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## Analysis of the functioning of urban deliveries in the city centre and its environmental impact based on Szczecin example

Kinga Kijewska\*, Stanisław Iwan

*Maritime University of Szczecin, Faculty of Economics and Transport Engineering, ul. Pobożnego 11, 70-515 Szczecin, Poland*

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### Abstract

The main problem arising in the process of analysing the functioning of the transport and distribution of goods in urban areas is the lack of data on their implementation, in particular with regard to the classification of vehicles, their routes, changes in demand for transport, etc. The paper introduces the methodology and results of analysis of the goods distribution within the city centre of Szczecin in the area covering the significant number of companies, retail and service entities, entities of the HoReCa sector, schools, universities, and public administration. Major objective of the study was to analyse the influence of deliveries on city environment. It should be emphasized that due to the polycentric structure of Szczecin it was difficult to identify its city centre. This example could be good reference for the analysis realized in other cities, especially taking to the account their similarity to Szczecin.

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*Keywords:* city logistics management; goods delivering system; environmentally impact; urban freight transport functioning

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### 1. Introduction

A complex urban system is an important area for human functioning as it is a place of work, living, recreation, shopping and culture. It can help in the implementation of many necessities of life of its citizens and other users (visitors to the city or entrepreneurs) by providing them with suitable conditions. These necessities include, in

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\* Corresponding author. Tel.: +48-662-118-867; fax: +48-91-48-09-648.  
*E-mail address:* [k.kijewska@am.szczecin.pl](mailto:k.kijewska@am.szczecin.pl)

particular, smooth movement and possible free access to a wide array of consumer goods, as well as resources. Nowadays, city transport is one of the key challenges faced by policy makers (Witkowski, Kiba-Janiak 2014). Ensuring an effective system for the movement of both people and freight to a large extent determines the quality of life in the city and its competitiveness in relation to other cities (Witkowski, Kiba-Janiak 2012). On the other hand, a noticeable increase in these needs contributes to the presence of many difficulties, which include: waste of time as the result of congestion, lack of parking spaces in the city centre (significantly limiting the efficiency of the transport system) or the unavailability of adequate information concerning the course of transport processes carried out within the city. One of the most negative phenomena occurring in modern cities, and resulting directly from the growing transportation needs and their fragmentation, is the environmental degradation associated with the destruction of valuable natural and cultural areas.

The main problem arising in the process of analysing the functioning of the transport and distribution of goods in urban areas is the lack of data on their implementation, in particular with regard to the classification of vehicles, their routes, changes in demand for transport, etc. The main two reasons for difficulties in obtaining these data include (Taniguchi et al. 2006)

- Transport in the cities involves mainly private companies that usually do not want to share data on their transactions, supplies and carried cargo to its competitors and the public sector;
- Lack of standardized study methods in the field of freight transport and supplies in cities.

Implementation of the distribution processes in urban areas faces the biggest number of difficulties within the city centres. This is mainly due to the significant condensation of workplaces, retail and service entities, entities of the HoReCa sector, schools and universities, and public administration. An additional difficulty is the topological structure of the streets resulting from historical background. This applies particularly to European cities, the centres of which were most often developed in the periods in which the demand for transport services was much smaller and the number of transport users did not have such a significant effect on the occurrence of congestion. On the one hand, city centres involve retail, service, administrative and tourist entities, on the other hand, they usually accumulate key hubs of urban transport system. All of this makes deliveries within the city a particular challenge for the smooth functioning of the whole urban organism, involving at the same time a significant number of difficulties associated with the traffic restrictions (e.g. the occurrence of zones protecting historical buildings), linear infrastructure not adapted to the increasing number of vehicles (mostly narrow streets and one-way traffic organization) or the lack of sufficient number of parking spaces.

## **2. Methodology**

### *2.1. Research area*

Delimitation of the research area was based on the aforementioned factors (primarily the accumulation of entities in a particular area, the operation of which helps to generate increased demand for deliveries (Czyszkiewicz et al. 2011)), as well as aspects of particular importance in the context of sustainable development, in particular emissions from transport.

The analysis of anthropogenic emissions (Chapman 2007) from road transport usually takes into account the level of carbon dioxide (CO<sub>2</sub>) as a key factor contributing to the formation of the greenhouse effect. This approach is justified in the global context (Lin Tzu-Ping 2010; Cadarso et al. 2010; He et al. 2005), however, it does not allow for a more complex analysis while focusing directly on the local impact on the urban environment. Given the expansion of urban organisms towards the large agglomerations, where the number of vehicles in relation to the population per square kilometre is many times higher than in non-urban areas (Rojas-Rueda et al. 2012), it becomes essential to take into account the chemical compounds directly related to the health status of the city population. These pollutants include mainly carbon monoxide (CO), which is an odourless and colourless gas with highly toxic properties, nitrogen dioxide (NO<sub>2</sub>) - brown, highly toxic gas with a pungent odour, hydrocarbons (HC), which include carcinogenic compounds, and particulate matter (PM) in the form of carbon-graphite compounds, ash and soot. As a result of photochemical reactions, NO<sub>x</sub> and HC compounds may cause photochemical smog in the cities

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