Identification of Information Systems Application in Road Transport Companies in Silesia Region

Sebastian Kot, Bogdan Marczyk, and Beata Ślusarczyk

Czestochowa University of Technology, Faculty Management,
42-201 Częstochowa, Poland
sebacat@zim.pcz.czest.pl

Abstract. Rapid analysis and transport's information transfer are extremely important in order to achieve the efficient transport system, which main task is to fulfil users' needs and requirements. Therefore, telematics called also intelligent transport system is gaining popularity and is still expanding its field of activity. The aim of the article is to identify the information systems applied in road transport companies in Silesian Region. The authors also draw their attention to the effects and benefits of using information technology in transport companies, functions and tools used in road transport activities and identify elements which are essential in the implementation of rapid and efficient transport.

Keywords: road transport, transport telematics, information technology.

1 Introduction

Means of transport along with indispensable technical devices constitute the basic component of the logistic infrastructure. They have the direct influence on the time of transferring goods, the quality and the productivity of transport and manipulative processes, but at the same time they guard against the loss of functionality. Moreover, means of transport indeed influence the realization of the production cycle. Available technologies, which serve for observation, supervising and managing transport processes are become more and more common through transport systems. They play an important role in supply chains, in which the greatest abilities of developing the economy and creating profits exist [1]. Intelligent transport systems enable the growth of productivity and safety of transport, through the exploitation of high-tech IT solutions [2-3]. Specifying - connecting information systems allows for the implementation of streamlining, test and organizational actions in transport. These connections create the multi structure of transport, consisting of the road infrastructure; of road users, cars and the organization and movement control system. *The application of ITS allows to streamline the information exchange between drivers, carriers and logistic centres*" [4].

In order to achieve the efficient transport system a rapid analysis and transport's information transfer is required. It results from the fact that during transporting goods a few factors are changing themselves in a constant way, e.g. conditioning of the traffic, customers' orders etc. The main task of the transport system is the fulfillment

J. Mikulski (Ed.): TST 2014, CCIS 471, pp. 273–283, 2014.

of users' needs and requirements, mainly of shipping companies in the area of accessibility of information, which are required for achieving deliberate objectives. Tasks of information concern limiting uncertainty of surroundings, the level of the risk taken, as well as the evaluation of chances and threats accompanying the company on the market [5]. Above all, information must be current and full, because they influence the quality of decisions made and the time of the response. Apart from that, obtained information should be readily available, what justify creating and using telematics systems. Which are cheap in the maintenance and give full and accurate details about current situations on roads. Telematics transport systems represents a new approach to solving transportation problems[6], enabling transport entities to make fast and precise decisions, those should be backed up with modern technologies.

Transport's information systems concern essential elements in terms of the realization of fast and efficient transport, i.e. the navigation system, communications, traffic control, cargo tracking, condition control of vehicles essential for the activity of transport and shipping companies. They also allow to prepare and to use databases, which support the area of the management. In the result of using the information technology, the following benefits can be achieved by the transport company [7]:

- improvement of financial results;
- growth of the productivity of the transport;
- improvement of the coordination in the communication and the transport in the global scale;
- limitation of the negative impact on the environment;
- optimization of the transport of cargo;
- improvement of the quality of transport;
- obtaining information about the current localization of vehicles and cargoes in the traffic;
- possibility of remote monitoring of conditions of transporting goods and the condition of the vehicle.

Moreover, in the macroeconomic scale these systems cause i.a. [8]:

- growth of the economic productivity;
- increase in the road safety;
- limiting the negative environmental impact;
- balancing the cooperation in the transport industry;
- greater possibility of the accumulation and using transport data.

Applications of systems and information tools are important also for the safety of vehicles, because they allow to control costs, to improve the profitability and to diversify products and services [5]. The condition of the proper implementation and using the application is the rational planning of supplies in the road transport. Such a plan fulfills customer's requirements; the lack of the correct planning causes the majority of failures of the implementation. However, before the schedule of routes is created, one should obtain answers to a few questions, what will cause avoiding generation of higher costs, associated with possible damage or delays.

2 Identification of the Applied Information Technology in Road Transport Companies – Case Study

The purpose of this research was an identification of applied information technologies in transport companies in terms of planning haulage activity.

The research was conducted via e-mail in the first quarter of 2013. The questionnaire was dispatched to randomly selected private sector road transport companies of the Silesia province. The analysis included micro, small, average and large enterprises (recognized on the basis of the number of employed workers), carrying out earning and economic transport with using delivery vans with laden weight above 3.5 tones. The sample put through the examination consist of 51 companies. Depending on their size, small and medium-sized companies constituted the greatest contribution (altogether 43 companies). Two large enterprises employing more than 250 workers and six micro companies took part in the examination.

Functions of information systems suggested in the questionnaire were indicated based on the information technology universally used in transport abroad. Evaluations of benefits resulting from functioning of systems, i.e. streamlining transport activity of goods, was made on the basis of systems' functions and tasks, which are directly connected with the implementation of shipments and which are being exploited also in transport companies.

Due to the fact that the technical interoperability between functions is the same as the interoperability between transport companies, it is possible to exploit individual functions in different information systems, what provides the flexibility of the information exchange among companies applying these systems. Therefore, in order to assess relations between different systems, they were classified according to the area of activity of the transport of goods, which they are supporting.

The most important area, which needs to be considered in the implementation of shipments is the assistance of the driver. In this area needs of drivers, concerning planning and completion of transport operations, safety etc., are important. In this area the main goal of functioning of IT system is streamlining the road to the destination, the safety assurance of the driver, as well as minimizing other road threats associated with driver's objectives.

The support for administrative actions, including staff management, training etc., is also essential. Moreover, managing of the mobile staff peculiar to the transport industry is much more demanding than of employees acting "on the spot". The area of administrative support includes planning, mapping up documentation, supervision, tracking shipments, solving out legal an salary issues. The majority of actions of the system in this are regard the service of orders and play an important role in the implementation of transport's operating activities.

In the transport company, which has at least a few vehicles, efficient vehicles management with the support of owned information system, is significant. Information concerning the condition of vehicles and their location constitutes the main data source for transport companies. Appropriate fleet management can be the essential factor of the competitiveness on the market. It has also an affect on the level of generated income and costs. Thanks to the correctly managed fleet of vehicles, the company is increasing the

level of customer service and can gain distinct financial benefits. An important aspect is the management of transport operations, which directly concern considered operations and are taking place in the transport of goods from one place to another. This sort of actions embrace locating and collecting appropriate packages, assigning packages to vehicles, reducing empty runs etc.

Table 1. Functions and devices used in the road transport's activity

Services/devices	Use area
Road tolls	traffic management
eCall (Pan-European emergency-call system)	driver's support, transport's operations management, traffic management
Navigation	driver's support, fleet management
Product mass index	driver's support, traffic management
Automatic speed adaptation	driver's support, traffic management
Accidents reporting	driver's support, transport's operations management, traffic management
Automatic driver's daily log	driver's support, administrative activities support
Monitoring of employees	administrative activities support
Transport resources optimization	administrative activities support, fleet management
Remote monitoring	fleet management
Goods identification	transport's operations management
Tracking real time	fleet management, transport's operations management
Goods monitoring	transport's operations management
Traffic informations	traffic management
Pointing direction	traffic management, fleet management
Burglar alarm	driver's support, fleet management, transport's operations management
Geofencing	fleet management, transport's operations management
Shipping orders service	administrative activities support, transport's operations management
Speed limit (traffic signs)	traffic management
Driver's working hours planning	administrative activities support

Source: own study based on [9]

Different kind of system's services, which aim is to streamline the flow of goods, are included in the area of traffic management. The strong emphasis is being put on the road safety, as well as on the mobility. This issue is important enough, because the efficient flow has an influence on the rest of the flow's participants. So, crucial functions support making the decision about planning routes out.

Data processed by information system with the help of different kind of transportation tools, are applied for monitoring the transport before, during and after executing the order by different transport's participants. Table 1. shows chosen devices and services, streamlining the transport activity, which deliver to information system the necessary data, which are the base of decision-making processes in the company.

In the international scale, information systems applied in transport, contain specific functions, being based on specific transportation devices and participating in the implementation of transport services. It is possible to characterize these systems with specifications of services directed for performing various tasks, in accordance with users' needs. Each of systems listed in Table 46 is characterized by more than one function, which are repeatable in many systems simultaneously.

Information systems applied in transport were described through 38 functions (Table 2.). They include the following areas: traffic management, public management, transport, electronic payments, crisis management, advanced safety of the vehicle, information management and roads maintenance.

Table 2. Functions of information systems applied in transport

Abbreviated form	IT system features
as	Accident sensing e.g. using sensors for detecting the occurrence of accidents
asg	Alarm signaling in vehicle for use during the occurrence of an event e.g. accidents
at	Automatic triggering for initiating events in vehicle e.g. over speeding, theft
btb	Back office-to-back office communication e.g. using Internet
cv	Camera vision (observation) for collecting video data in or out of vehicle environment
lrc	Long range two way communication to and from vehicle
da	Data anonymity for sensitive data that require advanced encryption into and from vehicle
db	Data broadcast for sending data to multiple vehicles with receivers/antennas
ds	Data storage for saving data within a certain time period in a vehicle
du	Data updates for downloading data into a vehicle from a database
dt	Event timer in in the vehicle e.g. OBU (for discharging tolls in electronic systems of toll collecting)
dd	Driver data logging for collecting data about driver such as id, health etc.
fcd	Floating car data collection e.g. using road side equipment
gp	Global positioning for determining the position of a vehicle internally
gds	Goods damage sensing for determining unusual changes to goods data
gd	Goods data logging for collecting and storing goods data

Table 2. (Continued).

Abbreviated form	IT system features
hs	Human sensing for detecting the presence of a person e.g. in accidents
ids	Identification of infrastructure changes e.g. infrastructure malfunctions
ind	Infrastructure data logging for collecting and storing infrastructure data
lp	Local positioning for location determination with respect to a reference point
mp	Map positioning and updates for calculating and updating map position
m	Monitoring for frequent report of changes on the road
no	Network optimization for determining the best possible route in the network
obu	On-board unit processing of vehicle data
odd	Origin-destination data information of the work of the vehicle
rm	Ramp metering for regulating traffic flow in given road segments
rc	Route congestion information for determining the average HGV density on route segment
di	Driver information display, e.g. LCD display
ed	Emission data logging for collecting emission data, e.g. CO_2 in a region/vehicle
src	Short range communication for transmitting small amount of data, e.g. DSRC between the vehicle and road side
sd	Signal delay information for pre-empting traffic light signals
tfc	Tidal flow control and traffic priority assignment for associating priority to given vehicles
ts	Time stamping for logging the time an event of interest occurred
wf	Weather forecasting information e.g. from weather station
vds	Vehicle damage sensing for detecting unusual changes to vehicle conditions
vd	Vehicle data logging e.g. vehicle number, category etc.
vs	Vehicle speed information collection e.g. using odometer
vc	Voice communication for transmitting audio signals

Source: own study based on [9]

On the base of mentioned above functions 33 IT systems were characterized, which streamline transport activity of examined companies [9]:

- Accident Warning Information (AWI) – informs drivers of accidents on roads in the real time, warns about the possibility of an accident depending on the style of the ride, of weather conditions etc., warns problems and proposes alternative solutions concerning the redirection to other route;

- Advanced Driver Logs (ADL) – is aimed at the accurate registration of the time of individual tasks of drivers, collects data about the driver, i.e. working hours, overtime, sick leave, vacation, additions etc., gathers information needed for the service for the driver, e.g. the tuning of the armchair, an inspection of the level of alcohol, keeping up with the driver's activity on the route, department's staff and lorries' drivers management;
- Driver Planning (DP) - improves the productivity of shipments by planning, which includes successive factors: the time of the day, route, vehicle, goods etc., collects and fulfills preferences for the driver, i.e.: the time of the day, route, season, what is important at planning the work of a few drivers out, determines expected workloads for the driver, collects details about transport orders, develops the work schedule for the driver;
- Dynamic Traffic Information (DTI) –ensures the accessibility of information in the real time about traffic and contributes itself to removal expenses, connected with delays for example in the result of traffic hold-ups;
- eCall – the Pan-European emergency-call system, which lets to reduce the duration of the location of the accident and saving their victims, facilitates intervention associated with the accident, e.g. through alarms, which can be started by hand by the driver;
- Emission Testing and Mitigation (ETM) – it serves the measurement and supporting the politics of the sustainable development, informs road users of consequences of the negative impact on the environment and thereby supports decisions, concerning reducing the emission of gases and other factors tied together with the road traffic, collects details about production from the vehicle along with determining possible damages, resulting from current production in real time;
- En-Route Information Driver (EDI) – provides information about the route of the loading or the unloading of goods, enables the communication with the back, determines based on the route such data as: traffic congestion, traffic conditions, weather conditions, traffic control;
- Estimated Time of Arrival (ETA) - serves monitoring the current situation and the evaluation of the departure time in place;
- Freight Mobility (FM) - transmitting current details about cargo between drivers, dispatchers, owners of goods etc.;
- Geofencing(GEO) – is a critical element of IT and communications system of transport companies, serves for the inspection of the location of the vehicle, provides information about the access to an area or to the infrastructure, dispatchers and owners of goods; enables non-impact control of the public sphere by accumulation, processing and sending information in the real time, determining the possible unauthorized access and potential consequences of action;
- Goods Identification (GI) - streamlines the transportation of goods (loading/unloading etc.) with the help of non-impact identification, provides up-to-date information about the state of goods for owners of goods, gates controllers, inspectors and emergency units, streamlines the identification

of goods for the purpose of the physical manoeuvreetc. by gates or loading-unloading stations, collects data based on documentation about goods e.g. of bills of ladingand of sensors of the goods data collection;

- Information About Infrastructure Repair and Maintenance (IRM) – is provides current information about infrastructure condition;
- Information about the transport of heavy loads (XXL);
- Information on Truck Parking (ITP)–providing information about car parks' location in the real time;
- Intelligent Speed Adaptation (ISA) – ensures up-to-date information about the current speed limit on the road;
- Navigation via a network of routes with the help of information on the map (NAV) which has the task to reduce delays;
- On-board Monitoring Driver (ODM) – tracking information concerning drivers in the real time;
- On-board Safety and Security Monitoring (OSM) –allows the driver for permanently monitoring the vehicle and his contents without manual monitoring;
- Pay as You Drive (PYD) - delivery of information associated with vehicles' insurance, collecting information for insurance companies, drivers and environmental inspectors, managing the history of transports i.e. parameters of the vehicle, speed, location of the delivery, time, productions etc., in the purpose of precise determining the amount of insurance premiums;
- Real Time Track & Trace (RTT) - provides such information as speed, location and status of goods in the real time;
- Remote Declaration (RED) – enables sending freelance agreements via e-mail, provides information for the owner of goods to places of loading, unloading and to vehicles about the whereabouts in order to reduce the time by goods gates, the meaning of this information depends on the origin and the aim of the delivery of goods and of the type of goods and information connected with it;
- Remote Monitoring (RM)- provides information about the diagnostics of the vehicle and their preventive conservation – to workshops, driversand dispatchers, information is being collected on the base of archived historical and current details about the technical condition of the vehicle;
- Road Hindrance Warning (RHW) – road information in the real time and advice to avoid traffic hold-ups;
- Road User Charging (RUC) - collection of fees connected with using of road infrastructure depending on place, time, type of the road and the vehicle;
- Route Guidance (RG) – information essential for specific places;
- Sensitive Goods Monitoring (SGM) - transmission of information about sensitive goods, e.g. perishable food products, medicines and other goods classified as dangerous, for transport's managers and the government control units;
- Staff Monitoring (SM) - gathering information referring to the health of staff;
- Theft Alarm and Recovery (TAR) – informs the owner of goods, entities managing the transport of goods etc. about the temporary actual location and about the condition of stolen goods;

- Transport Order Handling (TOH) – informs owners of goods, transport's managers, drivers etc. about ordering in the real time;
- Transport Resource Optimization (TRO) - the optimization of general stores, i.e. road infrastructure, vehicles' load capacities etc., information delivery to units managing the infrastructure about the way of the exploitation of it i.e.: roads, vehicles, bridges, tunnels, information are being collected on the base of data connected with the infrastructure capacity, with the schedule of exploitation etc.;
- Vehicle Follow-up (VF)- collecting and analysis of the data associated with the productivity - for example empty runs, fuel consumption etc., and then handing this over to all sorts of interested groups e.g. fleets owners;
- Weight Indication (WI) - making available in the real time information about the weight of vehicles and restrictions connected with it, the system hands over restrictions of the road infrastructure and the weight of the vehicle to drivers and control units, this information is based on data connected with restrictions of the infrastructure, so as the maximum height, total weight of the vehicle and other.

In order to identify individual information systems in companies researched, the research questionnaire was used. Through obtained replies it was possible to determine, what functions researched companies made use of.

Results showed, that entities applied 29 of 38 proposed functions of the system, which are possible to be assigned to 21 described information systems in the transport.

DTI and RHW systems, which are concentrated on the delivery of current information about the situation on the road to drivers, have the largest amount of functions. The large amount of exploited functions causes simultaneously, that they have the greatest potential of reducing costs generated while using the system and therefore of operating costs. There is a high plausibility of copying the function as a result of applying more than one system. Out of distinguished systems the least functions have ADL and IRM systems, which task is to register the work of drivers and vehicles.

The number of recommendations for individual functions was described in Fig. 1.

Based on the graph it is possible to notice that the most often indicated function was signed with symbol:

- lp, for local positioning for location determination with respect to a reference point;
- di, for driver information display, e.g. LCD display;
- gp, for global positioning for determining the position of a vehicle internally as information generated in the firm's main office.

The least applied functions in researched companies are voice communication for transmitting audio signals (vc), time stamping for logging the time an event of interest occurred(ts),weather forecasting information e.g. from weather station (wf).

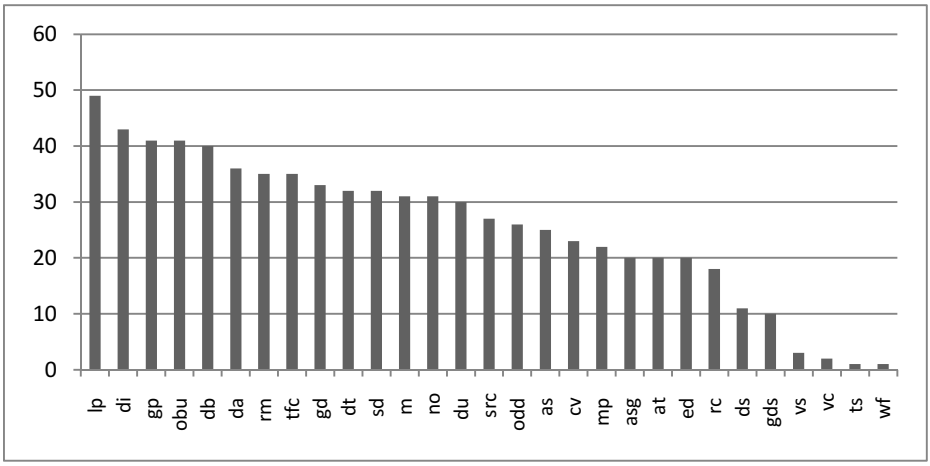

Fig. 1. The number of IT functions used transport management in researched companies [own study]

3 Conclusion

On the basis of an analysis of given functions of information systems according to companies' size, it is possible to point that:

- micro companies use the lowest number of functions of systems which most often concern supporting basic shipping activities, which are: downloading data from the vehicle to the database, determining geographical location of the vehicle, evaluating of the speed of the vehicle and the verbal communication between the driver and the base of the company, in their activity micro entities usually use up to 6 functions observed in ADL and IRM systems;
- amongst small-sized companies the number of used functions is rising, since these entities apart from functions used by micro companies, also apply the data transfer between the vehicle and the base of the company or between other vehicles, the monitoring and tracking the relocation of goods, showing information needed for drivers in the vehicle, determining the date of the appearance of the event, e.g. deliveries of goods, in their activity small-sized companies use up to 11 functions observed in DP, ETM, EDI, OSM, RUC and SM systems;
- medium-sized enterprises use similar functions as smaller companies. Moreover, the detection of accidents was being signed, e.g. with special sensors - clock of the event in the vehicle, concerning e.g. paying tolls in electronic systems of the collection of road tolls, sensor of the priority flow and the inspection of the vehicle connected with data of the vehicle. Altogether, in their activity medium-sized companies use up to 15 functions,

corresponding to AWI, ISA, PYD, NAV, RTT, RED, RM, RG, SGM, IRM, TOH and WI systems;
- large companies usually have at their disposal all functions of systems i.e.: DTI and RHW systems.

Systems identified on the base on the questionnaire, used in researched companies accomplish a lot of tasks associated with the main activity of the road transport correspondent to tracking, positioning of vehicles and goods and sending the relevant information to and from the driver. Above presented identification of information systems application in road transport companies allows for future researches on the information systems application effectiveness analysis as well as construction of model choice for choosing the suitable set of it systems for usage in particular road transport firm.

References

1. Grabara, J.: Sustainable Logistics Management. EdituraUniversitatii "Lucian Blaga"din Sibiu, Sibiu (2013)
2. Szołtysek, J., Jaroszyński, J.: Telematyka transportowa w sterowaniu przepływami ładunków na terenie miasta. GospodarkaMateriałowa i Logistyka 4, 11–12 (2009)
3. Ślusarczyk, B.: Transport Importance in Global Trade. Advanced Logistics Systems 4, 186–192 (2010)
4. Kożlak, A.: Innowacyjność w podaży usług, jako czynnik konkurencyjności przedsiębiorstw sektora TSL. In: KonferencjaEurotrans, Warsaw (2008)
5. Korczak, J.: Logistyka. Systemy, modelowanie, informatyzacja. BEL Studio, Warsaw (2010)
6. Mikulski, J.: Using Telematics in Transport. In: Mikulski, J. (ed.) TST 2011. CCIS, vol. 239, pp. 175–182. Springer, Heidelberg (2011)
7. Bartczak, K.: Korzyści zastosowania telematyki w transporcie, Materiały konferencyjne: Telematykaw transporcie, Uniwersytet Szczeciński, Szczecin (2003)
8. Laurie, A.: Telematics. the New Auto Insurance, http://www.towerswatson.com/assets/pdf/4125/1101-Telematics-FIN.pdf (date of access: June 14, 2014)
9. Mbiydzenyuy, G.: Assessment of Telematic Systems for Road Freight Transport. Blekinge Institute of Technology, Sweden (2010)
10. Mikulski, J.: Introduction of telematics for transport. In: Proceedings on 9th International Conference ELEKTRO 2012, Rajecke Teplice, IEEE Catalog Number CFP1248S-ART, May 21-22, pp. 336–340 (2012), http://ieexplore.ieee.org