The impact of the application of technological solutions in passenger transport on the environment

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Abstract: The main objective was to reduce the retention time at the bus stops, time for drivers' administrative actions, fuel consumption, air pollution emissions of SO2 and to increase the solvency of the company.

For the realization of the set objectives it was needed: to introduce electronic billing system with the use of contactless- chip card as a monthly ticket, all vehicles will be equipped with electronic conditions for the sale of individual tickets and recording contactless - chip card and receive training for direct partcipants.

All vehicles are equipped with electronic conditions for the sale of individual tickets and recording contactless- chip card. All the participants involved in the use of electronic ticketing systems are trained and equipped with the necessary means.

The result of the introduction of electronic toll collection system is to reduce: the retention time at the bus stops and to ensure good performance of administrative driver. The importance of introducing electronic toll collection system is the reduction of fuel consumption, air pollution emissions of SO2, faster handover and discharge of collected cards and increase the solvency of the company.

Keywords: electronic payment system, contactless smart cards, emissions, solve.

INTRODUCTION

The company was founded on March 21, 1958 under the name of "Zenicatrans". Its operation began with 3 trucks for passenger transport at the three city bus lines. Throughout its development, the company has been going through a great deal of organizational changes. In the year of 1989, it reached its maximum development: transporting 36 million passengers, travelling 10.4 million kilometers with 154 busses. In the time period between 1992 and 1995, a high number of driving units was destroyed. After the year of 1995, the company operated with a few obsolete buses.

In 2007, the company got a new name – Javno komunalno preduzeće (JKP) "Zenicatrans-prevoz putnika" d.d. Zenica (Public Utility Company "Zenicatrans - Passenger Transportation" joint stock company, Zenica.). "Zenicatrans-prevoz putnika" is a joint stock company with 80% state-owned share and 17% private share. The core business involves transport of passengers in the city, suburban and intercity transit. Today, the company has 176 employees and 50 buses with 600 departures in the area of municipality, canton and BH Federation.

By March 2007, the system of transport operation data processing was based on travel orders which did not allow an insight into the most of the activities in the process. Due to everyday organizational and subjective problems such as: issue of the individual and monthly tickets, signing them in and out, and settlement of funds by drivers and cashiers, the continuous and daily control of funds inflow was impossible. This way of data processing did not provide the company management the continuous and timely information crucial for smooth business operation.

In March 2017, a decision was made on starting the pilot project of the electronic ticketing system introduction. The main objective of the electronic ticketing system was the following - a contactless smart card was to reduce the time of: ticket issue at bus stops, time spent at bus stops, operation of motor vehicles in the neutral position. All of the vehicles, cash register and technological service were equipped with electronic devices for the sale of individual tickets and recording contactless smart cards. The application of this kind of ticketing system resulted in the reduction of: time of the issuance of individual and monthly tickets, administrative activities of bus drivers, time spent at bus stops. The electronic ticketing system also made a positive effect on the reduction of fuel consumption when at bus stops which directly influenced environmental pollution reduction.

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DESCRIPTION OF ELECTRONIC TICKETING SYSTEM

Handheld terminal IT 3000

Picture 1. Handheld device IT 3000 [2]

IIn March 2007, various activities were initiated regarding the introduction of the electronic ticketing system for passenger transport in cooperation with the company "Četrta Pot" Ltd. from Kranj, Slovenia. The first phase included the installation of two handheld electronic devices IT 3000 and the individual sale of tickets in the bus. Picture 1 shows the handheld device IT 3000 designed for ticket sale onboard a bus as well as ticket inspection carried out by bus inspectors.

Technical features of the IT 3000 device include: terminal, integrated terminal printer, integrated e-card reader, integrated SQL base, TFT touch screen, Windows CE OS, 32 MB RAM.

A detailed data analysis of the features brought about by the new system, indicates the useful information with respect to improvement of technical, technological and economic parameters for a particular means of transportation. Based on the analysis on the IT 3000 handheld device application, the decision was madeto embark on the second phase of the electronic ticketing system implementation.

Stable device TA – 400 including terminal BT3 and electronic ticket

The second phase of the implementation is the continuous procurement of handheld devices and stable TA – 400 devices including terminal BT3 and electronic tickets (smart cards). Picture 2 shows the stable device TA – 400 including terminal BT3 (reader) in the vehicle. The device is installed next to the driver who operates the device using touch screen and issues tickets in a simple way. Picture 3 shows the smart card.

Picture 2. Stable device TA 400 including terminal BT3 in the vehicle [2]

Technical features of a stable device TA – 400 including terminal BT3 are as follows: information on the funds available; full POS application, data key, WLAN or GPRS, integrated SQL base, connection to GPS system, LED displays, big TFT color touch screen. Passenger terminal BT3 is designed for the passenger who approaches the terminal with his/her card and in this manner does everything necessary for his/her ride. Technical features: e-card reader ISO-14443, fast terminal printer with a cutter and simple paper change, big graphic LCD display FSTN, electronic ticketing system.

Picture 3. Smart card [2]

Electronic ticket provides for a fast and simple daily payment of travel in passenger traffic. When the electronic ticket is held close to the terminal BT3, the computer checks the ticket functionality and distance and based on the complex algorithm approves or denies the entrance and at the same time reduces the amount of funds available at the card and prints a payslip.

The system also allows cash payments for occasional travelers who are then issued a bus ticket.

All those transactions are recorded and transferred into the central database, and additionally they provide a basis for internal calculations, drafting reports and traffic analysis.

Nowadays, PUC "Zenicatrans – Passenger Transporttion" has installed electronic ticketing system in all

its driving units. In addition, the bus inspectors, ticket (smart cards) sale officers, cash handling and registration officers handling the drivers and their daily paperwork are also equipped with the same electronic devices.

Picture 4 shows a bus at a bus stop.

Picture 4. Bus at a bus stop [1]

BUS4i Application

PUC "Zenicatrans – Passenger Trasportation" joint stock company Zenica operates through servers in Kranj, Slovenia owned by the "Četrta Pot" Ltd. Kranj Company which actually installed this program in our buses. This includes the following:

- operation by travel order (lines, station, departure time)
- all code lists, price lists, lines etc. are adjustable in the database,
- parallel tariff system
- selection of price list for given line, country, departure/arrival stations, cooperation etc.,
- automatic price calculation for all sorts of pas-

senger, luggage and package tickets,
- higher discount categories (disabled people, employees and others),
- fast printing of tickets with all the data,
- the possibility of cancellation and traffic review,
- the use of contactless card as a ticket (term-based, work, school, coupon ticket),
- recording of each particular ticket sale,
- handling travel orders.

Picture 5 shows electronic ticketing system.

EFFECTS OF THE ELECTRONIC PAYMENT SYSTEM APPLICATION

The introduction of the electronic ticketing system resulted in:

- raising the quality of services in transport
- improvement of technological discipline of employees,
- increase of the capacity availability,
- reduction of fuel consumption and other expenses,
- increased safety etc.

This kind of system provides for a continuous flow of a huge amount of information. The timely and quality information enable the company management to make a comprehensive and high quality analysis of all phases and elements of the transport system with the aim to make informed business decisions for the effective operation of the transportation process.

The system records each particular ticket sold including the place and time of sale, and also registers ev-

Picture 5. Electronic ticketing system, source: copyrighted [1]

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ery single buyer of a monthly ticket. This type of passenger entry recording system opens up endless possibilities for operation analysis on individual routes, as well as the performance of every driver, especially the ticket sale officer who sells smart cards and includes the possibility of monitoring how many of the monthly smartcard rides have been actually realized.

Daily analysis of all the operational elements show that this system has directly influenced the company's survival and its future.

Analysis of fuel consumption especially during bus stopping at bus stops shows that the time the vehicle spent at bus stops has been greatly reduced. The reduction of bus stop time is caused by faster sale of individual tickets and faster inspection and recording of monthly smart cards, which led to reduced fuel consumptions, the fact that directly brings about the reduction of environment pollution caused by exhaust gasses from vehicles.

The effects of the electronic payment system application on the air pollution reduction

Based on daily information provided by the electronic ticketing system, a detailed analysis of the fuel consumption and bus stop time was made for the year of 2014. The table 1 shows basic parameters of the analysis required for the calculation of the amount of sulfur dioxide emissions (SO2) and carbon dioxide (CO2) for the year of 2014.

TABLE 1 Parameters for the calculation of the amount of SO2 and SO2 emissions [1,2,3,5]

Paremeters	Value
Passengers transported, number	5.510.687
Departures for all bus lines in one day, number	600
Average number of bus stops per single departure	11
Average number of passenger boards per stop	3
Reduction of bus stop time per passenger, seconds	5
Daily number of bus stops, number	6.600
Average fuel consumption, 1/100 km	35
Fuel consumption in one hour during engine operation in the neutral position (idling) as driver sells tickets on the bus, 1/h	6
Daily reduction of the bus operating time at bus stops, h/day	27,50
Daily reduction of fuel consumption due to short bus stop time, 1/day	165
Average content of the sulfur in the fuel, mg/kg	6,49
Average specific weight of oil, kg/l	0,85
Combustion of 1kg of fuel, generating the quantity of mg SO2	12,98
Combustion of 1kg of fuel, generating the quantity of m^3 SO2	0,7
Combustion of 1kg of fuel, generating the quantity of kg SO2	2
Combustion of 1kg of fuel, generating the quantity of kg CO2	3,22
Density of the gaseous CO2, kg/m^3	1,98

The table 1 shows that in the year of 2014, the fuel consumption was reduced by 50.490 kg of fuel, all due to shorter bus stop time. Based on the aforementioned parameters and lesser quantity of the consumed fuel, the emission was reduced by 162,57 tons or 82.106 m^3 CO2 and 655,36 kg or 458,75 m^3 SO2.

CONCLUSION

Having analyzed all the information registered by the electronic ticketing system and information acquired, it is obvious that the application of new technologies in traffic contributes to the reduction of emissions of sulfur dioxide, carbon dioxide and other components caused by fuel combustion.

The reduction of emissions is caused by shorter bus stop time and lower fuel consumption. The system provides a great deal of information required for quality management of traffic processes.

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