Available online at www.sciencedirect.com

ScienceDirect

Transportation Research Procedia 16 (2016) 25 – 34

Transportation Research Procedia

www.elsevier.com/locate/procedia

2nd International Conference "Green Cities - Green Logistics for Greener Cities", 2-3 March 2016, Szczecin, Poland

The SmartFreight project as a superior way to cope with congestion and environmental negative externalities in urban areas

Dagmara Bubel[a], Katarzyna Szymczyk[b]*

[ab]*Czestochowa University of Technology, J.H. Dąbrowskiego 69, 42-201 Częstochowa, Poland*

Abstract

Congestion, car exhaust gases, permanent noise and risk of accidents are the most common and severe problems in conurbations, especially in their cores or commerce districts. Such problems basically result from the continuously increasing amount of private and business vehicles on streets. It is obvious that more cars moving on the streets indicate more environmental negative externalities, therefore, new solutions to combat them are not only needed, but absolutely necessary. The aim of this dissemination paper is to focus on the idea of the SmartFreight project which was introduced in the UE a few years ago, but still has been neglected by many city representatives or cargo delivery companies. The project deals with all the problems that appear inside city centres due to cargo trucks services or lorry door-to-door delivery. The authors of this paper posit the hypothesis that for the time being, the SmartFreight project is the best solution against congestion and environmentally harmful externalities in urban areas. To support the hypothesis and show the effectiveness and benefits of the SmartFreight project implementation, the authors discuss all assumptions of the SmartFreight project and analyse statistics, figures and survey data collected in the cities where the SmartFreight project has been launched.

Peer-review under responsibility of the organizing committee of Green Cities 2016.

Keywords: congestion, freight, environment,ecologistics, pollution

1. INTRODUCTION

Delivery companies are nowadays required to ensure high quality distribution on time, top standard and effective

*katarzyna.szymczyk@opoczta.pl

Peer-review under responsibility of the organizing committee of Green Cities 2016.
doi:10.1016/j.trpro.2016.11.004

customer service and attractive competitive prices. Distribution of goods in logistics terms combines the circumspectly organized route planning, selection of distribution channels, vehicle selection and best ways of transporting, as well as the necessary calculation of costs and timing (Łukasik, 2014). Enterprises need to put emphasis not only on successful management, efficient planning, and well-prepared and safe system of shipping, but they also have to remember about all the valid and compulsory environmental regulations and standards which have recently become more stringent in the Polish and European environmental policies. The most pressing problems at the present time are congestion and pollution in cities. This paper will focus on ways to combat these problems with appropriate transport policies, such as the special SmartFreight project introduced in the European Union. The aim of this paper is to review the overall aspects and concepts as well as to discuss assumptions and survey results of the SmartFreight project in order to verify the authors' implications that - so far - this is the most advanced and innovative traffic management solution for large and congested cities in Europe to fight the problems of clogging, noise and pollution and to make the transport better, more effective and environmentally friendly at the same time. The SmartFreight combines many systems in order to create a unified and fully developed system that will coordinate existing solutions in a better way. It puts great emphasis on city management and cooperation between delivery companies and city authorities in arranging and monitoring the flow of freight vehicles in cities. In contrary to other similar projects, the SmartFreight gives ready solutions on how to use ICT effectively to control each vehicle entering the city individually and how to stop unwanted congestion and pollution by planning the freight vehicles access to the main parts of the city. The SmartFreight project combines other similar existing projects in European cities and improves their tactics or assumptions.

2. MODES OF FREIGHT TRANSPORT IN EUROPE

The IEA report on Transport Energy and CO_2 published in 2009 shows that freight transport by trucks in Europe was in 2005 much greater than by rail - about 1500 billion ton-km done by trucks and less than 500 done by rail. Whereas in China, America or former USSR the results occurred to be completely opposite: freight rail in China was approximately 1800 billion ton-km, more than 2500 in America and almost 2000 billion ton-km in former Soviet Union. Rail dominates in large countries where the distance is the main factor (IEA, 2009). According to European Commission and Eurostat data published in 2013, in years 1995-2011 it was road as the most frequently chosen way to transport goods in Europe (Fig. 1). Distribution by trucks has been noticed to happen more often inside the European countries rather than between them. More of the larger international freight is done by ships. Rail has risen since the early years of the 21st century, but it is still not widespread and less developed in freight sector in comparison to sea and road modes (Table 1).

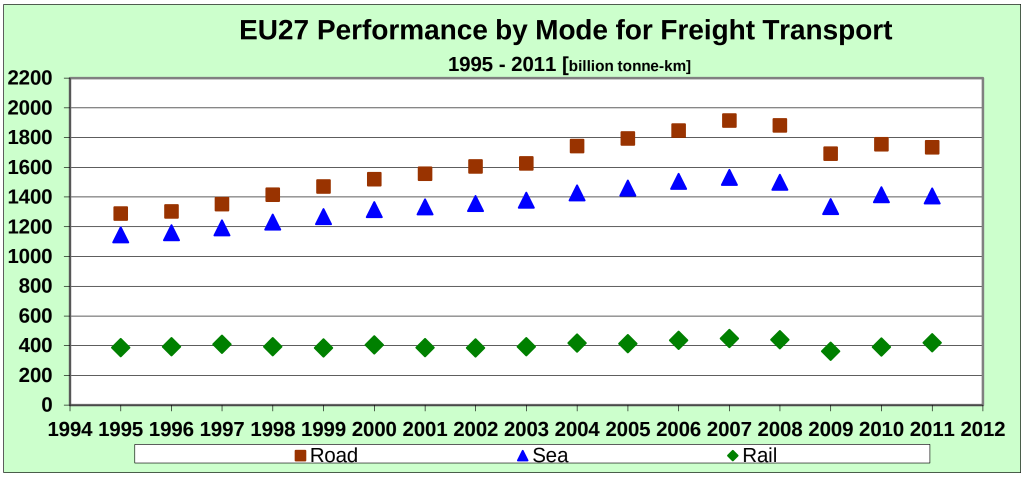

Fig.1. Performance of Freight Transport by Mode 1995-2011. Source: European Commission Directorate-General for Mobility and Transport in co-operation with Eurostat, Transport in Figures 2013. Eurostat 2013.

Table 1. Road, Sea and Rail Freight Transport Performance 2000-2011 (billion tonne-km). Source: own work based on Eurostat 2013.

	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Road	1518.7	1556.3	1605.9	1625.4	1742.1	1794.0	1847.6	1914.5	1880.5	1690.3	1755.6	1734.1
Sea	1314.0	1334.0	1355.0	1378.0	1427.0	1461.0	1505.0	1532.0	1498.0	1336.0	1414.8	1407.7
Rail	403.7	386.0	383.8	391.9	416.8	413.2	434.9	448.4	439.6	361.0	391.2	420.0

Both increasing number of motorways and national roads, as well as flexible warehousing infrastructure stimulate the growing process of vehicle transport. It is easier, faster and cheaper than for example rail shipping, especially for small and medium transport enterprises. Frequently, which is also the argument against, the choice of other possible types of transport like rail, inland water shipping, air or sea shipping are inaccessible, unprofitable or restricted in practice. Benefits of vehicle transport are fairly obvious: easily reached loading and unloading places, not such expensive like rail or sea transporting, variable and flexible to customer needs means of transport - vehicle types, quick services especially on short routes, fast delivery on demand (Skibińska, 2014). The percentage of total inland freight transport in ton-kilometres in chosen European countries in 2012 has been illustrated in the Table 2.

Table 2. Percentage of total inland freight transport in 2012 (tonne-km). Random EU countries. Source: own work based on Eurostat 2014.

EU COUNTRY	ROADS	RAILWAYS
Belgium	58.3	17.5
Czech Republic	78.2	21.8
France	80.6	15.2
Germany	64.6	23.1
Hungary	75.1	20.5
Italy	85.9	14.0
Poland	81.9	18.0
Spain	95.2	4.8
United Kingdom	87.8	12.1

3. THE IMPACT OF ROAD FREIGHT TRANSPORT ON THE ENVIRONMENT

According to a certain study, road freight transport causes 8% of worldwide carbon dioxide (CO_2) emissions and some more come from warehousing and handling. It is said that in 1995 22% of CO_2 emissions came from the energy use (fossil energy sources) in the transport sector and its amount was 4500 x 10^6 tonnes (Lenzen, Dey, Hamilton 2008). Road freight grew rapidly during the second half of the twentieth century, because the transport policy in many countries focused predominantly on low-cost, short and prompt ways of delivering goods, especially food, thanks to the global supply chain idea. Vehicles, even if more polluting, were considered as economical and faster modes of transport than trains (Jaroszweski, 2012). Transport, just like the growing demand for electricity, has impacted the total increase in global gas emissions in OECD countries. During the last 30 years, gas emissions have been noticed to rise more or less 1.7% per year. The average consumption of electric power and private cars in Australia, for example, accounts for about 20% of gas emissions, whereas 80% is connected with public and business services or consumer goods supply. Not only the carbon dioxide emission is a worldwide problem in transportation. In 1996 the National Greenhouse Gas Inventory Committee published the results of non-CO_2 emissions in the road sector, where it was clearly shown that medium and heavy trucks used in freight transport also produced great amounts of harmful gases such as: CH_4, N_2O, NO_X and CO (Table 3) (Lenzen, Dey, Hamilton 2008).

Table 3. Non-CO_2 emissions (g/km) in road sector. Source: own work based on Lenzen, Dey, Hamilton 2008.

TRANSPORT	FUEL	CH_4	N_2O	NO_X	CO
Medium trucks	diesel oil	0.02	0.017	3.1	1.8
Heavy trucks	diesel oil	0.07	0.025	15.3	7.9
Light trucks and cars	gasoline	0.05	0.05	0.9	5.5
	diesel oil	0.01	0.012	1.1	1.1
	LPG	0.09	0.008	2.0	22

The last decade of the 20th century saw the development of travel activity among the citizens around the world. The amount of private cars and the popularity of trucks instead of rail and sea shipping in the freight sector, as well as the cheaper and easier air travelling especially on short business trips, increased rapidly in the 90s making people's lives comfortable and pleasant, but on the other hand driving up the gas emissions so high that the environment issues have become the main topic of the 21st century. In 1998, according to the International Energy Agency, the percentage of emissions from road transport around the world was extremely high because of the fact that non-OECD countries had developed and become more industrialized than before. The formerly mentioned percentage of emissions from road transport is the highest in North America - 34% and OECD Europe - 18%. In Asia, including China, it scores 9%, OECD Pacific - 8%, Latin America - 6%, Middle East - 4% and Africa - 3%. Freight transport energy consumption, according to the IEA data for 1996, was the biggest in Europe (Table 4), but it should be noted that passenger cars were regarded as the most energy consuming (Lenzen, Dey, Hamilton 2008).

Table 4. Transport energy consumption in %. Source: own work based on Lenzen, Dey, Hamilton 2008.

Transport	Europe	North America	Pacific
Passenger cars	54%	57%	57%
Freight trucks	30%	24%	25%
Passenger railways	1%	1%	3%
Freight railways	3%	7%	3%

Life cycle analysis studies conducted by the Organisation for Economic Co-operation and Development confirms that the total life cycle energy use amounting to 80-90% accounts for the fuel used by operating vehicles. These machines, when in use, guzzle more energy and produce more emissions than the mixture of other stages of the life cycle, like production, handing out of materials, vehicles manufacturing, maintenance and disposal. Means of road transport are said to emit (Suchecki, 2006):

- 63% of nitrogen oxides
- 50% of organic chemicals
- 80% of carbon monoxide
- 10-25% of PM
- 6.5% of sulphur dioxide

Ways to protect the environment are multi-faceted. The very first step should be done on the road designing level. One of the most important things is to implement the right transportation policy including promotion of public transport, low-energy consuming vehicles, car pooling system, efficient road network (tunnels, by-passes, motorways connections), as well as controlled gas emission policy. A further way is to develop an efficient spatial policy which should focus on organised transport systems inside city centres: parking and entry zones, loading bays, closed (green) zones in cities for heavy lorries or entries with permission only, special policy and programs for pedestrians and cyclists. Furthermore, pro-environmental policies should also take account of improving the freight vehicle assortment, with the emphasis on modern and eco-engine vehicles, electric or hybrid vehicles, and extended implementation of innovative road traffic control and IT systems (Stańczak-Strząska, 2007). All such concepts should lead to one and fundamental rationalization of the freight distribution on a local scale in order to improve air quality, reduce noise and congestion in cities. The European Commission (EC) funded several projects studying transportation policies, such as: TRANSPLUS - a project to plan transport, land use and sustainability; LEDA - legal and regulatory measures for sustainable transport in cities or CIVITAS Initiative (METEOR, MIRACLES) (Smartfreight.info, 2015). The SmartFreight project includes the criteria and models of those projects, but improves the implementation of IT solutions.

4. THE SMARTFREIGHT PROJECT: THE TRAFFIC MANAGEMENT STRATEGY PLANNING

The European Commission, under the Seventh Framework Programme for R&D, Theme 3 “Information and Communication Technologies” has conducted an innovative research project to improve transport in urban areas, especially in city cores, reduce the problem of congestion caused by numerous vehicles entering the cities, and at the same time, reduce the problem of emissions and smog in the cities. The SmartFreight project is a unique special traffic and transport management system which includes the most pioneering information technology like ICT (Information and Communication Technology) in order to organize infrastructure and support by means of wireless on-board communication and on-cargo equipment. The project combines freight distribution management systems (FDMS) together with urban traffic management systems (UTMS) and individual freight vehicles. As the whole framework it provides general solutions on how to make urban freight transport more efficient, safe and environmentally friendly. Urban area freight and logistics in terms of management are intended to work together with the IT solutions to become more efficient and ecological, as well as safe and financially beneficial for the cities (Smartfreight.info, 2015). Some years ago, according to the EC report *Urban freight. Transport and Logistics – An overview of European Research and Policy,* ITS potential in freight distribution sector was not effectively used in such a way European cities could rely on certain experience from projects on a big scale and in addition, the results of projects of merging the freight distribution systems with traffic management were not fully studied. The SmartFreight project focuses on smoother and effective coordination between distribution and traffic management in order to guarantee enhanced control along the distribution operations (Barerra, McLeod, Natvig &Westerheim, 2008). The new traffic management based on ICT and integrated wireless communication infrastructure are supposed to provide individual freight vehicles with different service levels which should rely on environmental report, kinds of cargo and directions of distributions. Routes of delivery should be allocated according to the traffic information, in order to avoid congestion, time gaps or road conflicts. During the transportation process trucks are supposed to be monitored all the time and the data should be collected for further analysis. Route planning or re-routing for planned freight are the most important goals of the SmartFreight project's. It gives the necessary information about the travel time, traffic conditions and possible transport network to improve the efficiency of fleets and the whole interoperability between freight distribution systems and traffic management. This can be done only together with open ICT services, wireless communication infrastructure, on-board equipment and CALM MAIL (enables DSRC [Dedicated Short Range Communications] communication with battery-powered units) implementation. Thanks to these solutions, fleet managers are able to control the status of cargo, track the vehicles and drivers, monitor accidents, failures or unexpected obstructions or diversions on roads. Inside urban areas, the SmartFreight project helps to fight major environmental and social problems. Route and delivery time planning will help to avoid a number of heavy and slow lorries getting into city centres and blocking the traffic flow, or freight vehicles delivering cargo to places without loading bays. Information about the vehicles, their destination plans and cargo type should help to organise delivery at the most appropriate moment, especially if dangerous cargo is being delivered. A smaller number of freight vehicles or zero entries in rush hours should reduce pollution and noise in city centres (Westerheim, 2011).

The main goals of the SmartFreight project are (Barerra, McLeod, Natvig &Westerheim, 2008):

- development of new traffic management measures for communication with vehicles based on ICT services
- development of wireless infrastructure and on-board equipment in vehicles
- information flow between transport companies improving their route planning
- improvement of traffic management and freight distribution structures in terms of their mutual interoperability

There are several work packages in the Smart Freight project, such as (Westerheim, 2011):

- Analyses of urban freight transport challenges and requirements
- Traffic management and distribution management services
- Onboard support and control on top of CALM
- System architecture for open solutions for freight transport
- Proof of concepts and verification of ICT solutions
- Impact evaluation of new concepts
- Dissemination
- Exploitation

Its structural design includes conceptual, logical and technical features. The conceptual part embraces Reference Model and Roles Objects, the logical one consists of three viewpoints: Functional, Information and Process. The last technical feature of the SmartFreight structure includes the biggest Communication Viewpoint. The Reference Model for the Smart Freight project has been described in the Table 5 (Natvig, 2015).

Table 5. The Reference Model of the Conceptual Aspect of the SmartFreight project. Source: own work based on Natvig, 2015.

THE SMART FREIGHT REFERENCE MODEL			
USE CASES	ACTORS	INFORMATION FLOWING OUT	INFORMATION FLOWING IN
The Transportation Network Infrastructure Management	Transportation Network Manager, e.g. city or road administration, Transportation Network Equipment	Transport network information	
Transportation Network Utilisation	Traffic Manager, e.g. UTMS, city, road Administration Transportation Network Resource Manager, e.g. city or terminal	Network and traffic status, resource allocation, traffic management measures	Resource allocation, vehicle profile, cargo and route information
Transport Service Management	Transport Service Provider, e.g. FDMS, freight distributor, fleet operator, back office	Status, transport operation information, assistance, etc.	Transport operation information, assistance, status, etc., Transport service request, network and traffic status, resource allocation, transport network information, item status and condition
Transport Demand	Transport User, e.g. a city centre retailer or other business	Transport service request	Status
Transport Sector Support	On-Goods equipment	Item status and condition	
On-board Support and Control	Driver, Vehicle, On-Board Equipment (OBE)	Vehicle profile, cargo and route information, transport operation information, assistance, status, etc.	Traffic management measures, transport operation information, assistance, status, etc.

Different fields described in the Reference Model need a functionality which is specified via use cases in terms of functional viewpoint in the logical aspect of the Smart Freight project. The functional viewpoint identifies the use cases as activities in activity diagrams which demonstrate processes. Different persons with an interest or concern, like the exemplified driver, vehicle or the traffic management system, or the freight distribution management system are defined at different construct levels in different processes in terms of process viewpoint. Finally all information gathered and identified in the process viewpoint is now specified in the last information viewpoint. The content will help to characterize open interfaces needed to maintain necessary interactions. The SmartFreight project shows how the whole management, monitoring and supply provision as parts of the Transportation Network ideas are possible to be put into practice. The Transportation Network models give the chance for planning the individual vehicles, controlling all sectors like tunnels, restricted areas, green areas, assigned areas like bus lanes opened for freight vehicles outside rush hours, or booking the loading bays. This is the fundamental aspect of the traffic management strategy. The whole structure of the SmartFreight project indicates functionality and communication between vehicles, traffic management and freight distribution management system (Natvig, 2015).

5. THE SMARTFREIGHT PROJECT OBJECTIVES AND OUTCOMES

There are several international commercial technology companies, research institutes, freight distribution stakeholders and local or regional authority representatives which support and cooperate in the SmartFreight project testing (Smartfreight.info, 2015):

- SINTEF, Q-Free and Norwegian Road Administration in Norway
- ETRA Investigación Desarrollo S. A. and Asociación para el Desarrollo de la logística in Spain
- Dublin Transportation Office in Ireland
- Transportation Research Group (TRG) of the University of Southampton in the United Kingdom
- Comune di Bologna in Italy
- Chalmers Tekniska Hoegskola AB in Sweden
- POLIS in Belgium

The SmartFreight project has been so far simulated and evaluated in Winchester in England, Dublin in Ireland and Bologna in Italy**.** Its technical solutions have been introduced in Trondheim in Norway (Table 6).

Table 6. The SmartFreight Project survey objectives. Source: own work based on Smartfreight.info, 2015.

COUNTRY	ELEMENT	SURVEY'S OBJECTIVE
Trondheim, Norway	wireless infrastructure	• testing the technical solutions specified and implemented by the project • showing new functionalities for traffic management measures towards individual vehicles and support and control of transport operations • examining the technical solutions regarding capacity and usability
Winchester, UK	traffic control centre operating the SCOOT and urban traffic control (UTC) system implemented in Winchester	• simulating the functionality • evaluating how the concepts and technical solutions could change the traffic flow and freight operations within the city • calculating the benefits to the various users
Bologna, Italy	a new ITS system	• simulating the new, extended functionalities that the specified and implemented solutions provide • analysing how the technical solutions may concern urban traffic and transport.
Dublin, Ireland	ITS system	• measuring the information needs and exchange opportunities between different stakeholders in relation to goods and freight

	• providing user feedback • participating in the evaluation of the Trondheim work • informing the nature of future IT integration projects in Dublin • collecting information needs (drivers, fleet managers, and other logistics interests)

In Winchester there are narrow streets, high streets are mainly for pedestrians, a one-way system dominates and the limited parking problem exists, so freight vehicles face all possible difficulties with entering the city core. In the city, the Hampshire County Council operates the city's urban traffic control (UTC) centre partly funded under the EU Euroscope/ROMANSE project which basically assumes the freight strategy plan. Apart from that, another EU-funded MIRACLE project was introduced earlier which also focused on some freight initiatives. The SmartFreight project had been introduced in order to test all concepts inside the city. The main idea was to allow lorries to share lanes with city buses and share the loading bays. Such a concept was also introduced in Barcelona in Spain. Furthermore, the concept of prebooking the loading bays was introduced as well as the idea of giving the priority access to some parts of the city according to the emission zone concept. Concepts were simulated by the Transportation Research Group (TRG) from the University of Southampton and the survey measured journey time for vehicles and other traffic on key lorry routes, vehicles counts by vehicle and goods type, legal loading bays use rates and occurrences of delivery time windows (Barerra, McLeod, Natvig &Westerheim, 2008). The survey in Winchester showed that delays of lorries at the loading bays brought no benefits and the loading bays for lorries should be implemented with special holding areas or physical infrastructure payments in order to avoid all unnecessary disturbances and ensure arrival on time.

In Bologna, due to the traffic hub and the country's largest exhibition complexes, innovative urban solutions and freight management policies were implemented on a big scale. For example, the city has its permit-based limited traffic zone and access of vehicles is controlled by the system of automatic cameras. The new regulations helped to reduce traffic in the city centre up to 25% and bus lanes infringements up to 70%. Freight delivery is conducted by the 2006 City Freight Delivery Plan which assumes reduction of the number of kilometres driven while delivering the same level of service, as well as encouraging the delivery companies to use cleaner vehicles. Permits, annual freight delivery tariffs, pay-to-access passes and development of a technological transit point which can rationalize flows of freight transport, routes, loading procedures, parking slots prebooking together with centrally controlled vehicle monitoring are part of the huge all-inclusive ITS-based city traffic management system derived from the SmartFreight programme (Barerra, McLeod, Natvig &Westerheim, 2008). The system showed in Bologna that the existing technology solutions like the route optimisation tool based on Van Sharing system helped to carry out environment and trip distance positive effects. According to the SmartFreight project final report, the project supports and improves the architecture and algorithms of the Van Sharing platform. The SmartFreight project simulation in Bologna helped to put in practice Van Sharing aims to achieve economically efficient pick-up and delivery service, reduction of traffic and pollution which basically means reduction of environmental impact and more well-organized usage of parking spaces. Bologna largely accepted freight flow aggregation, incorporation of Urban Traffic Management Systems and the system of Bookable Loading bays (Smartfreight.info, 2015). In Dublin, the survey confirmed that large and small actors in urban areas that are companies should be addressed the same, equal, of the same range technical solutions. Trondheim in Norway illustrated how the technology of the SmartFreight project works and how successful it is. There were three applications introduced in Trondheim: basic access, control, dynamic tunnel access control and cargo monitoring. The demonstration showed the potential of the SmartFreight project. Other Internet applications like the CVIS, CALM communication and IPv6 or NEMO were also effectively demonstrated.

The SmartFreight functionality developed new management instruments to improve urban traffic condition, better collaboration between urban traffic management and fleet operators, and enhanced on-board control and support. The Smart Freight project works the best if some of the conditions are fulfilled. First of all, the city needs to be willing to cooperate with freight operators or freight vehicles and inform them about the most up-to-date traffic conditions and offer the dynamic traffic management policy. Secondly, the city is ready to make an effort and control single vehicles and, for instance, support green vehicles entering city centres. That can be done if the other partners that are freight operators would cooperate and inform the city about their transport aims and actions. Furthermore, the city would implement the information and communication technology to control and manage the transport network and vehicles movement inside the city. That would help to introduce several helpful instruments to improve deliveries, such as: monitoring of selected freight vehicles, loading bays booking and re-booking, introducing resource bookings and safety assessments that will define access assignments, or introducing dynamic access and priority offers to freight vehicles in special traffic situation or with special properties (Westerheim, 2011).

6. THE SMARTFREIGHT BENEFITS

Freight has its impact on the environment, traffic congestion and safety. Only if controlled and well-managed, it can bring some financial and wellbeing benefits. Today the supply chain is not just the simple old-fashioned scheme of loading – delivery - unloading, it is a comprehensive system based on cooperation between the actors of the supply chain and the implementation of modern IT solutions in order to reduce unfavourable social and environmental effects of the freight on the city life. Monitoring the cargo delivery from the starting to the destination points and the possible contact with the driver through the built-in technological system in vehicles can help to avoid accidents. Drivers, when instantly monitored, are said to be more aware of their driving techniques and abilities so they are more likely to avoid road incidents and accidents. Safety is also established when cargo is categorized and labelled as dangerous cargo and specially controlled during the delivery. Monitoring specific vehicles properties and cargo properties gives the opportunity to keep the delivery safe. The environmental issues can be improved due to the fact that the SmartFreight allows for the traffic management to gather information about individual freight vehicles and decide which of them should be permitted to enter city areas. Such properties like engine type, class and filling percentage may be taken into consideration when the city authorities want to protect sensitive urban areas. Thanks to the traffic management system, they can distribute the traffic according to settlements and appropriate transportation infrastructure. The freight operators sooner or later should adapt to the new standards and provide more environmentally friendly light-duty trucks and heavy lorries to be able to enter low emission or green city areas (Westerheim, 2011). Such a practice will help to reduce carbon emissions inside city centres. Fewer vehicles in cities mean less congestion and at the same time smaller amounts of fumes of carbon monoxide, carbon dioxide and nitric oxide or nitrogen dioxide.

7. CONCLUSION

The SmartFreight project combines the management knowledge, instruments and techniques and the most innovative information and communication technology solutions, which together allow city representatives and freight operators to reap the benefits from the well-structured and effective method that will help them to improve the cargo delivery system. It improves the existing systems of managing the traffic or delivery by offering ready and tested solution of information technology and management models prepared to plan and control freight vehicles movement in cities. The quicker, safer and smoothly operated freight distribution is not only financially profitable, but also brings environmentally positive effects. Avoiding congestion and traffic because of the unnecessary vehicle flow in urban areas reduces pollution and noise, as well as unnecessary accidents. Freight delivery, if controlled and scheduled, is less harmful for city environment. Only allowed and expected vehicles appear in specific parts of the city, which results in better air condition. Solutions for transport operators such as loading bays, special waiting zones, information about traffic and obstructions make the cargo delivery easier and faster, and do not cause unwanted frustration among drivers, transport managers or clients because of rush hours, delays or unexpectedly closed roads. In future, the supply chain will focus on seven priorities defining the sustainable logistics industry and municipality management: logistics will not figure just as a commodity, it will focus on effective low-carbon policy and economy; companies, governments and financial institutions will adapt technologically, which means they will promote companies implementing new technological solutions in their logistics models, for example hybrid, electric or other low-emission vehicles. Such delivery and freight companies will be supported with advise, low-cost loans, or other direct subsidies by local governments and financial establishment; competitors will be forced to cooperate closely in order to attain sustainability, and it means that all actors in the society, business and government will arrange standards, agree on price tags and support binding regulations in strict cooperation to achieve the goal of sustainable logistics, also the customers, suppliers and service providers will agree on low-carbon policy along the supply chain if they wish to be competitive on the market. For example, lower emission can be attained through the consolidated shipments and multiuser warehousing; together with sustainable innovations, business companies will change their models of logistics; CO_2 will be obligatorily tagged and carbon emission will cost so much that special adequate regulatory measures will have to be implemented. Furthermore, the promising trend to save carbon emissions along the supply chain is the use of the digital distribution of documents, books and other media (Deutsche Post DHL, 2010). This will be the standardized practice of "decarbonizing" supply chains and distribution processes. Therefore, the SmartFreight project so far seems to be the most effective and superior way to combat the problems of cities i.e. congestion and pollution. It combines the traffic management measures (priorities, monitoring, access control, etc.) towards individual vehicles in the city and information about the vehicle, the current traffic situation on roads in the city, instant online information about the free loading bays or limited access to them so that the whole commercial traffic is fully monitored and planned. Communication between the city and the freight drivers is the most essential assumption of the SmartFreight project. If something wrong happens, thanks to ICT solutions on-board and communication applications installed in vehicles, the drivers can be detoured if accidents on roads occur or the road is under construction, or stopped before unnecessary access to the city core, or guided to choose another faster or unclogged way to reach the destination. In order to reduce noise and pollution in the city cores, city authorities should arrange the traffic flow. For example, more tunnels for freight vehicles, delivery outside rush hours, privileges to green vehicles, denying access of heavy vehicles or those carrying dangerous cargo to special city zones (schools, parks, home areas, etc.), avoidance of mileage i.e. delivery companies should pre-book the loading bays so that the drivers will not drive around the city looking for loading bays. This helps to reduce or stop unreliable deliveries, late deliveries or unwanted jams inside the city cores. Again, a smaller number of freight vehicles inside the city central parts means less pollution and noise and more space for passenger cars and cyclists, as well as more options for city authorities to reorganize the city centers for pedestrians. The SmartFreight is a recipe with ready to implement keys to environmental and congestion problems of modern conurbations, which any city authorities can take advantage of.

References

Barerra, G., McLeod, F., Natvig, M., Westerheim, H. (2008). Towards rational delivery. In *In search of smarter solutions. (pp.20-21)*. ITSS October 2008. Retrieved from https://www.academia.edu/591161/Towards_rational_delivery.

Deutsche Post DHL, (2010). Delivering Tomorrow: Towards Sustainable Logistics. Retrieved from http://www.dhl.com.pl/content/dam/downloads/g0/logistics/green_logistics_sustainable_logistics_study_en.pdf.

IEA, (2009). Transport, Energy and CO2: Moving Toward Sustainability. Retrieved from http://www.iea.org/publications/freepublications/publication/transport2009.pdf.

Jaroszweski, D. (2012). The Impacts of climate change on the national freight sector. In T. Ryley & L. Chapman (Eds.), T*ransport and climate change (pp. 137-173).* Transport and Sustainability (Vol.2). Bingley: Emerald Group Publishing.

Lenzen, M., Dey, C., Hamilton, C. (2008). Climate change. In D.A. Hensher&K.J. Button (Eds.), *Handbook of transport and the environment (pp. 37-60).* Bingley: Emerald Group Publishing.

Łukasik, K. (2014). The system of distribution and transport of dangerous materials in Poland - legal conditions. In B. Skowron-Grabowska (Ed.), *Innovation of logistics processes*. *(pp. 35-43).* Ostrava: Vysoka Skola Banska.

Natvig, M. K. (2015). SmartFreight – a generic approach to its for smart urban freight distribution, *Research Gate,* Retrieved from: http://www.researchgate.net/publication/267561599.

Skibińska, W. (2014). Analysis of vehicle transport in terms of transport of goods in Poland. In B. Skowron-Grabowska (Ed.), *Innovation of logistics processes*. *(pp. 53-63).* Ostrava: Vysoka Skola Banska.

Stańczak-Strząska, K. (2007). Ochrona środowiska w transporcie. Wybrane zagadnienia. Kraków: Politechnika Krakowska.

Suchecki, B. (2006). Zanieczyszczenia powietrza emitowane przez transport drogowy. *Koalicja Lanckorońska na rzecz Zrównoważonego Transportu,* http://lanckoronska.zm.org.pl/?a=koalicja.broszuras_03. Access on: 12.12.2015.

Westerheim, H. (2011). Information and communication technologies. *European Commission DG Information Society & Media, Seventh Framework Programme Theme 3*, D1.2 – Smartfreight Final Report.

www.epp.eurostat.ec.europa.eu

www.smartfreight.info