

INTRODUCTION OF ELECTRONIC CARD SYSTEM IN LITHUANIAN CITY PASSENGER TRANSPORT

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Based on the research, the current Lithuanian city passenger transport ticket system has not been changed for already several decades; therefore it has lots of drawbacks (inflexibility of ticket prices, no stored banks of data on carried passengers, no common tickets for all types of transport, etc.). Thus, this system cannot meet the increasing needs of the transport system administrator and the passengers. Consequently, a necessity to improve the city passenger transport ticket system has become inevitable.

In 2006, the electronic card system in the biggest Lithuanian cities, for instance, in Vilnius, Kaunas and Klaipėda it has been planned to install. For this purpose the contact-less electronic cards are foreseen. Implementation of this project will cost about 60 million Litas (i.e., about 17,6 Euro). For the process of implementation of this project, also sources from different European Union funds will be used.

Keywords: *city passenger transport, ticket system, electronic cards*

1. INTRODUCTION

The global city passenger transport has been widely applying electronic ticket systems, made of electronic cards, card-loading machines, electronic ticket scanning technology, control devices, terminals – cash-registers and clearing software. The contact, contact-less, double interface and “hands-free” electronic tickets are used. Electronic ticket systems are considered as the most modern and advanced, as they are multi-functional and ensure a high passenger service level.

2. ANALYSIS OF THE GLOBAL URBAN TRANSPORT TICKET SYSTEMS

Currently, the following major ticket systems are introduced in the global urban transport [1]:

- paper tickets and (or) cards;
- magnetic cards;
- electronic cards.

Paper tickets and (or) cards. Onetime (single) and regular public transportation tickets are discussed. Usually, the fixed ticket prices are established, different discount systems are applied (for pensioners, pupils, etc.). Despite rapidly improving technologies, such tickets are still used in urban transport systems. They are produced of different paper – from a simple thin one up to inflexible cards, which are punched by dynamoelectric facilities. The protection level differs from a more complicate printing up to multiplex graphics, water signs and application of the fibre seen only under ultraviolet rays. For example, currently, the onetime (single) tickets used in Vilnius are covered with double strings, one strings gleam under ultraviolet rays; other ones are visible under simple lighting. Furthermore, each ticket is numbered by a number, which glitters in green under ultraviolet rays. The protection level of a public transportation pass is much higher.

Paper tickets are used in all Lithuanian cities and towns.

Magnetic cards. Magnetic cards are usually produced of thick paper, plastic or their mixture – it depends upon requirements raised on their durability and the printing quality. The difference between magnetic cards and paper tickets lies in one or several magnetic strips covering the cards. Magnetic strips can be pasted in accordance with ISO credit card standards or are simply set in the middle of a ticket. Usually magnetic cards in their size equal to credit cards (such cards are used in London, Dublin, Barcelona, Brussels) or they can be of the so-called Edmonton size (for example, in Paris underground stations, Marseilles).

The data held under the magnetic strip enable to check a tariff, to scan specific card data and save them in a dynamoelectric device. The device can reduce a ticket price (E.G. a number of rides, the rest of time or money), also recognize a magnetic card of other city or town and, if necessary, to scan it.

Most of underground, railway systems and an increasing number of bus carriers successfully use magnetic cards. To summarize, the following conclusion could be made: this ticket technological base is unsophisticated, reliable and safe to use in closed systems when deals of little value are made. Though it has the major drawbacks and shortcomings – it is not protected from falsification and is not comfortable for those passengers who are not frequent travellers and who come from other cities or towns.

Electronic tickets. The public transport electronic ticket system includes [1]:

- electronic cards,
- card loading machines,
- electronic ticket scanning technology,
- control devices,
- terminals – cash-registers,
- clearing software.

Electronic cards. The major component of electronic cards (integral scheme cards) is a microchip installed in a card. This could be a simple memory microchip or a microprocessor, provided with memory and able to process some data. Usually electronic tickets by their size resemble credit cards, however, they can be of any form as their main element – a microchip – is relatively small (e.g. the SIM card used in mobile phones is a sample of the integrated scheme card).

Subject to a way of communication between the integrated scheme card and the scanning device, there are four electronic ticket types: contact, contact-less, double interface and “hands-free” electronic tickets:

Contact electronic cards have a physical contact between ticket microchip plates and analogous microchip plates of a scanning device. Usually cards are inserted into a special gouge. A card receives energy from the scanning device, and then the data are scanned. In order to use a card repeatedly, it should be again inserted into the scanning device. Cards of this type are widely used in telephone, banking, medicine service fields, therefore, their standards and the architecture of open systems are more elaborated than those of other type cards.

Contact-less electronic cards do not need a physical contact with the scanning device to transact a deal. The card transfers data to the scanning device on the airwaves and is usually supplied by the inductive field created by the scanning device. It should be held in at the range of 2–10 cm from the indicated place of the device (e.g. in Helsinki, London, Honk Kong, Manchester). Contact-less cards do not provide such possibilities of data conversion and processing as the contact ones, however, the total time of deals, using them, is much shorter, as there is no need to insert them into gauges. Contact-less cards are usually more expensive, they are not so standardized, no systemic base is created for them, and usually suppliers of non-transport services do not use them. However, great interest for application of this rather new technology in transport sector may increase their popularity and demand.

Double interface electronic cards combine functions of both contact and contact-less cards. This is a combination of contact and contact-less cards created on basis of both technologies.

“**Hands-free**” electronic cards are still being tested; there are only first attempts to use them (the official name of these cards is not still introduced). The main peculiarity of these cards is an ability to scan data at the range of 1,5–2 m from scanning devices. „Hands-free“ electronic cards are provided with their own power supply and the airwaves transmitter. Cards of this type should still be improved with regard to a size and a price, though it could already be stated that their perspectives are greatly promising, especially in such cases when time of passengers’ boarding should be minimal.

Electronic ticket systems are considered as the most modern and advanced, therefore, they are installed mostly in bigger cities of the world, as they are multi-functional and ensure a high passenger service level.

The electronic transport ticket technology is most widely applied in the capital of Korea, Seoul. In Seoul even 7,5 million passengers use electronic cards, by means of which about 80 million deals are transacted per month. The project was started in 1996, when the biggest public transport companies in Seoul started to apply the contact-less card technology *Mifare*, instead of tickets.

Some public transport projects supported by electronic (integral scheme) cards are implemented or are being implemented in Great Britain.

Electronic ones in Manchester replace paper tickets as well. In this town multifunctional cards are being implemented. By means of such cards it is possible to pay for public transport services, to participate in programs of regular customers, to settle up for services in small shops, trading machines.

In 1998, electronic tickets were first introduced in London. Electronic ticket scanners will be implemented in 5800 buses and all underground stations in London. Electronic cards, based on an integrated scheme card, will replace the current technology supported with magnetic field-supported cards.

Electronic public transport ticket system is being implemented in Singapore. Five public transport operators, using 3 750 buses, will apply the common electronic card. The system will cover 22 000 card scanners and at the first stage – 5 million electronic cards.

In Trondheim, Norway, 14 carriers issued 100 000 double interface electronic cards up to the year of 2001. By means of these cards it is possible to pay for services in regional buses, trains, taxis and ships. A similar scheme is being implemented in San Francisco Bay region, where in 2001 26 trains, buses and road operators joined the electronic card settlement system

Electronic card systems used in public transport service settlement sector are being implemented in the Czech Republic and Slovakia.

Electronic tickets are particularly popular in Finland, which is one of the first countries that had introduced this novelty. Electronic tickets in Finland were introduced in 1988, and the first electronic ticket system started to be functioning in 1991. Up to 2000, in Finland more than 20 electronic ticket systems and several urban card projects were already in use. Popularity of electronic tickets in Finland is illustrated by the fact that within this country with population of 5 million inhabitants about 2 million people use electronic tickets.

Card loading machines. Card loading machines are used on ticket sales points and (or) on loading points for electronic ticket loading into a passenger's card. For transport needs, multifunctional loading electronic cards are used, i.e. a passenger, once having acquired a card with a certain amount of tickets, and having used up them all, does not buy a new card – he will need only to load (to enter) a new number of tickets into the same card on ticket loading points.

Electronic ticket scanning devices (punchers). Electronic ticket scanning devices (further referred to as punchers) are designed for passengers to settle for public transport services. A number of these devices in vehicles is unlimited. All punchers are linked into one system – they exchange information with the central device located in a vehicle. Punchers, subject to a type of devices, may give (or not) a passenger a paper ticket proving the deal. Punchers printing tickets are of more complex construction, therefore, they are more expensive, and their maintenance is more expensive as well.

Control devices. In case a puncher does not give a passenger a paper ticket, the control device scans the card information that shows whether a passenger has paid for his ride.

Terminals-cash registers. Terminals-cash registers perform three functions:

- 1) calculate settlements in cash,
- 2) accumulate information from punchers,
- 3) accept settlements by electronic cards.

These devices are used in cases if it is decided, when implementing the system that it will be possible to pay for a ride in cash in a vehicle, and this money should be calculated.

Clearing software. Clearing software allows the precise and fast collection of data from ticket selling offices and vehicles and the analysis. Based on the detailed driving deal analysis, the income received from card loading device is allocated by actual data to transport companies. Clearing software is localized in three system locations: dispatcher offices, local clearing centres and the central clearing unit.

Currently, electronic tickets are being widely implemented in the world; they are regulated by common standards, so that in future it would be possible to use one electronic ticket, for instance, when travelling through all over the European Union.

Electronic tickets have a huge perspective, as they can be provided with a wide memory and a possibility to process data. A high anti-theft protection level and a possibility to use complex coding algorithms make electronic tickets safe. They can be used to create multimedia, i.e. a ticket may perform different multiple functions, for example, it can be used as a meal ticket or as a card swimming pools, parking lots, etc. One ticket can cover lots of media and they can be adjusted to each consumer. An electronic ticket has multi-fold functions; it can be loaded for a new period or by a new

value [2]. This novelty basically changes an attitude towards ticket selling and distribution. As electronic tickets provide a possibility to create multimedia, they can be a perfect form of settlement for various services and are perfectly suitable to create a such a system in which more emphasis is paid on an individual than on a service (e.g., „Urban card“, „Urban guest“ or „Tourist card“). Its flexibility, capacity and memory capacity depends upon the ticket microprocessor, and these factors determine what kind of ticket system architecture (a degree of complexity) can be applied. Suppliers of different technologies determine different electronic ticket standards.

3. DRAWBACKS OF LITHUANIAN URBAN PUBLIC TRANSPORT TICKET SYSTEM

Taking into account all aspects of the existing ticket system, the following conclusion could be made – the current Lithuanian urban passenger transport ticket system has not been changed even for several decades, thus, it cannot meet the increasing needs of transport system administrator and passengers, In order to master complicated and precise transport traffic management technologies, to more rationally value passenger transport services, to provide a wider range of services and tariffs, there arises a necessity to modify the existing Lithuanian urban passenger transport ticket system [1].

The major drawbacks of the existing urban ticket system are as follows:

- the equal tariff is applied for different levels of passenger transport services;
- a ticket system is inconvenient for passengers, due to absence of the common ticket for all transport types;
- inflexible ticket price;
- tickets are inadequately protected against falsification;
- huge costs of ticket production, realization and accounting;
- limited possibilities to implement the advanced ticket selling methods, to introduce new forms of settlement;
- without precise data on the passengers carried it is difficult to plan traffic and coordinate routes;
- a ticket system is not proper, as, for a ride of one stop the tariff is the same as for a ride of ten or more stops.

Following the analysis and estimation of all possible ticket system versions, it was finally decided to introduce the electronic ticket system in the biggest Lithuanian cities - Vilnius, Kaunas and Klaipėda.

4. ASPECTS OF ELECTRONIC TICKET SYSTEM INTRODUCTION IN LITHUANIAN URBAN PASSENGER TRANSPORT

The project of introduction of electronic ticket system in Vilnius, Kaunas and Klaipėda passenger transport is being prepared. The author of this article participates in this project as a consultant. In the mentioned cities it will be possible to go by public transport using the common electronic ticket. Electronic tickets will be valid in buses, and Vilnius and Kaunas – in trolleybuses as well (in Klaipėda there are no trolleybuses).

The scheme of electronic ticket system being implemented is covered under the Figure 1.

The major components of the electronic ticket and information system offered for passengers are as follows:

- equipment installed in transport,
- the vehicle positioning system,
- tickets,
- data transfer system (a link between vehicles and servers, between servers and passenger notification locations),
- scoreboards in stops.

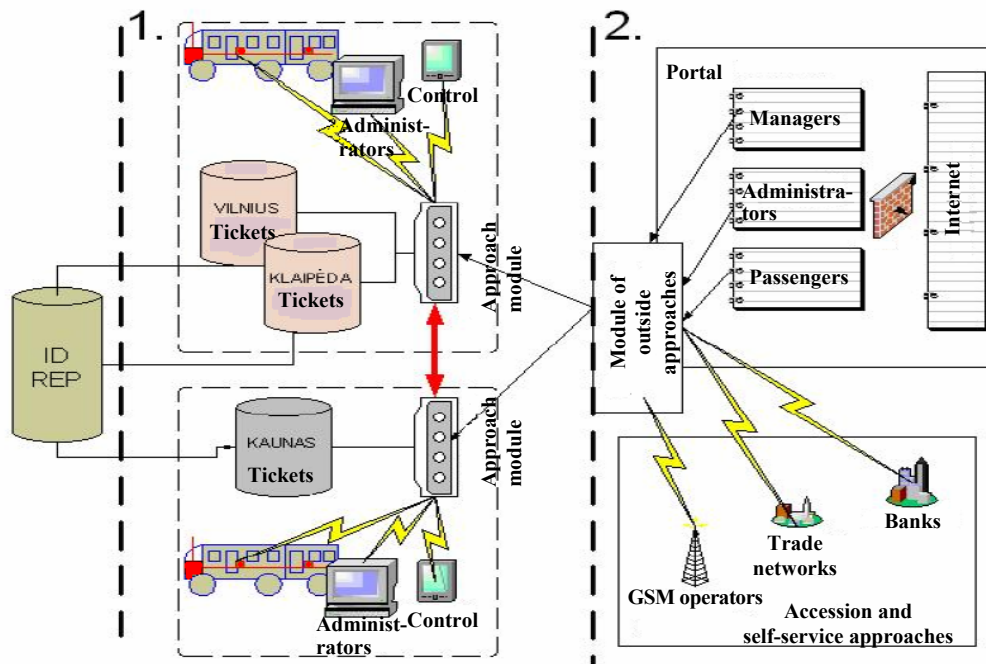


Figure 1. The electronic ticket system scheme

Equipment installed in transport

The main equipment installed in vehicles is the board computer and electronic punchers designed for passenger ticket scanning.

Electronic ticket punchers are definitely the most superior devices; they are most frequently used in modern systems. This equipment enables to flexibly apply different tariffs for passengers and price differentiation in time, provides the detailed statistical information on passenger flows, provides passengers with statements on their usage of public transport services, etc.

Vehicle positioning system

The following methods of defining the vehicle location are used in information systems:

- 1) odometer indication,
- 2) special “notation” of a vehicle in certain locations,
- 3) GPS (Global Positioning System).

Tickets

For electronic tickets system the tickets-contact-less cards are recommended. The following advantages of this ticket system are indicated:

- precise information received from electronic ticket database is used for statistics, accounting, planning and administration;
- a high level of passenger throughput due to extremely fast contact-less card scanning;
- cheap service and maintenance of the system;
- a high variety of methods of settlement for services (sales network, internet, mobile telephone, etc.);
- a high level of card protection;
- a possibility of supplementing the card;
- a possible differentiation of tariffs when using the same card.

Drawbacks:

- it calls for huge primary investments;
- a new, unknown system for users, based on the “electronic purse” principle.

Major elements of the electronic ticket system, using a virtual passenger’s account, are as follows:

Electronic ticket database, in which information on passenger accounts is accumulated and stored: ID, privileges for passengers, ticket tariffs, the account activation, replenishment and check deals, etc.

Such information is necessary in order to check validity of an electronic ticket and to execute allocation of money and statistic information from trade networks to separate urban public transport companies. The ticket database would be used all over Lithuania; it can be used in all Lithuanian cities.

A personal customer's *electronic card*, with its identification number (outside and inside). The card, at request, would be issued to each client using the public transport system. For occasional customers onetime (single) paper tickets with integrated microchip would be sold.

Selling system is the electronic ticket distribution network. Tickets may be distributed through ATMs (Automatic Telling Machines), trade networks, Internet, mobile telephones, stationary selling machines.

Portable control devices, designed for checking passengers by their ID card number and the number-related information under the electronic ticket database, e.g. is the ticket valid, to which category of benefits or tariffs does a passenger card belong, etc. The control device also enables to watch and monitor checkers' activity by tracing how many invalid tickets were found during checks and how many passengers were fined. The above said measures would allow escaping a probability of checkers' willful actions and increasing efficiency of checking system.

Electronic punchers are installed in vehicles and used to activate the purchased electronic tickets. An user, getting onto a vehicle, attaches an electronic card close to the electronic puncher which, after scanning its number, sends the information through the board computer to the electronic ticket database where certain records are made, for example, records on a passenger's usage of the vehicle.

Board computers, installed in each public transport vehicle, intercommunicate with the electronic ticket database and constantly update information on the tickets purchased (supplemented customers' accounts, also manage other systems).

The major elements of the electronic ticket system based on the electronic purse principle are as follows:

Personal customer's electronic card, with a certain amount of funds. A personal customer's electronic card would be issued at request to each public transport customer. For occasional customers single paper tickets with an integrated microchip and a certain amount of funds in it would be sold.

Card supplement system made of different card filling points, which are to be installed in each selling location. A card may be supplemented through the selling network, stationary checkout selling machines and ATMs.

Card debit devices – electronic punchers, installed in public transport vehicles. A passenger, getting onto a bus or a trolleybus, has to put his or her card close to the contact-less scanning device. At that time a certain amount of funds from the card is scanned and a receipt, a proof of the transaction, may be printed. Information, necessary for accounting and statements, is sent to a certain database after a vehicle returns to depot, or is constantly sent through the board computer to the database.

Control devices are used to control passengers and watch and monitor activity of checkers themselves. A checker scans the passenger card information (its number) and checks data of the last transaction (when and what kind of a ticket was bought). If a ticket is not bought, the control device may deduct a fine directly from the card.

A driver by printers installed in the board computer would print single tickets.

In future, possibilities of a transport card it seems will be expanded – they should be provided with the electronic purse function, also with other additional facilities (settlement for a parking lot, etc.).

Data transfer system

The communications system plays a major role in both implementation of such system and its further maintenance. The data transfer service provided by GSM operators are recommended (GPRS technologies).

This is currently the most developed data transfer technology. Solutions of GPRS data transfer intellectual transport systems are already tested by many producers. A price for data transfer is considered as the main drawback, blocking expansion of this technology abroad. The major advantages are as follows: transport operators do not have to feel concern about transport quality and its technological improvement; aspects of amortization and depreciation of the communication equipment lose any significance. The selected communication operator becomes directly responsible for a quality of communication.

Signboards in stops

In modern information systems passengers are informed about the public transport movement in real time on signboards installed in transport stops. Beside the said boards, other methods of providing the information are used – Internet, information stands, mobile telephones, etc.

Along with introduction of electronic public transport tickets in Lithuanian cities and towns, a legal problem is confronted – a number of legal instruments will have to be replaced. One of the major legal instruments needed to be replaced are as follows: the LR road transport code, Regulations on passenger and luggage transport by roads, Code of Administrative law violations, etc.

Implementation of electronic tickets will cost about 60 million LT (about 17,4 mill. EUR). For the purpose of the said project, financial support from the European Union (EU) funds is received. Municipalities of all three cities also allot funds for this project (1 million Lt, each, per period 2005-2006). Kaunas city bus and trolleybus parks have already invested about 4 million Lt on adjustment of the electronic ticket system equipment.

5. CONCLUSIONS

1. The existing passenger transport ticket system in Lithuanian biggest cities has not been changed for several decades; therefore, it has a number of drawbacks and shortcomings (inflexible ticket price, absence of stored banks of data on carried passengers, no common tickets for all types of transport, etc.). Thus, this system cannot meet the increasing needs of the transport system administrator and the passengers. Consequently, a necessity to improve the city passenger transport ticket system has become inevitable.

2. Electronic ticket systems are considered as the most modern and advanced, as they are multifunctional and ensure a high level of passenger service. The contact, contact-less, double interface and “hands-free” electronic tickets are used.

3. The electronic ticket system will be introduced in public transport of the biggest Lithuanian cities, for instance, in Vilnius, Kaunas and Klaipėda. Electronic tickets will be valid in buses and trolleybuses. Contact-less electronic cards will be applied. In future, functions of electronic cards should be extended, so that they could perform the electronic purse functions (settlement for a parking lot, etc.).

4. Implementation of electronic tickets will cost about 60 million LT (about 17,4 mill. EUR). For the purpose of the said project, financial support from the European Union (EU) funds was received. Municipalities of all three cities also allot funds for this project.

5. Along with introduction of electronic public transport tickets in Lithuanian cities and towns, a number of legal instruments will have to be replaced – the LR road transport code, etc

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