CITY LOGISTICS PERFORMANCE

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Abstract: *Problem identification, modeling, planning and management of the city logistics solutions requires knowledge about the parameters of logistic flows and systems, generators and logistics demands of the urban environment, i.e. the environment in which requirements are being realized. By combining the parameters, city logistics performances are being obtained. A set of performances and the way of their identification are not standardized, while the permanent monitoring of some part of the parameters is in fact an exception present in certain cities. Performances are analyzed and defined at the different levels of research, while being in line with the basic objectives and scope of the research. In this paper, the most commonly quantified parameters and performances of city logistics are presented. The necessary parameters are collected and processed in different ways so their reliability and comparability are questionable.*

Keywords*: city logistics, performance, research, reliability.*

1. INTRODUCTION

Problem identification, modeling, planning and management of the city logistics (CL) requires a large number of parameters that describe the logistical flows and systems which enable their implementation, as well as the parameters of the logistics demands generators and the urban environment, i.e. the environment in which the requirements are being realized. By combining the parameters, CL performances are being obtained (Tadić, 2014). Considering that logistical flows depend on the parameters of the urban environment (infrastructure conditions, economic structure, etc.), and that their implementation affects the parameters of the urban areas (traffic congestion, accessibility, air pollution, etc.), in addition to their establishment, continuous monitoring and updating of parameters of the surrounding and performances of the city logistics is necessary. However, a set of the CL parameters and performances that need to be monitored, as well as the way of their determination, are not standardized. Performances are being defined according to the specific research objectives, after which the necessary parameters are being collected, processed, analyzed and quantified. A comprehensive study of the logistics, in terms of space, activities, types of goods flows, activities and processes and participants, is a concept that has not been implemented in any study of a certain city in the world. The main reasons are the extremely high complexity and the lack of understanding of the problem, but also the different goals and interests of direct and indirect participants of the CL. The paper presents a set of the most commonly used city logistics performances, as well as the methods for their determination.

2. IMPORTANCE OF THE CITY LOGISTICS PERFORMANCE

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Identifying CL problems requires knowledge on the characteristics of logistics, goods and traffic flows, as well as the systems which enable their realization. The volume of flows is directly related to the size of the city. However, in addition to the consumer goods, it is also necessary to examine the flows of the intermediate raw materials, construction materials and different types of cargo. On the other hand, the volume of flows largely depend on the geographic and physical characteristics, spatial organization of the urban functions, logistics infrastructure and the role of the observed zone in the realization of cargo flows on a higher level (Tadić et al., 2015).

Due to the lack of research and constant monitoring of the CL performances, urban authorities and planners do not have a clear and complete picture of the logistics activities and processes. On the other hand, without the knowledge of the current situation, and without the identification and quantification of the CL performances and problems, it is not possible to search for the effective solutions (Figure 1).

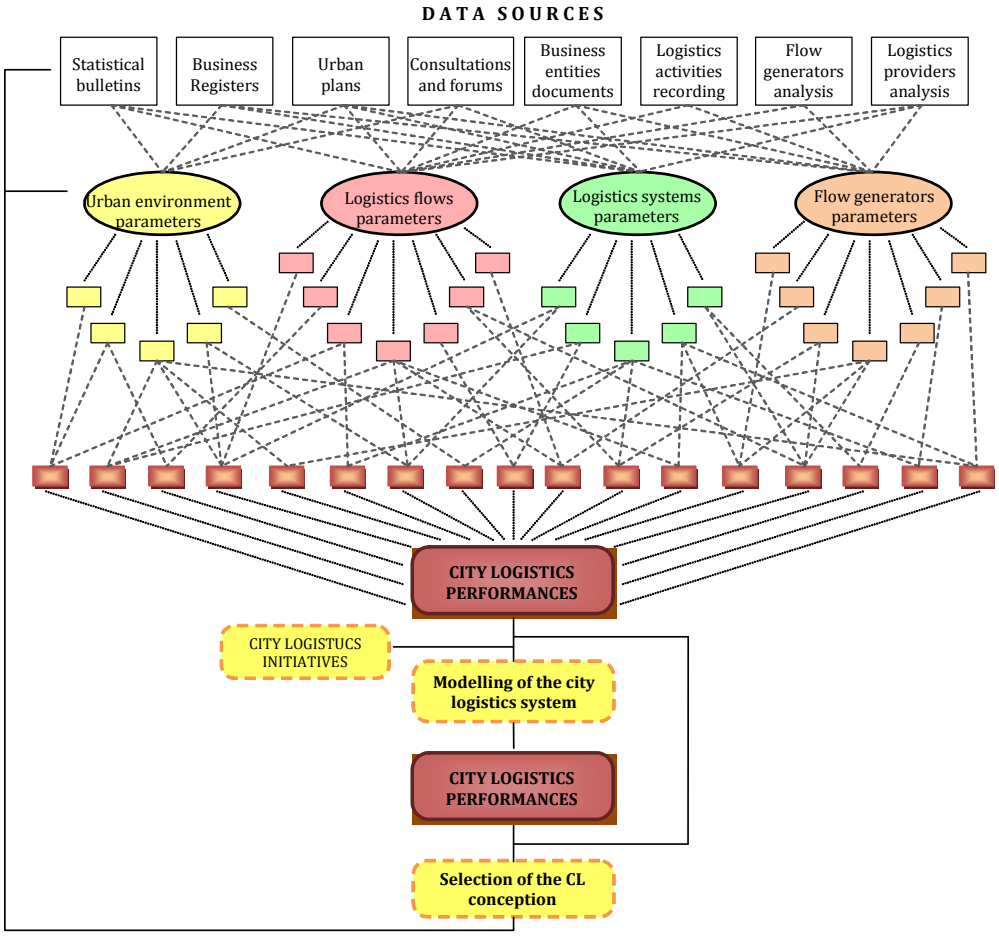

Figure 1. Determination of the city logistics performances and their importance (Tadić, 2014)

The parameters are being obtained using the different data sources, such as local and national statistical bulletins, transport statistics, business registries, urban plans, vehicle diaries and waybills, discussion forums, consultations with local governments and lawmakers. However, most of the information is being obtained by a dedicated research of the logistics activities (recording of the loading/unloading zones, GPS vehicle tracking, etc.) and participants of the CL (generators and logistics providers). By combining the parameters, the performances that describe the state of the CL are being obtained. Performances may be used for identifying the problems and modeling of the flows and CL system. On the other hand, the success of the initiatives, measures and concepts of the CL is determined by comparing the performance efficiency and the sustainability of the system before and after its implementation. Application of

the certain CL initiatives and concepts requires the change of the urban plans, infrastructure systems, legal regulations, price policy, traffic organization and other elements that represent data sources; it changes the parameters of the urban environment, attributes of the flow generators and parameters of the logistics flows and systems, i.e. CL performances (Figure 1). The lack of monitoring of the CL performances is more or less present in all the cities. The exceptions are the statistical data on freight traffic in the cities, but they are also relatively useless. Statistics only keep the records on the trips of the registered carriers, and only for the vehicles with the gross capacity of over 3.5 tones, while light commercial vehicles (less of 3.5 t) have the most significant growth in the number of vehicle-km in the city (Browne et al., 2007) and make up the largest part of the cargo vehicles, usually over 80% (DfT, 2012). In addition, the research does not include shopping trips, which in the large European cities make up between 45 and 55% of the urban goods movement (Gonzalez-Feliu et al., 2012) and can participate with 15-20% of the total vehicle-km (Dablanc, 2009) .

2.1 The parameters of the urban environment

The parameters of the urban environment include spatial, demographic and economic characteristics of the city and they are generally publicly available. The main sources are the publication of the public bodies at the local and national levels (statistical bulletins, urban plans, commercial registers, etc.). For the analysis of the CL performances the most important parameters are: size, population, family size, age structure, economic structure, number of employees, service price, taxes and the number of jobs. These parameters are determined for the whole city and the urban zones and have a great importance for the assessment and modeling of the CL flows and systems (Tadić, 2014). Logistics activities in the city largely depend on the characteristics of the traffic network: categories of roads, dedicated lanes, organization and regulation of the movement, taxi stands, location, organization and parking capacity, etc. These parameters affect the structure of the vehicle in the realization of the commodity flows, the intensity of commercial vehicles and traffic burdening, delivery vehicles' route planning, duration of the loading-unloading operations, operating costs of the carriers, service providers and others.

2.2 The parameters of the logistics system

Most of the flows that start or end in the city are realized through the various logistics systems. In order to determine the performances and conceptual modeling solutions of the CL, one needs to know their number and structure, purpose (type of goods), ownership, size, location, capacity, transshipment volume, the available modes of transport, but also the technologies of the logistics subsystems for storage, transshipment and transport of the incoming and outgoing goods flows (Tadić, 2014). Parameters of the logistics systems, especially those that are the part of the public infrastructure, are generally available and could be found in the planning documents, reports and publications of the city administration. However, determining the parameters of the private systems requires research and consultation with the owner.

2.3 The parameters of the logistics demands generators

The generator, i.e. the facility that requires the delivery and/or the collection of goods, may be seen as an entity with the attributes (parameters) which describe it. The parameters differ according to the economic sector, but also within the same industry. The most commonly used parameters of the generators are (Zečević & Tadić, 2006): business activity, size, ownership and location, the structure of the goods in the incoming and outgoing flows, used systems of ordering and supplying, the size of the storage area in the facility, the time of receiving and dispatching the goods, size and frequency of deliveries and shipments, the stopping places for the vehicles performing the operations of loading/unloading of goods, types of vehicles performing delivery

etc. In most cities, only some of these parameters are being recorded (e.g. location, ownership, business category, total surface area), while the largest number of the attributes are being obtained in the one-off researches, mostly through the interviews with the employees and by recording the loading/unloading operations (Tadić, 2014).

2.4 The parameters of the logistics flows

At the national level, the basic parameters of the commodity and transport flows are being monitored (volume and structure of the goods and transport flows, transport work). In certain countries, some other parameters, such as (Browne & Allen, 2006): transport intensity, traffic intensity, energy consumption; average transport distance; loading factor; number of empty runs etc. are being determined. However, none of these parameters is being determined exclusively for the urban freight transport, and the cases in which some of them are being studied apart from the national researches are rare. This is likely the result of the weak understanding of the CL importance at all administration levels. The most important parameters of the logistic flows are: type of vehicle, number of trips, time of realization, tour duration, number of requests per tour, trip duration, dwell time in front of the object, the length of the route, the distance traveled by the vehicle, the vehicles' operation system, type of goods, fuel consumption etc. (Tadić, 2014). Parameters are being determined for all flow categories (supply, recycling materials and service activities) and require extensive research (recording of the logistics operations, driving logs and waybills analysis, survey of the participants of the cargo flows - logistics providers, carriers and drivers, etc.). Due to the lack of continuous monitoring of goods and traffic flows in the city, the models that enable the obtaining of the part of the logistics flows parameters on the basis of the one-off researches are developed.

3. BASIC CITY LOGISTICS PERFORMANCE

CL performances describe the logistics activities and processes and enable the identification of the problems and the quantification of the specific measures and initiatives application effects, and they are being defined in accordance with the objectives of the specific researches. Their analysis, while defining the spatial, urban and development plans, can improve the sustainability of logistics and the urban environment. Generators structure and the number of vehicle launch requirements are the parameters that directly affect the number, capacity and location of the infrastructure systems for loading/unloading of the commercial vehicles. It is often wrongly assumed that the large retail chains are the largest generators of the freight traffic. However, they generally use a centralized system of supplying, bigger freight vehicles and have a predefined dynamics and delivery times. On the other hand, small shops and specialized stores may be responsible for a significant part of the activities of freight vehicles, mainly vans. In order to plan the logistics activities and the CL concepts, but also to define the urban plans (spatial, traffic), it is necessary to know various CL performances, some of which are:

The delivery frequency differs from city to city, between the economic sectors, but also within the same industry. At the city level, it depends on the economic structure, economic development, market conditions, share of the informal sector, share of the large retail chains, presence of the logistics providers, users' behavior, time of the year, policies and regulations of the local government etc.

The delivery time is an important parameter for the planning activities of the shipper and receiver of goods, as well as for the logistics providers, i.e. the carriers. It depends on regulations that define the access for the delivery vehicles (intervals of the restricted movement of the certain categories of vehicles, restrictions related to the stopping and loading/unloading of the vehicles, etc.); deliveries of the time-sensitive goods which loses its value after a certain time (daily newspapers, fresh dairy and bakery products, etc.), as well as the time intervals in which the facility can receive goods (during the working hours and off-hours). Suppliers (shippers) and

carriers (logistics providers) have the greatest influence on the delivery time, while a substantial part of the recipients has no effect on the time of receiving the goods (Cherrett et al., 2012).

The structure of the delivery vehicles depends on the business category, the supplying system, requirements for goods, delivery frequency, infrastructural constraints, regulations that define conditions of access etc. In the centralized supply system, the deliveries are mainly realized by the different vehicle categories, while in the decentralized they are mainly realized by vans. Passenger cars dominate in supplying the facilities of the informal sector.

The return loading of the delivery vehicles shows the frequency of the recollection of the goods from the facility (reusable packaging, defected goods or the date expiring goods, goods for the resupply in some other facilities) to the distribution center, suppliers' depot or some other facility in the route. Using the delivery vehicles for realization of the reverse flows, transport efficiency is increasing, the number of vehicles and vehicle-km is reducing,, as well as the negative impacts on the environment. However, a small part of the delivery vehicles regularly realize the reverse flows, while almost half of the generators do not use the services of reverse logistics by the provider that realizes the deliveries (Cherrett et al., 2012).

The dwell time of the delivery vehicles affects the deliveries coordination, vehicle routing, planning and better use of loading/unloading zones or street parking places. Researches show that the average time spent at the place of unloading the vehicle depends on the vehicle category (longer for larger vehicles) and service provider (longer in insourcing strategy). Researches show that there is not a strong correlation between the average dwell time of the delivery vehicle and the size of the facility, i.e. the supply system (Cherrett et al., 2012).

The place of unloading activities depends on the urban area. In areas with large shopping centers (mainly peripheral zones) delivery vehicles mainly stop on the reserved off-street parking spaces, while in the central, shopping streets, they stop on the street. Place and time of the vehicle stopping, for the loading and unloading operations at the facility, are affected by the type and form of the goods. Some goods require the use of special vehicles or special reloading equipment, so the vehicles are stopping as close as possible to the facility.

The number of deliveries per tour depends on the logistics provider, carrier, delivery sizes, the required delivery time, supply system etc. By applying the system of handling the multiple facilities in a single tour, the vehicles are traveling longer distances because they do not use the shortest routes to each facility, but on the other hand the number of trips is significantly smaller than in the system of the direct delivery. In practice, the number of vehicle-km is usually minimized by the use of the direct delivery and smaller vehicles. However, the direct delivery is often not acceptable for several reasons: a small amount of goods, long distances, etc.

The frequency of service visits to the facility depends on the business category and type of the service. Service flows can have a significant impact on the total number of commercial trips. On average, the frequency of the service visits to the facilities is 7.6 on a weekly basis (Cherrett et al., 2012). The highest frequencies have mail deliveries and waste collections, while others are not that often (maintenance of computer equipment, copier devices, elevators and escalators, etc.).

Vehicle types used for service visits and dwell times indicate that these activities may be responsible for a significant consumption of parking spaces and pavements in the urban areas. About 70% of the service visits are realized by the motor vehicles, half of which are vans. The vehicles' dwell time depends on the type of service, and the UK researches show that the mean dwell time for all services is 35 min (Cherrett et al., 2012).

A wide set of performances can be obtained by combining the basic CL performances with the parameters of the urban environment and logistics systems. The number and type of the obtained CL performances depends on the research objectives, but each of them helps understanding the situation of logistics and identification of critical elements with respect to the

business, time interval, logistics organization (insourcing and outsourcing), performers of the delivery, vehicle type, etc. For the assessment of efficiency and sustainability of the initiatives, measure and conceptual solutions of the CL, the most commonly quantified performances are (Zečević & Tadić, 2006; Tadić, 2014): the number of trips, i.e. the number of vehicles launched for the distribution of goods; the number of vehicle-km; the required number of delivery vehicles; driving time; delivery size; loading factor; delivery reliability; time and frequency of loading/unloading operations; the required capacity of the storage systems; fuel consumption; emissions; distance traveled per unit of delivery; operating costs; etc.

4. CONCLUSION

Researches of the CL significantly differ by the number and quality of the quantified parameters. The information concerning the collection and processing of data are mainly scarce, therefore their reliability and comparability are questionable. Even in the countries with a significant base of the CL parameters, most of the inputs are obtained by the disaggregation of the data collected for a wider geographical area. On the other hand, the parameters are being collected by the different public sector organizations, as parts of the short-term (one-off) studies and projects, but also by the private sector organizations, including industrial, retail, utilities and transport companies, trade associations and companies involved in the market research. However, their studies are not coordinated and there is a large number of the data sources that vary in quality and methodology of the assessment. This makes the comparison or combination of the parameters very difficult or impossible. Even in the cities where the large number of parameters is collected, it is still impossible to get a clear picture of the CL system when the data unites.

REFERENCES

[1] Browne, M., Piotrowska, M., Woodburn, A., Allen, J. (2007). Literature Review WM9: Part I - Urban Freight Transport, University of Westminster.

[2] Browne, M., Allen, J. (2006). Urban freight data collection - synthesis report. BESTUFS II, BESTUFS Consortium.

[3] Cherrett, T., Allen, J., McLeod, F., Maynard, S., Hickford, A., Browne, M. (2012). Understanding urban freight activity – key issues for freight planning, Journal of Transport Geography, 24, 22–32.

[4] Dablanc, L. (2009). Freight Transport for Development Toolkit: Freight Transport. World Bank.

[5] DfT (2012). Road traffic (vehicle-kms) by vehicle type and road class in Great Britain. Department for Transport, London, Great Britain.

[6] Gonzalez-Feliu, J., Ambrosini, C., Pluvinet, P., Toilier, F., Routhier, J.L. (2012). A simulation framework for evaluating the impacts of urban goods transport in terms of road occupancy. Journal of Computational Science, 3(4), 206-215.

[7] Tadić, S. (2014). Modeliranje performansi integrisanih city logističkih sistema. Faculty of Transport and Traffic Engineering, University of Belgrade, Serbia, PhD.

[8] Tadić, S., Zečević, S., Krstić, M. (2015). City logistics – status and trends. International journal for traffic and transport engineering, in press.

[9] Zečević, S., Tadić, S. (2006). City logistika. Faculty of Transport and Traffic Engineering, University of Belgrade.