Archives of
Transport System
Telematics

Volume 11

Issue 4

November 2018

# Telematics Tools as the Support for Unloading Bays Utilization

**K. KIJEWSKA[a], S. IWAN[a], M. NÜRNBERG[a], K. MAŁECKI[b]**
[a] MARITIME UNIVERSITY OF SZCZECIN, Faculty of Economics and Engineering of Transport, H. Pobożnego 11, 70-507 Szczecin, Poland
[a] WEST POMERANIAN UNIVERSITY OF TECHNOLOGY, Faculty of Computer Science, Piastów 17, 70-310 Szczecin, Poland
EMAIL: k.kijewska@am.szczecin

**ABSTRACT**
Unloading bays are one of the most popular and simple to implement measures in city logistics systems. The main strength of this measure is that it effectively reduces congestion effect due to that loading or unloading operations are realize in special area and not influence directly on traffic flow. However, the most important problem in utilization of unloading bays is their inappropriate use (as a normal parking space, not only for delivery vehicles during the delivering process) and the conflicts between users in the case of few deliveries at the same time and with utilization of the same unloading bay. The way to solve these problems is implementation of the telematics tools. The paper is focused on examples of utilization of mobile devices and sensors as the support for the unloading bays booking and use.

**KEYWORDS: unloading bays, city logistics, efficiency, mobile devices, traffic detection, vehicle sensors**

## 1. Introduction

About 70% of energy is consumed and about 80% of greenhouse gases are produced in urban areas (ISPRA 2008). Road transport in the city is responsible for consumption of 32% of energy, 40% of $CO_2$ emissions and the production of 70% of other pollutants. According to the data of the Polish Central Statistical Office, the transport sector in Poland is responsible for the emission of over 28% of nitric oxide, over 27% of carbon monoxide emissions and over 15% of particulate pollutants. One of the key transport problems in the city is transport congestion, understood as the overflow of the transport network and means of transport resulting from exceeding their capacity or its shortage [10].

Some of the above mentioned effects may be perceptible on a local scale (e.g. noise), whereas for example greenhouse gas emissions affect a larger area for a longer period. An important factor affecting the scale of the impact of the indicated effects or their spread is the population density of the city. Fig. 1 depicts the interdependencies between urban transport features and its negative effects.

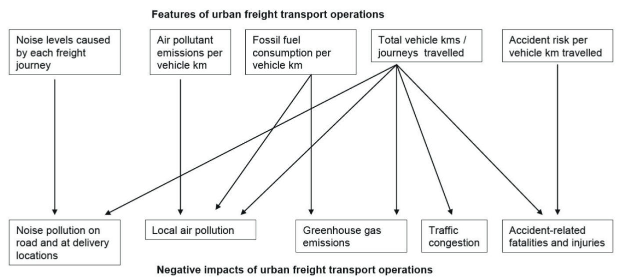


**Fig. 1. Interdependence between urban transport features and its negative effects [2]**

Distribution of goods in cities affects primarily the health of residents, noise and environmental pollution, safety and the occurrence of congestion [17]. Every year, the European economy loses about 1% of GDP as a result of overcrowding of urban roads, which results in lengthening the travel time. It should also be noted that despite the low share of delivery vehicles in accidents, their effects are very serious and often result in death or serious injury.

Freight transport emits a significant portion of air pollution both on a global and local scale resulting in a reduced quality of the natural environment in urban areas. On the other hand, emission of pollutants directly translates into the health of residents [16]. Increasing environmental pollution is responsible for generating about 70% of carcinogenic and dangerous substances in the air [16]. It should be emphasized that urban freight transport generates twice as much external costs in this scope as passenger transport, as shown in Table 1 on the example of Italian cities.

**Table 1. Percentage share of external costs per passenger and freight transport[16]**

| | Greenhouse gases | Air pollution | Noise | Security | Congestion | Total |
|---|---|---|---|---|---|---|
| **Passenger transport** | 1,17 | 4,84 | 2,62 | 5,44 | 4,38 | 18,17 |
| **Cargo transport, including:** | 1,75 | 24,81 | 5,31 | 0,3 | 10,79 | 44,17 |
| **light transport** | 0,71 | 9,94 | 2,39 | 0,2 | 4,17 | 18,66 |
| **heavy transport** | 1,2 | 14,87 | 2,92 | 0,1 | 6,62 | 26,28 |

Residents of urban agglomerations are exposed to communication noise almost all the time. People are constantly exposed to noise while working, learning, shopping, moving between many points throughout the day. Car engines, squealing tires, sound of horns, signals of emergency vehicles causes – people cannot hide from the noise even in their houses, especially if they are located in the city center on the main road arteries. Traffic noise affects the quality of sleep, rest and work. It may also lead to neurotic states. Being in constant noise leads to systematic impairment of hearing (www.halas.wortale). The consequence of chronic noise is e.g. the development of cardiovascular diseases, e.g. ischemic heart disease (share.pdfonline.com) .The noise from 40 to 60 and more decibels leads to hearing damage. In summary, it is possible to identify three basic points of influence of urban freight transport [13]:

1. people, traffic accidents, excessive noise, pollution of the environment, resulting in a deterioration of the health of urban residents;
2. profits, especially felt by carriers due to limited access to designated places at certain times, congestion delaying delivery or fees for environmental pollution;
3. planet, e.g. the impact of pollution on global warming.

An uncontrolled increase in the number of vehicles in urban areas contributes to inefficient distribution of goods resulting even from the lack or improper use of places for loading and unloading. In everyday situations, deliveries to commercial, service or HoReCa points are carried out by delivery vehicles stopping directly on lanes, generating road jams, which is particularly noticeable during peak hours.

Although the delivery of goods to city centers often with historical buildings is necessary to maintain the economic and social functions of cities, delivery vehicles in many places in the urbanized area are struggling with the lack of infrastructure necessary for proper functioning such as lack of parking spaces for loading or unloading. Even where such places exist, they are often occupied illegally by other vehicles. Therefore, drivers are forced to park their delivery vehicles on roads, causing disruptions to traffic and reducing safety.

From the point of view of environmental protection, business operation and road flow and safety, it is best for delivery vehicles to avoid blocking lanes, as well as to reduce the waiting time for a parking space in order to carry out loading and unloading. For this purpose, it is advisable to propose a service enabling booking of parking spaces before reaching the place of delivery.

# 2. Unloading bays as a measure supporting urban deliveries realization

## 2.1. The utilization of unloading bays

The unloading bays are one of the most popular and simple solutions supporting the functioning of sustainable urban freight transport. This measure aims to reduce congestion on busy city streets, which often results from parking directly on the lane of delivery vehicles for the time of loading and unloading operations. After designating special bays for unloading operations, traffic flows smoothly, thus avoiding the consumption of additional energy and fuel, environmental pollution, time losses and costs incurred as a result of stops in road congestion. The most important strength of this solution is therefore the impact on limiting transport congestion, and thus the perceived reduction of pollutant emissions. As the research conducted in French Bordeaux showed, the implementation of unloading bays reduced $CO_2$ emissions by as much as 40 kg per day [14]. In addition, the analysis carried out in Szczecin showed that the drivers of delivery vehicles travel an average of about 1.8 km more in order to find a parking space or also stop vehicles on lanes. Similar research conducted in Oslo showed that the distance traveled by drivers to find a parking space for the implementation of unloading operations is even 2 km [6].

The need to establish unloading bays was also the subject of research conducted in Shanghai [8]. The authors presented a discreet model for estimating the demand for using unloading bays. In [1] their influence on the phenomenon of congestion was investigated. The authors proposed a method for determining the optimal size and location of unloading bays. The conclusions from the previous research presented in [12] also confirm the need to establish unloading bays in the context of delivery vehicle drivers' time. In addition, in a model was developed to determine the optimal location of loading/unloading places in relation to the delivery cost category. Compliance with the schedule, delivery time and use of unloading points, taking into account their purposefulness, both from the point of view of truck drivers and other road users, is provided in [9]. Interesting research results are presented in [7]. On the basis of surveys, observations and indications of GPS systems, it was found that unloading bays are utilized not only by delivery vehicles. They are utilized by taxis (8%), private cars (18%) and other company vehicles (17%). Studies have shown that only slightly more than 50% of vehicles using unloading bays were delivery vehicles.

## 2.2. The strengths and weaknesses of unloading bays

The main strength of unloading bays is that they effectively reduce unloading or uploading time for freight vehicle drivers, thus ensuring active use of the loading slots. Also, the costs for setting up the loading slots are very low so that this is a very cost effective measure for the municipality. Furthermore, freight vehicle drivers will also support the measure because it immediately improves their unloading operations. Finally, local residents and passenger car users also benefit because there will be less or no congestion due to 'double parking' of freight vehicles on the streets when unloading goods. Based on the results of C-LIEGE project, the elimination of parking search traffic has a significant effect on freight vehicle kilometers – both in absolute and relative terms. The reductions of pollutant emissions are also very significant, namely 29%. This also has to do with the fact that the shopping area served by the unloading bays is only shopping and services cluster, thus any improvements here affect all retail and services freight traffic [3].

A potential weakness identified for the measure is that parking space is taken away from passenger traffic, which would reduce the popularity of the measure for residents. However, this might be compensated by the noticeable improvements for residents and passenger car users of the street due to the reduced traffic congestion by this measure and in particular the reduction of the 'habit' of parking freight vehicles on the street for loading or unloading them.

The particular impact of unloading bays depends on how efficiently the loading bays are utilised, i.e. if it can be ensured that freight vehicle drivers do not have to wait in the street due to occupied loading bays or do not resort to 'traditional' parking in the street. If freight vehicle drivers do not 'park' in the second row, they need to drive further in search for a suitable parking space, which again creates further pollution and costs. There are opportunities for further enhancing this measure. For example it seems appropriate that the municipality develops specific regulations for the use of these and future unloading slots. Furthermore, a booking system could be installed that would allow drivers to book the loading slots for particular times – or to find out the current status of a particular slot and when it will be free again. Lastly, the measure could be easily expanded to cover more streets in the city center with a high volume of commercial freight traffic.

## 2.3. Utilization of unloading bays – the Szczecin analysis

One of the biggest problems associated with the utilization of unloading bays is the fact of their incorrect use as ordinary parking spaces. For the purpose of this study, observation of the use of unloading bays located in Szczecin, at ul. Jagiellońska on the section from al. Wojska Polskiego to pl. Zamenhofa and from pl. Zamenhofa to Śląska Street (Fig. 2) was made.

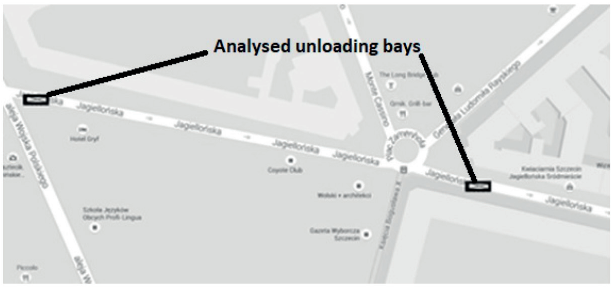


**Fig. 2. Location of the analyzed unloading bays in Szczecin [own study]**

The location of unloading bays at ul. Jagiellońska is dictated by a significant number of deliveries generated by business entities operating in this area. There are a total of 518 entities, including 285 commercial, 185 service, 28 HoReCa and 18 production entities. Section of ul. Jagiellońska from al. Wojska Polskiego to ul. Śląska is crossed by the pl. Zamenhofa, at which Księcia Bogusława X pedestrian street is not used for public transport. In order to carry out orders for entities located on the promenade drivers of delivery vehicles are most likely to use the parking spaces at ul. Jagiellońska.

In the analyzed period, a total of 57,728 wheeled vehicles were identified on both sections. Detailed data broken down by vehicle category is given in Table 2 (from al. Wojska Polskiego to pl. Zamenhofa) and Table 3 (from pl. Zamenhofa to ul. Śląska). Traffic intensity studies were carried out in three-week periods; data included in the tables are average results.

**Table 2. The number of vehicles identified on the section from al. Wojska Polskiego to pl. Zamenhofa [own study]**

| Day | Passenger cars | Delivery vehicles / light trucks | Large trucks | Delivery vehicles / light trucks from 7 am to 4 pm |
|---|---|---|---|---|
| Monday | 5676 | 195 | 71 | 170 |
| Tuesday | 5563 | 240 | 107 | 155 |
| Wednesday | 5484 | 336 | 162 | 288 |
| Thursday | 5364 | 442 | 133 | 358 |
| Friday | 5339 | 476 | 159 | 390 |
| Total per vehicle category | 27426 | 1689 | 632 | 1361 |

**Table 3. The number of vehicles identified on the section from pl. Zamenhofa to ul. Śląska [own study]**

| Day | Passenger cars | Delivery vehicles / light trucks | Large trucks | Delivery vehicles / light trucks from 7 am to 4 pm |
|---|---|---|---|---|
| Monday | 5471 | 187 | 19 | 158 |
| Tuesday | 5146 | 423 | 28 | 340 |
| Wednesday | 5478 | 315 | 33 | 246 |
| Thursday | 5193 | 363 | 47 | 294 |
| Friday | 4829 | 374 | 75 | 278 |
| Total per vehicle category | 26117 | 1662 | 202 | 1316 |

The study showed that the largest volume of traffic for delivery vehicles falls on hours from 7 to 16 (about 80% of all vehicles). For this reason, the analysis of the utilization of unloading bays was carried out at these hours. Tables 4 and 5 summarize the observation results for one week of study.

**Table 4. The number of vehicles stopping at the unloading bay on the section from pl. Zamenhofa to ul. Śląska by category [own study]**

| Day of the week | Vehicles stopping at the unloading bay | | |
|---|---|---|---|
| | passanger cars | delivery vehicles | total |
| Monday | 15 | 8 | 24 |
| Tuesday | 15 | 9 | 26 |
| Wednesday | 17 | 8 | 25 |
| Thursday | 17 | 7 | 26 |
| Friday | 13 | 8 | 21 |

**Table 5. The number of vehicles stopping at the unloading bay on the section from al. Wojska Polskiego to pl. Zamenchofa [own study]**

| Day of the week | Vehicles stopping at the unloading bay | | |
|---|---|---|---|
| | passanger cars | delivery vehicles | total |
| Monday | 13 | 8 | 21 |
| Tuesday | 8 | 3 | 11 |
| Wednesday | 11 | 8 | 19 |
| Thursday | 13 | 7 | 20 |
| Friday | 14 | 8 | 22 |

As the observations showed, the stopover time in the unloading bays ranged from 8 to 20 minutes. It was also observed that only from 5 to 10 minutes the bays remained empty. During the period considered, it was shown that delivery vehicles accounted for 27% to 39% of all vehicles stopping in unloading bays.

Interviews with 60 drivers of delivery vehicles (including those working for courier companies) were also conducted. 40% of them declared that they occasionally use unloading bays. As they emphasized, the reason for this is that most of the time these spaces are occupied by passenger cars. The remaining respondents claimed that always at the time when they deliver, unloading bays are occupied by passenger vehicles, thus making it impossible to use them as intended. 6% of respondents declared that they happen to block a passenger car in the unloading bay, thus blocking the lane.

The reason for this is the lack of supervision by order units over the types of cars stopping at places designated for unloading and loading. It should also be added that due to the lack of data on the route of vehicles, the actual demand for unloading places cannot be determined.

# 4. The examples of utilization of telematics based solution in supporting of unloading bays effectiveness

Telematics tools could help to solve this problem and make the unloading bays utilization much more efficient [4]. Telematics systems are spatially arranged physical information systems with dedicated functionality that, using communication capabilities, enable the recipient to provide designed services. The general principle of operation of telematics systems is the collection, processing, transmission and analysis of data within three functional subsystems:

- data acquisition subsystem,
- data processing and communication subsystem,
- content presentation subsystem for users.

The scheme of telematics system supporting unloading bays utilization is shown in Fig. 3.

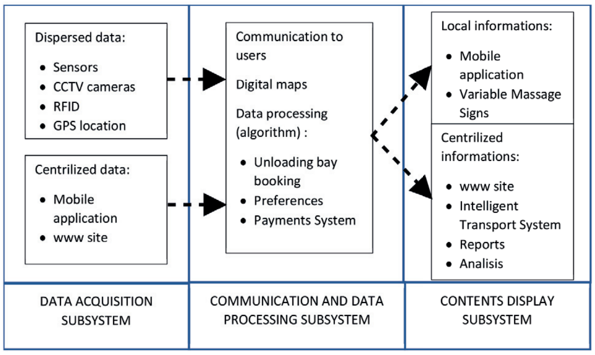


**Fig. 3. Scheme of telematics system supporting unloading bays utilization [own study]**

The data acquisition subsystem, the task of which is to support the effective utilization of unloading bays, in this case should provide real-time information on the status of the unloading bay and the demand for bays submitted by stakeholders. Data on the bay utilization can be collected using a wide range of sensors, ranging from inductive, magnetic or contact sensors, which provide information only about space occupancy, ending with video or RFID sensors allowing identification of the vehicle, and therefore also on access control to the bays, if it is one of the system's functionalities.

In the case of systems in which registration of each user is required, it is possible to use a GPS locator. Booking of a specific time of using the unloading bay should be reported online by entities using the system. These entries via the dedicated website or application go to the data processing subsystem.

In fact, the data processing subsystem is an algorithm that takes into account the demand declared by users (vehicle route, loading and unloading times) and the assumptions of local transport policy, e.g. preferences for electric vehicles, or allocation of time slots for some groups of goods in specific locations.

The content presentation subsystem for users is extremely important. Due to the fact that the current mobile devices (smartphones, tablets) allow for almost unlimited data transfer capabilities in real time, the most convenient solution seems to be creating an application presenting the content in a form adapted to the type of recipient. Other information will be needed by the driver, operating in the urban space, and the dispatcher planning the transport. Local presentation of content, e.g. using VMS, may prove to be late and ineffective, because the presence of a vehicle in the vicinity of a busy bay is associated with traveling an additional distance in search of a free space, or occupying a lane, which was intended to be avoided. It seems to be extremely important to integrate the management tools of the unloading bays with other ITS systems listed below.

The example of Barcelona proves the effectiveness of telematics solutions in relation to the effectiveness of the unloading bays. As a part of the NOVELOG project, an AREADUM unloading bays booking system (Fig. 4) was presented, based on the use of 9,000 on-street unloading area parking spaces for entities carrying out freight deliveries [11]. After the pilot period (March - November 2015), the mandatory use of a system for monitoring the use of space in unloading bays was introduced. The system was based on an application available for smartphones. Users install the application on the terminal device and register in the system, obtaining an individual identifier. The location of the vehicle is carried out using the smartphone's GPS receiver. The assumption of the system is to limit the parking time in the unloading bay to 30 minutes. After the place is occupied, the user selects the parking option in the application and sends it to the system via the cellular network. After the permissible time (30 minutes) has elapsed, the user is notified by the application that he must leave the bay and then, by means of the application, he reports to the system that the he leaves the parking space.

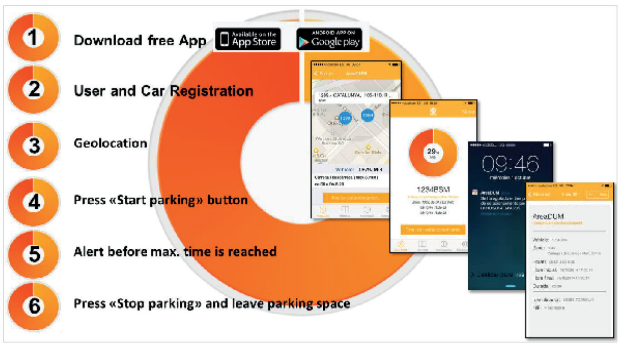


**Fig. 4. Utilization of AREADUM system in Barcelona [11]**

The benefits reported by the system operator, Barcelona de Serveis Municipal, include primarily:

- optimizing the use of public space and strengthening the image of the city as a „smart city",
- reduction of about 20% of the time of searching for a place for unloading, reduction of improper use of unloading bays and improvement of air quality in the city and noise reduction,
- possibility of managing the unloading space based on the collected data on the time and location of logistic operations.

Since the pilot implementation of the telematics system in the third month, the number of unloading operations registered was 254 thousand / month, while at the time of introduction of mandatory use of the system - 502 thousand / month. In the third month of the system's operation, 1763 thousand operations were registered. It is worth noting that about 85% of them are made using the application, the reaming using SMS.

# 5. Conclusion

In recent years, along with the development of information and communication technologies, many solutions have been developed to support the operation of urban freight transport, based on the use of transport telematics and intelligent transport systems. A great example are systems supporting the unloading bays utilization. This solution is, by its nature, extremely useful and allows to limit the negative impact of freight transport on the urban environment. In addition, it is characterized by a relatively low cost-intensive nature and does not require complicated implementation procedures. However, its effectiveness depends mainly on the way the bays are utilized. They are often used by vehicles as regular parking spaces, which makes them completely lose their usefulness. Telematic systems allowing for supervision over the unloading bays and informing municipal services about their unauthorized utilization seem to be an indispensable element of the whole system.

# Bibliography

[1] ALHO A., DE ABREU E SILVA J., PINHO DE SOUSA J.: A state-of-the-art modeling framework to improve congestion by changing the configuration/enforcement of urban logistics loading/unloading bays, Procedia - Social and Behavioral Sciences 111, 2014, 360 – 369

[2] BROWNE M., et al.: Reducing social and environmental impacts of urban freight transport: A review of some major cities, Procedia–Social and Behavioral Sciences, vol. 39 2012, p. 21

[3] C-LIEGE Project web-site, www.c-liege.eu, [date of access: 20.02.2018]

[4] COMI A., et al.: DynaLOAD: a simulation framework for planning, managing and controlling urban delivery bays, Transportation Research Procedia, Vol. 22, Elsevier 2017, pp. 335–344

[5] ISPRA Qualità dell'Ambiente Urbano - VI Rapporto annual, Istituto Superiore per la Protezione e la Ricerca Ambientale, Edizione, Rome 2008

[6] IWAN S., et al.: Analysis of the environmental impacts of unloading bays based on cellular automata simulation, Transportation Research Part D: Transport and Environment, Vol. 61, Part A, June 2018, p. 104-117

[7] JOHANSEN B.G., ANDERSEN J., LEVIN T.: Better use of delivery spaces in Oslo, Procedia - Social and Behavioral Sciences 151, 2014, 112 – 121

[8] MA N., SHI X., ZHANG T.: Urban Freight Transport in Shanghai: The Demand for a Commercial Loading/ Unloading Bay, CICTP 2015 - Efficient, Safe, and Green Multimodal Transportation - Proceedings of the 15th COTA International Conference of Transportation Professionals, 2015, pp. 788-797

[9] MCLEOD F., CHERRETT T.: Loading bay booking and control for urban freight, International Journal of Logistics Research and Applications 14 (6), 2011, pp. 385-397

[10] MENDYK E.: Ekonomika transportu, Wyższa Szkoła Logistyki, Poznań 2009, p. 17.

[11] MORILLO C., ROMÁN M.: Overview on implementation of the On-street Delivery Space Regulation APP, NOVELOG Barcelona Workshop, January 2017

[12] ODANI M., TSUJI T.: An experiment to demonstrate the effectiveness of On-street parking facilities for delivery vehicles, Proc. 4th International Conference on City Logistics, (E. Taniguchi and R.G. Thompson, Eds.), Institute for City Logistics, Kyoto, 2001, 107-116

[13] QUAK H.J.: Urban freight transport the challenge of sustainability, in: C. Macharis, S. Mello: City Distribution and Urban Freight Transport: Multiple Perspectives, NECTAR 2011, p. 37–39

[14] ROCHE-CERASI I.: State of the art report. Urban logistics practices. Green Urban Distribution, Deliverable 2.1. SINTEF Teknologi og samfunn 2012

[15] share.pdfonline.com/607fce17e45e4c569c0e5a1b0a5b76da /N_410_15_Badyda.htm, [date of access: 20.02.2018]

[16] SILVA A.B, RIBEIRO A.: An integrated planning for cities to promote sustainable mobility. Proceedings of European Transport Conference 2009

[17] WITKOWSKI J., KIBA-JANIAK M.: Correlation between city logistics and quality of life as an assumption for referential model [in:] E. Taniguchi, R.G. Thomson (red.)Procedia. Social and Behavioral Sciences. Vol. 39, Elsevier, 2012, p. 577

[18] www.halas.wortale.net/107-Wplyw-halasu-oraz-wibracji-na-organizm-ludzki-szkodliwosc-halasu.html, [date of access: 20.02.2018]