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Connecting traffic management and freight transport for sustainable logistics and supply chains: The case of ITSLOG and SAILOR projects in Amsterdam

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ABSTRACT
In the city of Amsterdam commercial transport is responsible for 15% of vehicles, 34% of traffic's CO_2 emissions and 62% of NOx emissions. The City of Amsterdam plans to improve traffic flows using real time traffic data and data about loading and unloading zones. In this paper, we present, reflect, and discuss the results of two projects from the Amsterdam University of Applied Sciences with research partners from 2016 till 2018. The ITSLOG and Sailor projects aim to analyze and test the benefits and challenges of connecting ITS and traffic management to urban freight transport, by using real-time data about loading and unloading zone availability for rerouting trucks. New technologies were developed and tested in collaboration with local authorities, transport companies and a food retailer. This paper presents and discusses the opportunities and challenges faced in developing and implementing this new technology, as well as the role played by different stakeholders. In both projects, the human factor was critical for the implementation of new technologies in practice.

KEYWORDS: ITS, Traffic Management, Urban freight, Loading zones, Amsterdam

INTRODUCTION

The Amsterdam Metropolitan region (MRA) is an important logistics hub in Europe with the international Airport Schiphol, the port of Amsterdam, Greenport Aalsmeer, datahub AMS-IX, and the high concentration of the agrifood sector in the region. However, the accessibility to the region, which is crucial for the regional economy, has been degraded during the last ten years because of the growing population of the Amsterdam region and the increase in the number of daily commuters, students, and visitors (PBL & CPB, 2015).

Around 80,000 addresses in Amsterdam are visited daily by truck or light commercial vehicles. The most important freight flows are related to retail, catering, construction, facility management, waste, services, and parcel. Commercial transport is responsible for 15% of vehicles, 34% of traffic's CO_2 emissions and 62% NOx emissions (Amsterdam data form 2016). The historic city center of Amsterdam is congested, has issues with road safety problems air quality, resulting in a lowered quality of life for Amsterdam residents and less attractiveness for local business (Amsterdam, 2017). The urban traffic flows lead to problems because of narrow streets. The old bridges and road infrastructure are not designed for larger and heavy vehicles. The number of pedestrians and cyclists are a road safety issue when using the same infrastructure with urban freight vehicles. Vehicles have no information on the availability of loading and unloading zones, and urban freight that does not need to be in the city center still uses the center as a short-cut.

Amsterdam is taking measures for smoother urban freight. The local authorities plan to have a zero-emission zone for the inner city in 2025-2030, and for the whole Amsterdam Metropolitan region by 2050. This should be supported by an 'intelligent access' scheme based on stricter low emission zone requirements (including specific exemptions for vehicles), stricter time access control (with positive exemptions for clean vehicles) and improving traffic flows using ITS, real time traffic data and data about loading and unloading zones to optimization of delivery times windows. The use of new technology (ITS) is an essential tool for these measures. Today, the availability of new technologies (beacons, LoRa, RFID, NFC, etc.) and the high adoption rate of longer-term technologies (4G, 5G, apps, WiFi, etc.) offer solutions for the challenges of city logistics. An example of this is the smart loading and unloading zones where the driver can see whether a loading and unloading zone is occupied or not, and where enforcement gets a signal when a vehicle is parking too long or illegally. Better managing urban freight should lead to an improvement in the reliability and effectiveness of the city logistics 'last mile', a reduction of related urban problems concerning air quality, congestion and safety, and a more effective use of the limited public space.

Loading and unloading zones

Various studies on loading and unloading zones that have been carried out in Amsterdam showing that 74% of unloading events take place on the roadway and 24% on the sidewalk with a lot of annoyance for pedestrians, cyclists, and cars. A possible explanation to this is that loading and unloading zones are used illegally, for example by passenger cars, taxis or construction vans of contractors working in the neighbourhood. Another explanation is the behaviour of drivers who do not want to go any further for delivering the goods and just simply stand still on the road in front of the delivery address. The chance of getting a fine is minimal. The fact that one single unloading event, in which 50% on the road and 50% is parked at the loading and unloading zone, affects more than 100 other road users, does not contribute to the reputation of truck drivers in the city.

ITSLOG and SAILOR project

In this paper, we present, reflect, and discuss the results of two pilot projects (ITSLOG and SAILOR projects) conducted by the Amsterdam University of Applied Sciences with research partners from 2016 till 2018. Both projects are focused on connecting ITS to traffic management to increase accessibility to the city, optimizing the freight transport and decrease the negative effects of urban freight transport on the city of Amsterdam. The main question that both projects try to answer is as follow: How can real-time rerouting and buffering of trucks based on real-time information on capacity utilization of current loading and unloading zones and the current traffic situation contribute to accessibility, better use of infrastructure, reduction of congestion and CO2 emissions, better and more efficient planning, and cost reduction for transportation companies.

The paper is organized as follows. Section 1 gives an overview of the theoretical background and present a conceptual framework for the application of ITS/traffic management and urban freight transport. Section 2 presents and discusses the development, approach and methodology and lesson learned of the ITSLOG pilot project in Amsterdam. Section 3 presents and discuss the same elements for the case of the SAILOR pilot project. Section 4 discuss the results from both projects and present concluding remarks and questions for further research.

BACKGROUND

The quality of infrastructure, transport technology and traffic systems, both technical and functional, should be of a high-quality level to ensure good and reliable accessibility to the cities and regions. However, in most urban agglomerations in Europe, transport infrastructure suffers from capacity problems, congestion, environmental damage, noise pollution and decrease quality of existing of physical infrastructure (PBL/CPB, 2015). Existing infrastructure, can be optimized by using traffic management and intelligent transport systems (ITS). The seamless sharing of (real-time) data between forwarders, shippers, transporters and receivers is of great importance for improving urban freight transport. In recent years, along with the development of information and communication technologies, solutions have been developed to support the operation of urban freight transport, based on the use of transport telematics and intelligent transport systems. Various traffic management and ITS measures can be used to improve the flow, reduce fuel, CO_2 emissions and improve road safety (PBL/CPB, 2015). Traffic management and ITS can be implemented at multiple levels. At the level of infrastructure regulations, such as adaptive traffic lights and regulate ramp dosing systems based on information from loops in the road (I). A step further is the communication between infrastructure and vehicles (Infrastructure to Vehicle - I2V) or vice versa (Vehicle to Infrastructure - V2I). An example of this is the passing of the remaining green time to the vehicle or a speed advice for it approaching a traffic light. Conversely, the regulation of the traffic lights can be improved as the approaching vehicles report their position and expected arrival time to the traffic light (V2I). Finally, vehicles can communicate with each other (Vehicle to Vehicle - V2V) enabling concepts such as truck platooning.

If communication between vehicles (V2V) or between vehicles and the infrastructure (V2I) takes place, there are cooperative ITS systems (C-ITS). Examples of measures are truck platooning, CACC and shock wave damping and smart routing. Dependent of the penetration rate of the systems, individual measures can increase flow by 0% to 10% improve (Ricardo, 2015). In addition, there are other C-ITS measures aimed at safety such as measures that ensure that you stay on your lane, giving warnings for upcoming traffic jams, badly road surface, ghost drivers, smoothness etc. In total, about 25% of traffic jams are caused by incidents (PBL/CPB, 2015). Improved road safety thus also leads to less unexpected travel time loss as due to occasional traffic jams and more reliable travel times. According to the market monitor 'competitiveness ITS 2016' (DITSM Innovations and Connekt, 2016), the ITS sector in the Netherlands is expected to grow relatively fast, because of the availability of high quality and density of infrastructure (both in terms of high penetration of the smartphone and internet use and road infrastructure), and the implementation of new technologies, especially in-car systems. ITS test pilots were conducted at local and regional level, but no pilot is yet implemented at larger-scale. However, less attention has been given to connecting ITS to traffic management and freight transport to optimize logistics processes in terms of efficiency, flexibility, and sustainability. The Amsterdam Practical Trial (APT) is a series of major pilot tests that use the latest innovations, both in cars and on the road. The APT tests new and improved services that integrate innovative systems on roads and in cars for road users. The objective is to improve traffic flow, make traffic safer and help make cities cleaner.

The number of European research projects in this area are limited. In 2013, a project titled *'Travel time forecasts in Transport Management Systems'* (RITS-2 project) was evaluated by TNO. The aim of RITS-2 project (two pilots' studies) was to provide reliable traffic information to the shippers to adapt their planning in real time according to changes in traffic situation (Jonkers and Croes, 2013). According to TNO study, RITS-2 provides a better and more reliable estimated time of arrival (ETA) of trucks. However, information on loading and unloading locations and the costs of congestion and delays are not provided, mainly because of the limited functionality of the system implemented and the unreliability of the information collected by the companies involved in the pilot. In France, the study of Baudel et al., (2016) shows that sharing traffic data with city logistics potentially leads to 18% fewer kilometers and 11% less time transport.

A Dutch food-retail company has been working with a 'Retail Control Tower' providing real-time traffic data of almost 25 transportation companies in the past 5 years. Another example of connecting ITS to traffic management is the pilot project Freilot-1 in Helmond, which involves communication between intelligent traffic lights and trucks. The aim is to reduce congestion and improve accessibility by assigning priority to specific trucks. Also, around Greenport Aalsmeer a similar project was implemented with intelligent traffic lights and trucks as part of a Dutch TalkingLogistics project.

Alho et. al. (2014) conducted a study on loading and unloading zones in urban areas. They show that the planning of loading and unloading zones should take into consideration the location, size, and number of loading and unloading bays, as well as enforcement. In a similar study, Alho et. al. (2015) consider the development of APIs (application programming interfaces) for customizing existing micro, meso, and macro simulation software packages. A potential innovation will be to 'feed' the software with real time data from other sources, such as HERE and TomTom. By using real time data, the operational route planning will be more predictable and reliable. Also, Malik, et. al. (2017) and Escand et. al. (2017) conclude that freight parking-demand models are more complex than car-parking models and require more data collection and validation. Letnik et. al. (2018) developed a model for dynamic assignment of loading bays for urban last-mile deliveries. Results of their simulations demonstrated a significant savings of time and distance travelled, as well as of $CO2$ and fuel. Iwan et. al. (2018) present examples of utilization of mobile devices and sensors as the support for the unloading bays booking and use.

THE AMSTERDAM ITSLOG PROJECT

The ITSLOG project focuses on the interface between logistics, traffic management and ITS, taking supplying stores of a food-retailer in Amsterdam as case study. The ITSLOG project focuses on the effects of the real-time rerouting and buffering of truck, based on 'real-time' traffic information and information about the availability of loading and unloading locations at the stores.

The aim of the ITSLOG project is to connect the available data on loading-unloading capacity to data on the actual position of trucks and ETA at the loading/unloading locations, using additional data such as the actual traffic to generate uniform re-routing and buffering instructions that are communicated to the board computers and the driver of the truck. Different stakeholders can profit from these improvements such as forwarders, transport companies, in terms of decreasing costs of fuels, transport costs, better planning, optimal use of trucks, faster delivering schemes, increasing reliability in occupancy of loading- and unloading places in urban areas, improving use of existing infrastructure, and better distribution of traffic.

Approach and methodology

The research project was being carried out in collaboration with various public and private partners including a food-retail company, a transportation companies and ICT company Simacan. The project has been carried out in three phases: project preparation, execution of the pilot and evaluation and dissemination.

Preparation phase: defining needs, goals, requirements and functionalities of the systems and tools, specification of the type and sources of data, etc., in close cooperation with the stakeholders, like traffic managers, transporters and shippers, etc. An ex-ante evaluation was carried out with to determine the best way to implement the buffer and rerouting concepts. In addition, preliminary data analysis of scheduled times (driving times, loading, and unloading times) and kilometers versus the realized times and kilometers for the delivery stores was conducted by Simacan. Based on this analysis, various deviations of trucks, disruptions at the distribution center, congestion between distribution center and delivery stores in Amsterdam (and vice versa), and congestion within Amsterdam were identified.

Subsequently, specification of data, in terms of which (type of) data, quality and frequency of data, was determined, and buffing and re-buffing algorithm were determined. In the following step the functional design and ICT architecture of the system was determined.

Implementation phase which consist of two steps. The first step is to implement a system that works at closed loading and unloading locations. The complexity of registering occupation and reservation of time slots, such as is required in public locations, are omitted in this phase. The focus was more oriented towards the implementing a working and uniform link between reroute and buffer instructions to on-board computers. In in the second step, the extra complexity of registering occupancy and reserving time slots was implemented as an extension. Figure 1 below gives an overview of the functionalities of the system.

Figure 1: Functionality of the system - Source: ITSLOG (2018).

Evaluation, scaling up and dissemination: During the implementation phase, the algorithms and functionalities of the system were continually adjusted and monitored. In addition, assessment of the impact on traffic flow, logistical processes and stakeholders were evaluated to determine the possibilities and the impact of upscaling of the developed system. An action program is drawn up for the short, medium, and long-term application of the system.

Lessons learned ITSLOG

On one hand, the ITSLOG pilot project shows the potential of systems that connect ITS/traffic management to urban freight transport that can help solve urban traffic issues. On the other hand, the implementation of the concept faced several challenges. One important challenge is the lack of government policies on intelligent access. Also, there is no shared awareness in the transport industry concerning the application of ITS/traffic management systems as tool to improve freight traffic in general and the goods transportation at the city and regional level. There are still issues in connecting traffic data to TMS and planning software of the transport companies and other stakeholders in the supply chain. Finally, the human factor turns out to be -by far- more important in determining the success of the implemented system, especially in the communication with the truck drivers using real-time data (for example about loading and unloading time slots and locations) through apps or other communication devices on board.

AMSTERDAM SAILOR PROJECT

The aim of the Amsterdam SAILOR project was to develop a prototype for dynamic allocation and on demand loading and unloading zones. As stated before, the availability of loading and unloading zones in the city of Amsterdam pose traffic problems for local government and transport companies. Delivery vehicle often cannot find the right zone, because other vehicles are parked illegally in these zones, and most trucks unload deliveries on the streets. This situation leads to delays and hence the unpredictability in freight transport. Also, enforcement (based on e.g. privileges and permits) is lacking and the locations of the zones are not systematically managed by local authorities. For Amsterdam, the original plan was to develop a use case for last mile commerce through the development of prototype using the SAILOR platform for last mile logistics, including:

- Dynamic on demand loading and unloading zones (e.g. more space on Monday- Wednesday and less from Wednesday-Sunday and morning versus afternoon).
- Virtual allocation of loading and unloading based on privileges for e.g. electric vehicles or specific companies based on smart planning algorithms (and the role of government herein in providing open data).
- Linking information about available loading and unloading zones to operational transport.
- Transport Management systems, including sharing open data on local traffic control/ITS with TMS.
- Digital enforcement by government.

A prototype was developed for a leading parcel company by Dutch tech-company 'Technolution'. Future customers for this solution will be local governments seeking to reduce the number of loading and unloading bays in the streets (or make use of flexible capacity), digital reinforcement of using loading and unloading zones, reducing congestion and accidents and giving specific privileges to transportation companies. The benefit for transportation companies is increased reliability of network and planning (and reduced cost of delivery).

During the SAILOR project, a pilot on smart loading and unloading zones in Rotterdam and Amsterdam was carried out by Technolution. In Rotterdam Technolution has developed a stand-alone street sign (with its own energy generation and low energy use), which detects the occupation of a loading and unloading zone, and communicate this information in real-time to the back-office. The system makes it possible to upload reservation plans of a location on the board via the back office, that can be actively monitored by the sign for authentication of the vehicles. The board matches then the reservation with the identification of the vehicle (via a small Bluetooth beacon), and gives a signal to the back-office and parking handheld devices that are nearby, that there is possibly a fault parking. The status and any warnings are communicated to passers-by and users via a display and LED lighting on the sign.

November 2017 the traffic sign was placed at the van Ruysdaelstraat in Amsterdam (see figure 2), and was active for three months. Due to location and installation issues only one sign could be realized. Results of this pilot were positive, regarding energy management, system robustness in various weather conditions, LoRa connectivity uptime, and vehicle detection and monitoring.

Pictures of the sign at the van Ruysdaelstraat Amsterdam, and in test state at Technolution office

Figure 2 - Stand-alone street sign board - Source: SAILOR (2017).

The system architecture consists of different parts, signing and screens on the street, a back-end solution for the realization of the loading and unloading zone planning and offering the possibilities to reserve loading and unloading zones and a data broker for sharing the open data. The back-end system is a proven technology used in many cities worldwide for day-to-day traffic management. With the connection to this system, the status of the loading and unloading zones is real time available. Because data is gathered centrally, it can also be easily integrated with app developers and/or navigation vendors to use this open parking data in their TMS-applications, with which the status of the loading and unloading zones can also be presented to the truck driver.

The integration of the information (sign) with the planning back office of the parcel company was not realized within the project timespan. Problems in the implementation were: an unexpected bankruptcy of the sign assembly partner, reliability issues of BT-transmitters in the delivery vehicles (e.g. low metal signal penetration in combination with isolated van-windows), and shifting management priorities. Therefor it was not possible to measure the effects on the baseline KPI's like cost per delivery, CO2 per delivery and kilometres per delivery.

Lessons learned SAILOR project

The modular approach applied in this pilot project offers opportunities for scalable solutions. This scalability works both in volumes and in functions. The basic data that is collected for the pilot already provides opportunities to gain insight into the use of the loading and unloading zones. New functions can be added relatively easily to the system, such as building a camera connection to the enforcement staff, so that they can immediately picture the situation when an alarm signal is triggered.

The link of the system with external traffic management systems offers practical solutions that can improve traffic management for urban freight. Similarly, connecting the functionalities of the system with third party's data via the open data platform can contributes to further upscaling of the system as traffic management solution. This makes it possible to share information in navigation systems, transport management systems or a website with an overview of all available, reserved loading and unloading zones. The availability of data on parking facilities are already collected and saved in a central system in the cities. By making these data accessible as open data, different app builders and navigation suppliers can then integrate it into their solutions to gain more insight into the availability of the loading and unloading zone.

DISCUSSION AND CONCLUDING REMARKS

Different challenges have been identified during the ITSLOG and SAILOR projects on the integration of ITS/traffic management with urban freight transport. These can be considered as lessons learned from these projects showing the potentialities as well as the limitations developing intelligent strategies for loading and unloading zones and intelligent access, as well as a fundamental problem for active enforcement.

First, the development and implementation of ITS/traffic management systems is done by different departments within the municipality and requires complex coordination. This can be a bottleneck for projects. Not only a municipality must grant permission for the implementation of new systems in the public space (sometimes including formal participation), district managers and enforcement officers must also be involved. Despite having faith in the potential of the concept, the project did not lead to large scale implementation.

Second, local authorities' experts on traffic management, transport, and urban mobility, know very well how technology can support them solving local practical problems, but they are dependent on other people that should bring the concept into practice and work with the solution (for example transporters, truck drivers, retailers, etc.).

Third, current legal frameworks for loading and unloading zones in city areas offer few instruments for active enforcement of the use of loading and unloading zones. Using sensor and/or camera systems at loading and unloading zones can facilitate active enforcement of regulations.

Fourth, companies in the transport sector experience problems related to the reliability of travel times and schedules, unloading times and services to customers. However, transportation companies do not feel a sense of urgency yet, partly due to the often used 'open book' tariff structures (shippers benefit, transportation company not), but also because the uncertainty related to the financial benefits from investing in new systems. Today, the use of loading and unloading zones is still done on an ad hoc basis - largely based on experience of drivers, and therefore not visible in the systems. However, the allocation and reservation of loading and unloading zones in the city is technically possible by connecting the TMS-systems of transportation companies and traffic management system of the municipality in a neutral control tower that can be managed by an independent government agency. For this to happen, transportation companies should be prepared to share planning data. In addition, standardization of these systems is necessary.

Fifth, the human factor plays a crucial role. For example, in the ITSLOG project, feedback from drivers was negative. In the city, with all the cyclists, pedestrians, and other traffic, the drivers want to focus on road safety than checking the information about rerouting and occupancy of loading/unloading zones. In fact, truck drivers want less, rather than more apps, systems, and information on board.

Last, but not least a smart loading and unloading zone application should be accompanied by a broader development of digital dynamic traffic management in cities with ITS for both urban freight, public transport and personal cars. Further development of a smart loading and unloading zone concept using a hardware sensor on location is certainly worthwhile, and in the longer term the application will slowly shift to urban management where loading and unloading zone and parking space are digitally provided with functions depending on the dynamic demand (for example parking space during the day and terrace space during the evening/night).

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