DOI: 10.26411/83-1734-2015-2-42-14-19

Road Fee Charging Systems in the Management of Transport Logistics

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The article discusses the logistic utility of registration data of automated measuring systems in the practice of operational management of national roads, expressways and motorways, as well as the shaping of the quality of logistic services.
The analysis of the key problem is presented in the article on the example of the automatic toll collection system viaTOLL, operating on the indicated roads.
The publication draws attention to the key and extramural information character of data registered, stored and offered by specialized, automated record systems. He points to the multifaceted and simultaneous usefulness of this data to the organization and management of the scale of road logistics processes, regardless of the chief, specialized function assigned to a specific automated recording system involved in the recording of specific road incidents.

Keywords: transport logistics, business information, measurement automation, measurement systems.

1. INTRODUCTION

The modern economic era based on intangible business capital, which is information and knowledge created by unprecedented in the history of the world economic development of technology and technologies, in particular information technology and the Internet has opened new perspectives and conditions for economic activity.

New possibilities of shaping the quality and effectiveness of results managed, conditioned by the use of unconventional sources of information and business knowledge generated by highly-advanced and integrated technologies of data recording and processing, have become the hallmark of the modern digital economic era.

The use of modern technologies has started to significantly determine the ability of effective management of enterprises, industries, economies and regions, and the use of information technologies and the Internet in a step-by-step manner accelerated the development of the globalization of markets and competition. Intensive international economy has become a fact in which the increase of significance and development of transport is gaining importance and experiencing rapid growth.

In the circumstances of widespread demand for the intangible nature of business capital of this economic age, and commonly available information technology, automation and information technology - the use of these tools for business management of transport logistics and road infrastructure proves to be a modern necessity because through these tools, information capital is crucial for the quality of transport logistic processes and the knowledge about which way and what to transport economically, how to shape delivery on time and on what factors shorten the delivery time, what technical parameters of rolling stock should prefer to minimize the costs of travel on national roads, expressways and motorways.

The considerations relevant to the topic of this study will be presented below in the example of the national toll system.

2. MISSION, TASKS, VIATOLL RESOURCES

The automatic toll collection system viaTOLL is an example of one of many specialized IT

systems designed to implement a specific business function. The foremost purpose of viaTOLL is charging and collection of tolls for specific sections of national roads, expressways and motorways with vehicles and vehicle combinations with a maximum permissible weight of over 3.5 tonnes and buses with a total weight of more than 9 seats.

The viaTOLL mission is to raise funds for the construction and modernization of roads. For this reason, an automatic toll collection system dedicated to the permanent acquisition of funds from a specific group of road users.

The persistent character of fulfilling its mission by viaTOLL deserves attention not only for this reason, but also because the viaTOLL record operates in a permanent way, i.e. continuously. Without human participation in the data registration process, through all hours of the day, days of the week, month, year and days off from work, Sundays and holidays, the viaTOLL system records vehicles and records their traffic on roads covered by viaTOLL monitoring. Automatically assigns vehicles to the appropriate classification groups for the purposes of calculating tolls according to the criteria recognized by viaTOLL.

In practice, this means that the record of data registered in this automatic system keeps current information up-to-date. It reflects the resource and information about the monitored objects in real time. The thing is significant, as it does not only concern registered states of payments due and collected, but they concern a wide range of data and information about road users who are also viaTOLL clients. So here we are talking about:

a) data and information that have been subjected to multicriteria studies and analyses are able to emanate business knowledge useful for contexts much wider than just settlement,
b) information scope of data, which at the same time and in a multi-criteria manner is characterized by:
   – areas through which these roads run,
   – users of these roads and socio-economic phenomena relevant to these areas and shaped by traffic.

The informational nature of viaTOLL data is thus able to satisfy the informational business needs of multi-branch users far from the gestures of the viaTOLL system, i.e. the Main Directorate of National Roads and Motorways (GDDKiA) and the specificity of its economic business process.

The essence of the problem expands in this way to the practical informational utility of the data of the automatic toll collection system viaTOLL, which is important for the regions supervised by viaTOLL.

The transnational language of data registered by automatic record systems (and stored in these systems) creates a specific language of Esperanto technical communication that allows for a comparable character of analogous and identical phenomena occurring in remote, different locations. Including locations that belong to different countries, and those that focus on the interface and within their boundary line that administratively separates autonomous political, social, economic, legal, religious, cultural and other systems that are characteristic of each of the neighbouring systems.

Therefore, operating on identical data, i.e. originating from an analogous, automatic registration (measurement) system, e.g. a system of toll collection by communities, each operating in its location, allows these communities to current and independent decoding of reality about transport traffic and socio-economic phenomena by this movement being triggered from any time interval and at a very high level of accuracy. The thing is so considerable that it is unachievable by none of the existing and traditional production systems of statistics, which:

a) involve human work in the stage of obtaining primary data for the process of their processing in result information,
b) operate in a non-continuous manner,
c) take place in individual countries in non-logical, separate dates, ranges and non-identical methodologies focused on individuals and through this inconsistent accounting and cognitive goals,
d) do not provide online information but provide information resultant always in historical status.

For these reasons, the use of automated data recording and processing systems in traffic information and business knowledge is gaining importance, as the identification of traffic volumes in real time determines investment decisions in road infrastructure, and the rules for collecting tolls on roads change the decision on rolling stock changes on the rolling stock with the parameters preferred by the road toll pricing. This aspect as a component of transport costs and prices continues to grow in importance.

3. PRINCIPLES OF viaTOLL OPERATION

The viaTOLL system is based on short-range wireless communication technology. For a defined category of vehicles it is mandatory and these vehicles are obliged to mount via the windshield of the vehicle, on-board electronic payment device viaBOX registered for a specific vehicle and possible to use only in the device assigned to this device.

Vehicles with a total weight of less than or equal to 3.5 tons also covered by the obligation to make payments for using roads operated by viaTOLL, the use of an automatic toll collection system was still voluntary at that time. As part of this voluntary service, this category of users may regulate their debts without a service, i.e. by joining viaTOLL and installing a viaAUTO on-board device, acting in the same way as a viaBOX device, or paying by servicing method, i.e. by manually paying receivables at the toll collection points [22].

ViaBOX (viaAUTO) along with 2 types of gates equipped with antennas (*gate for toll collection and control gantry, whose task is to monitor the correct process of payment of fees by each user of the tolled section of the national road*) are integral elements of the automatic measurement system. The viaBOX device (viaAUTO) each time when the vehicle passes under the gantry mounted above the national road covered by the toll collection system, viaTOLL transmits data about the vehicle to the sensors and on this basis the toll for the toll road is automatically calculated and the driver is informed about this fact by a sound signal.

ViaTOLL settles directly with customers via invoices or indirectly through the fuel card operator.

Transactions performed in the viaTOLL system can be observed on line in special programs for managing these payments, which are within the responsibility of the viaTOLL operator and fuel card operators. An innovative solution is the eReporting DKV program, which is the first in Europe to simultaneously analyse road toll payments in all European countries, as well as other transactions from the fuel card, such as refuelling, purchasing accessories, repairs, etc. The program enables automatic creation of reports according to individual criteria, e.g. about the amount of road tolls in Poland for a given vehicle in a given period [20].

The operation of the chief functionality of the viaTOLL electronic toll system is carried out through fee rates depending on the classification group represented by the vehicle. The rates of fees are even two times lower for vehicles that emit the least amount of harmful substances into the atmosphere.

4. PRACTICAL INFORMATION UTILITY OF viaTOLL DATA

Already after three months of functioning of viaTOLL, the data supervisor announced that the largest number of admitted total weight (DMC) vehicles registered in the vehicle system at that time was recorded. He also stated that 72% of those registered were vehicles over 12t with or without a trailer, and the least numerous group of registered vehicles was light vehicles with a DMC of over 3.5t with a trailer [15]. After a year of operation viaTOLL, the owner of its data confirmed the maintenance of this trend, but also reported an increase in the share of passenger cars and vans with a trailer forming a set with a DMC of over 3.5 t to the level of 7.59% from earlier 5.6% [18].

From the viaTOLL data, it was possible to determine the dominance of the heaviest vehicle category and observe the trend in this area, which maintains cognitive significance to the nature of economic phenomena also for other users of this type of information. If it is stated that only 6% of the total registered are buses with more than ten seats including the driver, the knowledge of an analyst originating from outside the GDDiK circle expands to the conviction that on national roads observed via viaTOLL the traffic is mainly of an economic nature , business, earning, not tourist. The same source of data states that after the first three months of operation of the system from the viaTOLL data, it appeared that: 34% of all registered in the toll collection system are registrations made by foreign carriers, the rest are enterprises and people from Poland [15].

Already after 4 months of operation of the automatic toll collection system, the operator published that national vehicle registrations still dominate. He made public the percentage share of foreign cars in the general viaTOLL records, and thus: Germany 17.7%; Lithuanians 12.3%; Russians10,2; Ukrainians 9.7; Czechs 9.4%, Belarusians 6%; Slovaks 5,2; Latvians 3.9%, Hungarians 3.5%, Romanians 2.8% [16]. After a year of viaTOLL operation, thanks to the courtesy

of the data operator, the public could learn that in the total number of vehicles registered in the system, the share of those from abroad increased to 34.5% and that Germany, and then Lithuanians, Czechs and Russians, continued to register. [18].

cargo by road and the costs of traveling the specified route.

Therefore, the information viability of the viaTOLL automated measuring system goes far beyond the information needs of the system's own manager.

Fig. 1. Roads monitored by viaTOLL

After thirteen months the viaTOLL operator gave for the first time the 10 most-loaded roads with the total number of kilometres travelled on each of them. He stressed that it is also ten roads that bring the highest income to the National Road Fund. According to data from viaTOLL, these roads included: A4 - 76.40 million km; DK 92 - 17.64 million km; A2 - 16.42 million km; S7 - 10.90 million km; S1 - 9.01 million km; S3 - 8.98 million km; DK 7 - 7.23 million km; DK 91 - 6.04 million km; S8 - 6.02 million km; S6 - 5.09 million km [19].

While the operator focuses on the incomes obtained for the passage of certain sections of national roads and his interest is the highest load on these roads, his attention is also focused on this information from the system, which can be used by him to maximize the proceeds from driving on the roads .Business analysts, entrepreneurs, shippers and others from outside GDDKiA, traffic intensity and characteristics of this traffic will be interested from a completely different point of view. For them, it will be information about congestion of roads, dominating transport directions, locations and construction of new logistics and distribution centres, economically developing locations and geographical business centres, the existence of opportunities, opportunities, competition, cooperation etc. For others information on traffic on certain sections of roads, at certain times of the month, day, etc., it will be helpful in planning the dates and routes of transport means, as well as in estimating the time required for the passage of the

This phenomenon once again proves the increased, simultaneous demand of many diverse users for the availability of data resources of automated traffic recording and measuring systems. It also indicates that the demand in question covers the demand for data that arise in the specialized system under consideration as a by-product of the operation of its core functionality.

Data that is not economically interesting for the system manager from a business point of view, remain in practice for potential information users other than the viaTOLL manager. If they are not made available to separate users, they remain unused in spite of social costs incurred for their permanent production as part of the key function of viaTOLL.

5. THE INTERNATIONAL ASPECT OF THE IMPORTANCE OF VIATOLL DATA

If viaTOLL can not only derive information about what kind of cars are moving on roads covered by fees, then due to technical parameters recorded during vehicle registration in the toll collection system, you can determine, for example: the route and its length, time, date of travel of vehicles , their owners / disposers, addresses of the companies' headquarters for vehicles using natural persons using viaAuto, number of vehicles of a given carrier, specialization of carriers, scale and directions of transport of particular types of fleet and identification of seasonal transport operations

that only temporarily load roads. The viaTOLL data may participate in the analysis of the impact of seasonal transport on the level of income not only of GDDKiA, but also regions of destination for motor vehicles subject to toll for road tolls.

Technical parameters of vehicles registered in viaTOLL and reflected in the DMC classification system for the needs of toll collection allow to categorize these vehicles. Specify, for example, the brands, age of these vehicles and associated technical characteristics of the car fleet according to specific criteria. They allow to observe trends in the renewal of fleet, to identify units and groups of owners investing in the renewal of the transport fleet. And so, from the viaTOLL data after three months of its operation, the operator said that Polish carriers use old trucks and buses [15], and a month later announced that German carriers use a very modern fleet and that 50% of their vehicles registered in viaTOLL meets the highly restrictive Euro 5 standard. According to the owner of the viaTOLL data, the Czech vehicles are also used by Czechs and Slovaks, and the oldest fleet has drivers from Lithuania and Ukraine [16]. After a year of operation of the system from the viaTOLL data, it was known that the phenomenon of mass rejuvenation of the fleet by domestic carriers and the fact that foreign carriers started to route Polish and national roads, expressways and motorways to newer vehicles, and although those that met the Euro 3 standard were still the highest number of vehicles in the total number of vehicles registered in viaTOLL was higher, i.e. the number of vehicles representing the Euro4 standard - 14.89% and vehicles meeting the most restrictive Euro5-emission standards - 26.7% and Euro 6 - 0.23%. [18]

The above example does not exhaust the cases of practical usability and the use of information additionally available from viaTOLL, and non-key for business DDKiA. The registration of vehicles in viaTOLL according to the classification of vehicles adopted for the purposes of calculating tolls, makes that viaTOLL data through the registration of vehicles, including their brands, can identify the preferred by the market: makes and types of vehicles. Thus, you can observe trends of changes taking place in such preferences. The causes of such or other shaping of these preferences and the influence of changes in these preferences on the volatility of the economic situation in the regions. One can observe, for example, the impact of the increase in demand for specific vehicle brands, car parts for vehicles of these brands or increase in demand for diagnostic and workshop services on the economic level in regions or the reverse observation of the effects of a drop in demand for other brands, the effects of a drop in the level of car parts sales to these brands or a drop in the demand for workshop and diagnostic services regarding brands with declining market popularity, e.g. on the standard of living of the population in the regions in this respect.

With this type and other viaTOLL data, it is also possible to formulate views on:

a) the level of wealth of vehicle owners, broken down by economic operators and natural persons,
b) the intensity of the use of transport means,
c) the amount of financial resources allocated for the purchase of fuel,
d) the impact of fuel price increases on the level of traffic of motor vehicles,
e) the impact of transport competition on the volume of traffic on paid road,
f) ownership status of motor vehicles traveling on national roads.

The variation in fees used by viaTOLL, promoting vehicles with low and lowest emissions, makes the viaTOLL system and in this area generate data about non-essential suitability for their business, and which remain extremely useful, e.g. for entities responsible for the national environmental policy, for which information on the scale of harmful exhaust emissions to the atmosphere is the basis for the implementation of projects and bonds, prompting vehicle owners to exchange vehicles for those that meet the more demanding standards. In fact, for this group of users, information in this field means a tool capable of supporting the effectiveness of their statutory goals. An example of the information referred to may be the viaTOLL operator's publication, according to which after three months of the operation of the automatic toll collection system it was known that:

– 34.4% are registered vehicles that meet the Euro3 standard;
– 22% complying with the Euro 2 standard;
– 20.2% meeting the Euro 5 standard,
– 13.4 complying with the Euro 4 standard,
– 43% representing the Euro 1 standard, and only,
– 0.1% corresponded to the most restrictive Euro 6 emissions standard [15].

A month later, it was clear to viaTOLL that within four months of the system's start-up, the number of vehicles registered in it doubled, and although the number of those that met the Euro 3 standard still dominated among the registered, their share in the total number of registered vehicles decreased since July 2011 and amounted to 33% ,. Clearly, modern, ecological vehicles arrived, which meet the Euro5 standard (23%) and the Euro 6 standard (0.2 increase by 100%) [16].

Although the analysis of this information remains useful in shaping policy and principles of environmental protection, at the same time from this data one can observe the phenomenon of renewing the road transport fleet, and thus identify the level of increase / decrease in revenues in regions resulting from this type of transaction.

Listed as an example of the possibility of additional use of data recorded in viaToLL for the purposes of only collection of tolls for national, express roads and motorways, they do not exhaust the amount of information generated from the system in the additional and extrajudicial status for the viaTOLL handover or other than GDDKiA data users. However, they confirm the multifaceted socio-economic usefulness of these data and the permanent demand for it.

Only many of the economic information capable of supporting the identification of transport trends, as well as global and local trends in the organization and management of domestic and international transport logistics can be derived from viaTOLL records made only for the collection of fees for using only certain types of roads. Information about this type of character includes, for example, identifying information:

a) transit and routes as well as its duration including domestic transport including transport from abroad to destinations in individual regions of Poland,
b) share of individual types of national road transport vehicles and vehicles registered by foreign companies,
c) the number of carriers from particular countries together with determining the class of vehicle that they travel and the level of emissions of that vehicle;
d) the intensity of transport contacts of specific regions and countries with specific areas of the country along with the economic specificity of these contacts
e) travel destinations,
f) car fleet specializations and changes occurring in them,
g) the categories of carriers and the countries of origin of those who invest in the car fleet and those not investing in the fleet exchange in general.

If in further consideration we consider together:

a) supportive, integrated with viaTOll and also embedded in automation
b) a system to control the implementation of the obligation to register via viaTOLL [21], and
c) the process of making payments,

then the identification accuracy of vehicles in terms of their specific set of characteristics and certain features of their travel on roads covered by toll collection viaTOLL must represent a high level of system effectiveness.

The level of identification of vehicles, their features and parameters recorded in viaTOLL, is confirmed by the viaTOLL data controller in public, announcing the payment rate at 99.9% [18].

High viability of viaTOLL corresponds to the high precision of the mapping of parameters and traffic characteristics generated by automatic systems for measuring traffic parameters. This, along with the data ranges:

- generated by viaTOLL and
- provided by other automatic measuring systems of traffic parameters, indicates the possibilities of cooperation of automatic measurement systems and the complementary nature of data sets generated by these systems and in these stored systems.

The confirmation of this can be a combination of data available from viaTOLL with data available from other automation systems for measuring traffic parameters, such as vehicle speed measurement data; data allowing to determine: road strip occupancy, traffic density depending on the time of day, year or vehicle flow parameter [2], [14].

Therefore, the complementary character of data sets registered by automatic record systems, eg concerning phenomena on roads, is the possibility of their integration and, as a consequence, the construction of an integrated database with many threads characterizing road traffic and its participants.

The issue is important for the observation and effective shaping of road transport as well as shaping effective transport logistic processes, as well as network-integrated logistics transport processes; tracking trends and managing the use

and burden of monitoring of national and international roads, including the organization of detours signalled to drivers in real time, monitored by automation.

6. MULTI-ASPECT INFORMATION VIATOLL BUSINESS DATA FOR TRANSPORT PROCESSES

If the scope of viaTOLL data is extended by this, resulting from transactions registered in the eReporting program made by fuel cards with the number of completed fuel refuelling, purchased car accessories and repair services, etc., and take into account the value of the contract for the viaTOLL system with a value of 4.9 million PLN and actual costs incurred until 02 Dec 2011 by GDDKiA by GDDKiA amounting to 595,222,091.39 PLN [17], it is proved by this example also the social legitimacy of making this data available to a wide variety of users in a systematic, systematic and courtesy manner of the gestures of the automatic recording and registration system measurement.

The rationality of this type of activity results from the broadly understood general social interest. First of all because:

a) such systems and many other slot machines including central ones are financed from public funds, i.e. from citizens' taxes,
b) economic efficiency of taxpayers' entities is conditioned by access to high quality information, i.e. one that at a credible level describes the reality of their operation, economic decision-making and management risk in various foreign locations, which they are not able to individually to produce for own logistic processes,
c) the interest of the state is to achieve the economic effectiveness of industries, including transport because effectively operating enterprises are taxpayers, creating jobs, serviced by successive taxpayers.
d) it is a business duty of the state in a market economy to create conditions for the development of enterprises and entrepreneurship.

Meanwhile, the practice illustrated by the viaTOLL case, an excellent part of the data produced by this system leaves outside the business use of information by other users, including by transport companies, to the detriment of their competitiveness and entrepreneurial activities.

The need for a system approach to open access to the data and information resources in question arises also for the fact that under current conditions only the data manager depends on whether and how and to what extent it will be made available to the public. On the example of the viaTOLL manager, it was possible to show that it only depends on the possible and specified by him regularity of publishing a specific type of data aggregates or lack of such regularity. The owner of the data, if at all, occasionally publishes data which he considers to be interesting for the general public and does not deal with satisfying the information needs of anonymous users of this information.

7. SUMMARY

Automatic recording and measurement systems of traffic parameters and parameters of its participants constitute contemporary sources of high quality data and information necessary to shape effective logistic processes taking place in the conditions of globalization of markets and competition, in the environment of high dynamics of change, dynamic development of transport services and demand for these services .

The multi-aspect business information utility of data generated by automatic recording and measuring systems capable of integrated cooperation with other specialized, automated recording and measuring systems, demonstrated on the example of a toll collection system, confirms the legitimacy of investing in the implementation of these systems in road areas that support logistic transport processes and systemic an approach to sharing data aggregates and result information with interested entities and industries.

Logistic transport processes and management of these processes, aimed at increasing their effectiveness defined by expectation, in particular customer preferences, remain particularly open to the use of high-quality external data generated from primary sources. The above covers both transport organizers, logistics and distribution centres as well as entities operating in the area of creating quality and shaping the directions of road infrastructure development. The contemporary essence of transport services, the efficiency of transport logistics processes, their costs, implementation times, etc. are in practice the main areas of managerial challenges and dilemmas that cannot be met at the highest level without access to advanced information about the possibilities and constraints in the business environment, projecting,

implementation and improvement of logistics transport processes.

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