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## City logistics - a strategic element of sustainable urban development

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### Abstract

The main purpose of this article is to present the basic development trends in the logistics area of the city, some concept of sustainable logistics and innovative technologies prerequisites to its implementation. The author shows such intelligent technologies as e.g. intelligent traffic control, modular containers, which help to improve utilization of vehicle capacity, and alternative means of transport. This will help to reduce the load on the road infrastructure, thus improving the quality of the environment and life in the city. The main trend in sustainable city logistics is cooperation between suppliers, customers and the public administration. Implementation of intelligent logistics requires developing of new business models, enabling to generate benefits not only for the city, but also its operating entities.

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### 1. Introduction

The smooth functioning of cities without efficient logistics is currently impossible. It concerns many household tasks, manufacturing and service companies. However, the classic concepts of urban logistics have not produced the desired effects so far. Cities are becoming more and more crowded, and requirements for environmental and climate

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protection - increasingly stringent. † As a result, logistic activities must be adapted to the requirements of sustainable development and allow for an increase in the flows efficiency.

The problem of requirements for sustainable city logistics is included in the new “Green Paper” of the European Union. In accordance with the guidelines contained in it, the basic idea is called “the smart city” which is a modern city using innovative technologies in all areas of its operation and complies with the requirements of environmental protection. The smart city concept is part of sustainable mobility, responsible management of natural resources and space. Their basic task is to improve the quality of life and competitiveness of businesses located in urban areas. Implementation of the idea of sustainable logistics requires involvement of stakeholders, openness to change and readiness to compromise.

This tends to reflect on the challenges which a modern logistics center is facing. This is often treated as a strategic factor for the development of urban areas. Therefore, the purpose of this article is to present the basic development trends in the logistics area of the city, some concept of sustainable logistics and innovative technologies that are prerequisite for its implementation.

### *1.1. Literature Review*

Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland 1987). Sustainable development consist of three main components: economic growth, social equity for meeting the needs of today’s generation, and environmental protection for the ability to meet today’s and future generation’s needs. (Behrendsa, Lindholma and Woxeniusb 2008). A transport system in a sustainable society is very important, because it has a direct impact on human health and safety. The World Bank estimates that 0.5 million people in developing countries die each year from transport-related air emissions, a similar death toll results from traffic accidents. The urban population in the developing world is close to 50% and has been growing rapidly. In the developed world, which already has a 75% urban population, designing sustainable transportation systems is considered one of the most pressing issues faced by modern cities (Kennedy, Millera, Shalaby, Macleana and Colemana 2005). The urban transport system is a complex system in which freight is moved in the same transport system as that in which passengers travel (Russo and Comi 2010). A sustainable transport system contributes to economic growth and social equity without systematically increasing concentrations of substances in the atmosphere and degrading the natural environment (Russo and Comi 2010). Sustainable urban logistics and sustainable transport have been the subject of interest of many scientists.

Bojkovica, Macuraa, Pejic-Tarlea, Bojovica (2011) developed a framework for a cross-country comparative assessment of transport sustainability in central and eastern European countries. Behrendsa, Lindholma, Woxeniusb (2008) in their study presented a definition of sustainable urban freight transport (SUFT), based on the existing theories and concepts, and developed an indicator set that describes SUFT. Anderson, Allen and Browne (2005) tried to answer the question how urban freight activity can function in a manner so as to meet the urban sustainability objectives that the policy makers are now beginning to implement. According to them, freight transport is an important component of urban environments and without effective freight delivery systems the vitality of urban areas can be disadvantaged, both in terms of their economic and environmental states. Russo and Comi (2010) in their study defined city logistics measures that can be taken to regulate freight transport and logistics within urban and metropolitan areas. Cohen-Blankshtaina, Rotem-Mindalib (2016) made a review of more than 40 years of research regarding the relationship between ICTs (Information and Communication Technologies) and urban mobility. They discussed the expectations for the changes in travel demand, travel patterns, and the urban form as a result of the development and introduction of ICTs. Dominic Steada (2016) summarized some of the key developments and opportunities related to information and communications technology, urban space and scale,

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† Today 75% of GHG emissions are related to urban areas, and the trend is still increasing. According to the report of the International Panel on Climate Change (IPCC) from 2007, most climatic changes, particularly temperature, are a consequence of human activity.

lifestyle and behavior, regulation and pricing, and institutions and governance. Christopher Kennedy (2012) made a comparison review of private and public transportation systems in relation to the sustainability of the Greater Toronto Area (GTA) from economic, environmental and social perspectives. The study demonstrates that from an environmental perspective the use of public transportation in the GTA is quantifiably more sustainable than private automobile use.

## 2. Trends and challenges for sustainable logistics of the city

The changes which are taking place in the modern global economy mean that new trends emerge, which in the future will have an impact not only on how the logistics companies function, but also on how they work in urban areas. The future holds many uncertainties and problems to be solved. The number of urban areas is rising. It is caused because of the growing number of cities with populations exceeds one million. Currently, there are over 800 such cities in the world. Below there are other changes which influenced the phenomenon:

- consumption patterns of the population;
- the age structure of the population;
- climate and the need for efficient management of natural resources.

Consumer behavior in general is understood as a reaction to stimuli from the environment, and the needs are the main basis of its development. They describe the manner in which consumers shape the hierarchy of needs, choose products and use them. Today's consumption behavior is the consequence of the increasing globalization, spreading of mobile technology and the Internet, and consequently the development of Internet commerce. There is no doubt that mobile technologies and e-commerce have changed consumer behavior. Electronic communication is ubiquitous, and digitization spreads over almost all areas of socio-economic development. Mobile technologies influence our ways of communicating and doing purchases. We can now place orders 24 hours a day, and expect delivery within a few days. These capabilities increase the frequency of purchases and rise the demands on the flexibility of supply. The diversity of assortment and pressure of uninterrupted availability of goods lead to the changes in the structure of supply. E-commerce has forced the need for new channels and distribution processes, and a growing share of B2C transactions has intensified the problem of the last mile.

According to the research done by the Center of Public Opinion Research [Centrum Badania Opinii Publicznej] every second Pole makes purchases via the internet, and one in five buys groceries in this way (E-commerce in Poland 2015). The study was based on direct interviews held on 3-9 April 2014 and involving a 1,028 people representative random sample of adult Polish citizens.

E-commerce, social media and mobile devices today plays an important role in the distribution of goods and services. The number of freight transport individual orders (courier, express mail) is steadily rising. In the future, individualization of production and trade will entail a further increase in the number of flows. Increasingly, products ordered through the internet will be not only classic products like books, clothing or appliances, but also groceries. E-commerce and related services present growth opportunities and quality in terms of supplying urban residents with goods, but cause a significant burden on the infrastructure. This results from the increased amount of items and handling, especially in the last mile of delivery.

The vastness of the challenges facing the city logistics is also connected with the rapid growth of the urban population and its aging (Silver Society) - they want to be fitter and more active. It is expected that by 2030 the number of people aged 80 will be 4 times higher than it is today. Aging of the society drives the demand for a customized range of products and services and the need to ensure decent living conditions for the elderly. The population of seniors is not coherent; some of them are full of strength and pursue their hobbies. Others have to face limitations resulting from declining abilities and loss of independent functioning. As a result, the needs of this population will have to be met efficiently and cost-effectively. This concerns both the supply of everyday use goods, medicines and medical care services. Ensuring the quality of life for all citizens is necessary for development. In the logistics area of the city, it means you need to adapt the offer to the specific requirements of seniors, in particular, to ensure the availability of the physical environment. It is connected with adapting the infrastructure, transport and urban space. The discussed trends determine ways of supplying urban areas, as well as the formation of spatial structures in industry and trade. For many years, retail outlets were located in peripheral areas, close to

transportation routes. However, in recent times, especially in Western Europe, the revival of locations in city centers has been observed, and shopping malls are opened in the halls of railway stations (e.g. Warsaw, Katowice).

Changes in the spatial structures of trade affect the amount and type of the flow of goods in urban areas; supplies are becoming more frequent and include small parts of goods (Verhagen and Van Dolen 2009). This in turn determines the effectiveness of the means of transport use, and it appears likely that in the near future demands on the flexibility of the supply will be even greater. This fact presents new challenges for logistics, which aims at uninterrupted supply of cities while caring about the quality of life and striving to reduce the negative impact of transport on the environment (reduction of CO<sub>2</sub> emissions, reducing noise and the number of cars). Cities should try to improve or at least maintain its current quality of life for its residents. However, preservation of long-term economic sustainability necessitates constructing such infrastructure that will encourage operators to choose locations in the cities (Browne 2010). These goals compete with each other. The discrepancies are, among others, in their efforts to create a low-carbon city with a high quality environment, transport and increased traffic resulting from supplying production facilities and waste management. Additional traffic, in particular connected with freight, causes excessive load on the linear infrastructure of urban areas. The objective concept of sustainable logistics should be eliminating conflicts between quality of life and the development of business in the city. Industry concentration resulting in an increase in the amount of flow and the environmental burden also opens wide possibilities of preventing negative climate change. The use of modern information and communication technologies enables shortening of the routes flows. Multimodal transport systems may improve air quality and noise reduction. Production plants in urban areas can be specific centers of innovation and knowledge.

Care for the environment and achieving sustainable development is the key challenge of modern logistics. The need to implement the principles of sustainable development has been communicated for more than twenty years, since the conference in Rio de Janeiro and issuing the document on the need to provide decent living conditions for residents and to minimize negative impacts on the natural environment. Currently, these discussions are conducted also in the European Union. The key terms for the management of urban areas based on a coherent strategy and sustainable development are included in the Leipzig Charter (2007), Declaration of Marseilles (2008) and the latest Declaration of Toledo (2010). Achieving the goals of sustainable development, in the form of reduction of CO<sub>2</sub> emissions can be achieved only if the negative impact of transport on the environment is limited. These goals, however, do not comply with the observed trends: increased mobility of people lead to the increasing number of individual means of transport and flow of goods. And while freight is less than 10% of the total flows, its impact on the load on the infrastructure, environmental pollution and noise is enormous. According to the guidelines of the World Health Organization (WHO), the level of noise at night should be less than 30 decibels (WHO 2010). However, research conducted by the WHO shows that more than 34 million EU citizens are exposed to noise which exceeds 50 decibels (European Environment Agency 2010). This results in health problems. It is estimated that in Poland over 13 million people are exposed to excessive noise (Marczak 2012). Noise is now the second (after pollution) cause of dysfunctions of human body (WHO 2011). Costs of noise in the European Union are estimated at 40 billion Euro, of which almost 90% is attributable to transport. Effects related to the issue of traffic noise fall into the category of external costs, which are particularly difficult to measure. So city logistics should focus not only on implementation of modern technology, but also on development of such concepts that will allow eliminating unnecessary burdens. This means, among others, developing an appropriate system of incentives and sanctions.

### **3. Solutions for sustainable city logistics**

The observed socio-economic transformations make the fundamental duties of city logistics supply should be balanced and meet the requirements for the municipal waste management. The main challenge is to synchronize the tasks of distribution logistics, reverse logistics and waste management logistics. These tasks cannot, however, be implemented using conventional logistics structures. This is because of the increasing demand for the space intended for the implementation e.g. transport and handling tasks with the same infrastructure and spatial constraints. Free spaces are scarce and cannot compete with other functions in the city. It is therefore important to seek solutions allowing for uninterrupted operation of the city while maintaining the principles of sustainable development. Among

possible concepts for implementation of sustainable city logistics, there are solutions which will be focusing on the last mile, using multiple channels and urban logistics terminals.

It seems that in the future the concepts of city logistics will be based primarily on cooperation and synergy effects generated by participants in supply chains. The chains of economic concepts of vertical cooperation based on CPFR and VMI have already come true. In the case of horizontal cooperation there is still much to be done. Huge potential for improvement, in the form of consolidation of supply and reduction of transport flows, seems to occur between the dimensions of the same level of the supply chain. City logistics should aim to replace existing structures with personalized structures used by many actors (multi-user). Examples include concept sharing, allowing for increased efficiency of transport processes in the city (Kauf 2012). The basic condition for the joint use of logistics resources is the identification of converging processes and service standards, allowing for the consolidation of deliveries and create common network flows.

In the context of sustainable logistics, cooperation of players is important for the so-called last mile, because orders made via internet platforms involve a growing number of heavy traffic flows and increase the volume of transport in the city. The concept of cooperation in the last mile should be based on a combination of items supplied by different operators (couriers, suppliers' expressways).

Consolidation could take place in inner-city transfer points. This concept should be based on sharing of logistics resources (e.g. transport, handling) and flexible consolidation of entering and leaving shipments. The aim of this approach is to combine different vendors (e.g. food, cleaning agents) supplying various recipients (institutional and individual) as well as carrying out tasks of reverse logistics (including complaints, waste). Logistics last mile should underpin the optimization of multimodal links between the suppliers involved in the local distribution of small consignments and long-distance transport operations. The basic condition for the smooth implementation of last mile logistics is to create centers / terminals for the city (Kauf 2008).

Consolidation should take place starting from small, personalized packages to small customers. So far the effectiveness of the terminals in the city has not produced the desired effects, although their contribution to reducing the negative impact of transport on the environment can be enormous. Past failures of the concept of urban terminals seem to be a consequence of the complexity of logistics tasks, shortage of information and a large number of companies supplying the city. The key to success seems to be networking all players and taking effective control of the flow of goods based on the existing point and linear infrastructure.

The last mile logistics can also be used according to the Drop-off and Pick-up concepts. Points of Drop-off and Pick-up can be maintenance-free and take the form of parcel lockers. These are mostly located in petrol stations and retail outlets. Introduction of these solutions is also a condition for implementation of a logistics concept based on multi-channels. Its legitimacy stems from the fact that modern consumers operate in an multi-channel environment in terms of access to the market offer. New channels (e.g. online) might be included in the processes purchase, replace the ones previously used in the current solutions provided by the supplier or use multiple solutions at one time (Lipowski 2014). Each channel can be used for different purposes, depending on the needs. Logistics can help to maintain the attractiveness of town centers by optimizing the offer online and offline. Satisfying the requirements of customers with respect to product availability and speed of delivery forces integration of sales structures and distribution logistics trade. This can be done by joining the B2C and B2B supply. Today, partial solutions complemented with handling returns and complaints and Click and Collect service can prevent ineffectiveness of the existing multichannel logistics center. The main advantage of logistics multichannels results from coordinated management of multiple channels of the supplier. For customers, this means the increasing convenience of purchasing and improving relations in dealing with suppliers.

The possibility of free choice and switching between channels at any time is also significant. As for sustainable city logistics in the future, there may be not only multichannels, but also multifunctional urban space. The concept of Shared Space is becoming increasingly popular. It means shared space, e.g. road on which pedestrians, cyclists, cars and public transport may move. The use of the Shared Space concept aims at improving safety and fluidity of traffic, increasing the attractiveness of urban areas, reducing noise emission and enforcing specific kind of traffic for all participants. New logistic concepts and technological development also allow for a temporary shift of deliveries, e.g. at night hours. And they create the opportunity for application of the concept of Shared Space also for buildings and structures.

#### 4. Innovative technologies for sustainable city logistics

The previously mentioned solutions for sustainable city logistics might be implemented provided that all innovative technological solutions will be applied. Hence, joining the supplies on the last mile requires innovative, intelligent and mobile systems for transfer of shipments.

The research shows that one of the most common reasons why customers decide not to make purchases, in 70 % of cases, is a limited offer of delivery options. Not surprisingly, interest in innovative solutions in the field of shipping and receiving shipments is growing. It allows for asynchronous transfer of shipments, thereby decoupling the delivery time from the time of receipt by the customer. A period of time between the delivery of the parcel and its collection allows for a significant increase in the delivery efficiency, which is possible through consolidation of deliveries and optimizing the flows. In addition, delivering during reduced traffic hours is possible, e.g. in the late evening. Night deliveries might constitute a good example, where the collection takes place only in the morning, before the store opens. For recipients it means a substantial increase in convenience concerning deliveries.

Application of new solutions in this area requires the development of flexible and modular systems for the transfer of parcels (Pick-up and Drop off), both by individual consumers, industrial and trading companies. Solutions called Pick-up and Drop off guarantee punctuality of deliveries and comfortable collection of the order, also outside the opening hours of the store. Pick-up and Drop off terminals guarantee not only fast and reliable form of delivery, but above all, they set a new standard; can be accessed 24 hours a day, 7 days a week, and collecting the consignment takes only several seconds. Terminals for arrivals and dispatches are already installed, among others, by French La Poste. Until now, the railway stations of Paris and the surrounding area operate 110 automated terminals. By the end of 2015, another 500 machines are planned to be installed in major French cities. There will be 1000 machines in 2016.

One of the elements of the intelligent city are electric vehicles. They reduce CO<sub>2</sub> emissions in the city. Although the potential for such solutions is enormous, and these vehicles are more practical, their implementation is extremely carefully. One of the most enormous barriers is the high cost of retrofitting the fleet. Such actions are taken today and companies try to convince others to use cars which do not produce fumes. Implementation of green logistics requires new business models and introduces a system of incentives. It can be lower local taxes as well as the ability to enter the zones with limited freight traffic. Introduction of electric vehicles would also help to reduce noise in areas where supplies are delivered. However, not only sounds of engines cause noise. Its intensity is also a consequence of loading and handling operations on ramps, and for example the noise resulting from car door closing reaches 70 decibels, and the sound of moving containers reaches nearly 80 decibels. In this area, it seems necessary to train the workers, and above all to introduce modern technologies that permit quiet delivery.

#### Summary

The argument points to significant developments which will be largely determined the action in the logistics area of the city. The most topical issues of logistics include infrastructure and space constraints associated with the time and place of deliveries, inefficient processes, loading /unloading of goods, increased energy costs, as well as high CO<sub>2</sub> emissions. The solution requires new, intelligent (smart) technologies, such as e.g. Intelligent Traffic Control, modular containers, helping to improve vehicle capacity utilization and alternative means of transport. Intelligent logistics can make a significant contribution to implementation of the concept of sustainable development. This will reduce loading of the road infrastructure, improving the quality of the environment and life in the city. The main trend in sustainable city logistics is the cooperation between suppliers, customers and the public administration. Implementation of intelligent logistics requires development of new business models, enabling to generate benefits not only for the city, but also its operating entities.

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