO 2012.

## **REFERENCES**

- Awasthi A., Proth J.M., 2006, A systems-based approach for city logistics decision making, *Journal of Advances in Management Research* , vol. 3/2.
- Domańska A., 2006, *Wpływ infrastruktury transportu drogowego na rozwój regionalny*, PWN, Warszawa, s. 21.
- Estevan A., Sanz A., 1996, *Hacia la reconversion ecologica del transporte en Espana*, Libros de la Catarata, Madrid, s.23
- Lewandowski K., 2002, *Użycie tramwaju towarowego w logistyce miejskiej*, *Logistyka* nr 6/2002.

- Pawlak Z., 2004, Ekologiczne uwarunkowania spójności systemów logistyki miejskiej, w: Logistyka a infrastruktura miejska, red. Nowakowski T., Wydawnictwo CiL, Wrocław, s.85
- Pawlak Z., 2007, Factors Determining the Management of the Traffic Congestion in the Urban Area, LogForum, vol.3/4/3.
- Taniguchi E., Thompson R. G., 2001, City Logistics, Pergamon Press, s.186.
- Tundys B., 2008, Logistyka miejska - koncepcje, systemy, rozwiązania, Wyd. Difin, Warszawa, s. 116.
- Szołtysek J., 2007, Podstawy logistyki miejskiej. Wydawnictwo Akademii Ekonomicznej w Katowicach, Katowice, s. 93.
- World Bank, 1994, World Development Report 1994, Oxford University Press, New York, s. 46.

## RACJONALIZACJA PROCESÓW TRANSPORTOWYCH W LOGISTYCE MIEJSKIEJ

**STRESZCZENIE.** Artykuł obejmuje treściowo problematykę racjonalizacji przepływów osób i towarów w obszarach aglomeracji miejskich. W warunkach wzrastającej kongestii ruchu drogowego stanowi to jeden z ważniejszych problemów efektywnego zarządzania miastami, zgodnego zwłaszcza z zasadami zrównoważonego rozwoju. W poszczególnych częściach artykułu przedstawiono lokalne uwarunkowania logistyczne dla aglomeracji miejskiej Poznania, ze szczególnym uwzględnieniem utrudnień związanych z miejską dystrybucją towarów. Ponadto wskazano na możliwe źródła pozyskania dobrych praktyk dla władz lokalnych, jakimi są m.in. projekty europejskie, np. projekt SUGAR. (Sustainable Urban Goods logistics Achieved by Regional and local policies).

**Słowa kluczowe:** zarządzanie miastem, logistyka miejska, rozwój zrównoważony, miejska dystrybucja towarów, przepływy osób i ładunków, infrastruktura drogowa miast, projekt SUGAR.

## OPTIMIERUNG VON TRANSPORTPROZESSEN IN DER STÄDTISCHEN LOGISTIK

**ZUSAMMENFASSUNG.** Das Problem der Rationalisierung des Flusses von Menschen und Gütern in städtischen Gebieten ist in den vorgestellten Artikeln diskutiert. In den Bedingungen von der steigenden Verkehrsstockung ist das eines der wichtigen Probleme der effektiven Stadtverwaltung, die im Einklang mit den Grundsätzen der guten Praxis ist. Der Artikel präsentiert die heimischen logistischen Anforderungen für die städtische Agglomeration von Posen, mit besonderem Augenmerk auf Schwierigkeiten der Verteilung von Gütern in städtischen Gebieten. Zusätzlich, die mögliche Quelle des Gewinn von guten Praxis wurden vorgestellt, z.B. Europäischen Projekten wie SUGAR Projekt.

**Codewörter:** Stadtverwaltung, städtische Logistik, nachhaltige Entwicklung, Verteilung von Gütern in städtischen Gebieten, Flüsse von Menschen und Gütern, die Straßeninfrastruktur in den Städten, SUGAR Projekt.

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