Data Flows in an Integrated Urban Freight Transport Telematic System

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Abstract. The fast growth of cities as well as the increasing complexity of processes taking place within them forces changes in planning and managing them. One of the key factors necessary for controlling the increasing disorder in the area of urban freight transport and conditioning its sustainable growth is ensuring effective data flows between individual parties engaged, to a smaller or greater extent, in its functioning. This paper is focused on assumptions and analysis of data sources for integrated UFT management systems supported by telematics systems.

Keywords: urban freight transport, city logistics, data flows, integration of management systems.

1 Introduction

The fast growth of cities as well as the increasing complexity of processes taking place within them forces changes in planning and managing them. The development of advanced societies, which translates into the increasing requirements regarding the provision of products and services necessary for well-being of the city users, businesses and visitors to the city result in more and more complex tasks for city administrators.

The research conducted in Germany has shown that 80% of the transport performed within cities is done by means of road transport [6]. Choosing this kind of transport for making deliveries in urban areas leads to many adverse effects connected mainly with environmental pollution, compromised safety on the roads and a negative image of a city along with diminishing its functionality. Another problem is the congestion effect which contributes to increasing costs of vehicle operation and infrastructure maintenance, time wasted by transport users and losses connected with the time needed for delivery making, etc. The majority of transport in urbanised areas is generated by industrial, commercial and service companies. The distribution function initiated by the businesses contributes to an increase in logistic flow streams within a limited area. Currently they are usually implemented in an uncoordinated and chaotic manner and it is extremely difficult to organise, manage and optimise them.

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A solution to stop all those negative processes is sustainable growth which deals mainly with analysing the reasons for excessive use and deterioration of the environment, and also with specifying a strategy for limiting the process in three main areas: ecological, economic, social and cultural. The most effective activities in a sustainable freight transport policy are those which concurrently take into account all the three aspects while minimising the costs connected with meeting the expected goals.

Sustainable growth is now one of the key challenges for more and more diversified and complicated economic systems. Developing appropriate assumptions for implementing the concept becomes of key importance for achieving a success and minimising the costs connected both with the implementation process itself and the subsequent use of the solution. One of the key factors necessary for controlling the increasing disorder in the area of urban freight transport and conditioning its sustainable growth is ensuring effective data flows between individual parties engaged, to a smaller or greater extent, in its functioning. Lack of knowledge regarding cargo streams and their direction, structure etc. makes it difficult to control and manage them so as to limit their negative impact on the city organism, particularly on the environment and inhabitants. Additionally, development of information society and continuous digitalisation of different areas of life make it necessary to get control over the data resources regarding urban freight transport, as it is becoming indispensable for its correct functioning.

2 Importance of Data Flows for UFT Efficiency

Utilization of telematics systems in the area of urban freight transport depends on [7]:

- reducing freight distribution costs
  - increasing productivity of local delivery vehicles;
  - increasing reliability of commercial vehicle operations;
  - increasing safety;
- increasing the capacity of urban freight systems (without providing additional traffic infrastructure).

The basis for efficient management of urban freight transport is an effective information flow and ability of knowledge extraction from the fast growing data resources. In view of the above assumptions, the following question remains unanswered: What is the actual demand for data and information voiced by the participants of the above mentioned transport processes within the city, their stakeholders and other beings (institutions, organisations, entities) connected with them and dependent on them? On the other hand, where should we acquire the specified data resources, what structure and scope they should have and what can be the costs connected with the data acquisition? And consequently, what can be the impact of determining the demand for data on urban freight transport effectiveness?

Specifying the information needs within the area of urban freight transport, and also the interdependencies between them and the other elements of the city's transport system will make it possible to take control over the increasing disorder in this area and enable its development in accordance with the principles of sustainable growth.

3 The UFT Solutions Based on Application of Telematics

It‘s possible to divide the present UFT solutions into many kinds. “BESTUFS Good Practice Guide” divides them into three major groups [1]:

- goods vehicles access and loading in urban areas,
- last mile solutions,
- urban consolidation centres.

This classification not clearly emphasises the needs at the area of IT and telematics systems application. All kinds of the above solutions include, to a greater or smaller extent, a necessity of information and communication technology implementation. More detailed classification is proposed in C-LIEGE project. The document “Definition of suitable set of actions/measures for an efficient and energy saving organization of goods transport and delivery in urban areas” indicates 17 categories of UFT soft measures in 7 activity areas [3]:

- administrative (access restrictions, access incentives, advance booking (un)loading areas, low Emission/Environmental Zone);
- financial (mobility credits schemes and congestion charging, vehicle financing models);
- organizational (freight traffic routing information, alternative delivery systems);
- technical (intelligent freight traffic routing, IT logistics tools);
- awareness (promotional and awareness campaigns, eco-driving, Freight Operators Recognition Scheme);
- governance (Local Freight Development Plan, distribution plan-scheme, Freight Quality Partnership);
- special urban planning conditions.

Table 1. Urban Freight Transport measures based on IT and telematics systems

Measure	Description
Freight traffic routing information	Channelling trucks that drive into cities of the urban agglomeration through designated truck routes, e.g. by setting up special road signs or providing special maps with designated routes and lorry-relevant road information.
Intelligent freight traffic routing	Integrating designated lorry routes and lorry-relevant information in navigation software. On this basis, data received from freight vehicles in traffic with regard to their current locations, loaded cargo and destination plans can be connected with real-time road traffic data.
Integrated logistics tools	Web-based logistics tools linking and coordinating producers, recipients and freight operators in order to optimise logistics flows.

It's possible to point out three kinds of measures which are based on IT implementation and telematics system application: freight traffic routing information, intelligent freight traffic routing and IT logistics tools (Table 1).

Also some of the other measures need the telematics support for proper functioning. The descriptions of the measures and types of support are presented in Table 2.

Table 2. Urban Freight Transport measures supported by IT and telematics systems

Measure	Description	Type of IT support
Access restrictions for (un)loading and transit	Access restrictions for loading/unloading operation as well as for moving/circulating related to (a) the type of transport means, and most commonly to vehicle emissions, weights and sizes; (b) access time within specified areas; (c) preferred truck routes and designated lanes; (d) loading and unloading zones; (e) based on licences.	Support for optimization, supervision and management
Advance booking of (un)loading slots	From an environmental, business and traffic flow/security point of view it is best for freight vehicles to avoid double lane stops and reduce waiting times for getting into a loading/unloading parking space. To this end a service can be offered that gives drivers the ability to book a delivery parking space before they reach their delivery point.	Support for slots' booking and management
Low Emission/ Environmental Zone	Institution of protected areas that include both vehicle access restrictions and incentives for environmental or historical/heritage reasons.	Support for supervision and pollution detection
Mobility credits schemes/ congestion charging	Limiting the access of freight vehicles to an urban area by making freight operators 'pay' for each access with mobility credits that were initially distributed by the public administration (or money payments for entries in excess of the assigned credits). Access control equipment in freight vehicles record every entry to the zone and permits the implementation of a mixed pricing / enforcement scheme for different users.	Support for supervision and management
Alternative delivery systems	Van-sharing, cycle-logistics, night-delivery service, packstations etc	Support for booking, supervision and management

4 The Data Sources for Integrated UFT Management System

IT and telematics systems application consists of the three following elements: data acquisition, data processing and information dissemination [7]. The data flow structure depends on interactions between the functioning system elements. Table 3 presents the major interactions in a typical transport system.

The most important factor in proper data acquisition for UFT management systems is the identification of appropriate data sources. Based on the analysis of urban freight transport functioning and structure of local road administration (the major area of analysis was West Pomeranian Voivodeship) as well as on literature research [4, 5, 7, 8, 9], the model of data flows in integrated UFT management system was developed. From the system usability point of view and its regional scope, it was possible to indicate 5 groups of entities:

Table 3. Interactions between major components of a transport system (source: own work based on [2])

Components	Description of information flows	Technology
Trackway – vehicle	Communication between the infrastructure and the vehicle with no direct intervention by the users.	GPS, automatic identification, electronic toll collection, advanced traffic control, automated highways.
Trackway – user	Communication between the road infrastructure and the user (static or dynamic).	Road signs, traffic lights, VMS, personalized information systems.
Vehicle – user	Information provided to the user from the vehicle	Sensors and on-board diagnostics systems.
Trackway – vehicle – user	Communication from the roadway to the vehicle and then to the user.	Real-time vehicle navigation systems, vehicle dispatch systems, driver and public transport information systems (in cars, bus and trams stops, computer kiosks, available through computer networks).
Other	By using a wider range of sensors and exploiting high-speed communications and computing, road authorities can access more information about current traffic conditions.	Detection systems, on-board computers.

- public administration units (including road authorities):
  - local, regional and national roads and motorways authorities,
  - local authorities,
  - road transport inspectorates ;
- safety and emergency units:
  - Police headquarters,
  - medical rescue services ,
  - fire service headquarters ;
  - engineering and technical services;
- traffic detection systems:
  - subsystem of transport environmental impact detection ,
  - subsystem of road and traffic conditions detection ;
- system users:
  - shippers, freight carriers, logistics companies and suppliers:
  - road users (drivers);
  - companies (purchasers);
- other institutions:
  - inspectorate for environmental protection,
  - insurance companies,
  - research and development units ,
  - community-based organizations .

Then, data flows were identified, taking into account their importance for the system efficiency as well as their relevance for the above mentioned entities (Table 4).

Table 4. Data Flows In the Proposed System

Terminator	Flow	Specification
Local, regional and national roads and motorways authorities	In1	Road infrastructure data.
	Out1	Data about: • present road situation, • congestion, • road incidents (collisions, accidents, etc.).
Local authorities	In4	Administration decisions in the area of transport system functioning. Road maintenance data. Regulations and rules in the area of transport system functioning.
	Out4	Data about present road situation. Statistical data.
Road transport inspectorates	In5	Regulations and rules in the area of transport system functioning.
	Out5	Data about delivering structure, traffic flows and present road conditions.
Police headquarters	In6	Regulations and rules in the area of transport system functioning.
	Out6	Data about: • the present road situation, • congestion, • road incidents (collisions, accidents, etc.).
Medical rescue services	In7	Emergency units location data.
	Out7	Data about road incidents (collisions, accidents, etc.).
Fire service	In8	Data about external factors (fires, floods, weather events, risk of pollution etc.). Fire units location data.
	Out8	Data about: • the present road situation, • road incidents (collisions, accidents, etc.).
Engineering and technical services	In9	Data about on-going road works. Engineering units location data.
	Out9	Data about: • the present road situation, • road incidents (collisions, accidents, etc.).
Insurance companies	Out10	Data about road incidents (collisions, accidents, etc.).
Subsystem of transport environmental impact detection	In10	Data about the current situation on the roads: • road traffic parameters: – vehicles detection, – vehicles classification, – speed measurement , – traffic intensity measurement, – dynamic vehicle weighing, • weather monitoring: – measurement of air temperature and RH, – measuring the temperature of road surface and the ground, – detecting icy road conditions, – measuring the wind velocity and direction, – atmospheric pressure measurement, – precipitation measurement, • detecting the road surface condition, • visibility measurement (fog detection).
Subsystem of road and traffic conditions detection	In11	Data on the environmental impact of the transport system: • measuring carbon oxide level • measuring nitrogen oxide level • measuring noise level Tracking vehicles carrying hazardous cargo .

Terminator	Flow	Specification
Shippers, freight carriers, logistics companies and suppliers	In12	Data about freight transport (directions, freight specifics, etc.).
	Out11	Data about present road situation. Data about regulations and rules in the area of transport system functioning, including tolls fees.
Road users (drivers)	In13	Vans and lorries location data.
	Out12	Data about the present road situation.
Companies (purchasers)	Out13	Data about the present road situation.
Community-based organizations	Out14	Information on the transport system impact on the social and economic situation in the Province (unemployment level, accident rate, etc.).
Research and development units	In14	Data from research works and results of scientific projects.
	Out15	Data and surveys necessary for research work and scientific projects implementation, including statistical data.
Inspectorate for environmental protection	Out16	Data about pollution, noise level, structure of hazardous cargo transport.

5 Conclusion

In view of the information society development, the more and more important aspect is getting to know the structures and directions of data flows found between objects being part of particular systems functioning in the economy, and their impact on its functioning both in micro scale as well as at the region or country level or even globally.

Efficient functioning of a transportation system is to a large extent dependent on a proper data and information flow as well as on acquisition of knowledge that enables effective management of the processes taking place in the transport system. On the other hand, the complexity of interdependencies occurring in the system and its considerable heterogeneity imply a need for research regarding the demand for specific data and data aggregates that are needed by individual beings engaged in the transport system functioning (transport system participants, self-governments, local administrative units, etc.). Organising information flows within the area of urban freight transport is a much more difficult task than any similar research carried out with regard to passenger transport. Attempts are made to formulate theoretical bases for determining data streams and their scopes, however, currently there is no universal model based on direct investigation of needs of particular objects of the system. The assumptions presented in this paper constitute an initial stage of work in this area for West Pomeranian Voivodeship.

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