KRISTIJAN ROGIĆ, Ph.D.
E-mail: rogick@fpz.hr
University of Zagreb,
Faculty of Transport and Traffic Sciences
Vukelićeva 4, HR-10000 Zagreb, Republic of Croatia
BRANISLAV ŠUTIĆ, M.Sc.
E-mail: branislav.sutic1@gs.t-com.hr
Polytechnics Nikola Tesla in Gospić
Bana Ivana Karlovića 16, HR-53000 Gospić,
Republic of Croatia
GORAN KOLARIĆ, B.Eng.
E-mail: goran.kolaric@mzos.hr
Ministry of Science, Education and Sports
Trg hrvatskih velikana 6, HR-10000 Zagreb,
Republic of Croatia

Intelligent Transport Systems (ITS)
Review
Accepted: Oct. 2, 2007
Approved: Mar. 13, 2008

METHODOLOGY OF INTRODUCING FLEET MANAGEMENT SYSTEM

ABSTRACT

Fleet management systems are increasingly changing in various transport companies. Although according to claims of different producers, the usage of such systems can achieve great savings in the business operation, the studies show that for optimal functioning of such systems it is necessary to carry out the evaluation of the company and the very systems according to several criteria. The methodology that allows the FM implementation within the transport companies starts from the analysis of the characteristics of carriers, characteristics of programme packages, which is followed by the evaluation according to several criteria which influence the final choice. The objective of such approach is the adaptation to the users' requirements which eventually results in the improvement and savings in the operation.

KEY WORDS

fleet management, road transport

1. INTRODUCTION

The usage of various systems of information technology support in the fleet management process is the consequence of the development of information technologies that have achieved the necessary level at which they can be operatively applied in the transport companies. On the other hand, in the very transport companies the need has occurred for control and development of various factors which influence the efficiency of using the fleet. The implementation of the Fleet management system is especially widespread in the USA, where different forms of fleet management are used in numerous transport companies, as well as in public administration and the government institutions that have the fleet. In Europe, the information technology fleet management systems are also increasingly used, with the aim of more rational fleet management (reduction of costs) and better adaptation to the transport service users' requirements.

The benefits of implementing the fleet management system are reflected in the improved business organizations and expected savings. Regarding various characteristics of companies that are potential users of the system, when implementing the system, analyses need to be carried out which allow selection and implementation of the system that is adapted to the needs and characteristics of the users.

2. FLEET MANAGEMENT SYSTEMS

According to different research carried out in the world, especially in the USA [3], where fleet management information systems are widely used, the potential system users can be divided according to several criteria.

2.1 Potential system users

The first criterion refers to the size of the fleet of the potential user. According to this criterion the potential users are divided into:

- carriers with small fleet of up to 20 vehicles,
- carriers with mid-size fleet - 20-99 vehicles,
- carriers with large fleet - 100-499 vehicles,
- carriers with very large fleet – more than 500 vehicles.

The notion of vehicle in this case refers to trucks and vehicles with gross weight greater than 5t.

The second criterion is related to the size of the scope of activity (operative zone) of the fleet. The fleets are divided into the fleets with local operation (covering the area of one city), regional operation (within the county), and the carriers of national significance.

The third element refers to the characteristics of the daily vehicle routes, distinguishing the fleets for the fixed routes and the fleets (carriers) with a variable route.

The fourth criterion refers to the time framework of the delivery, with essential tolerance in delivering particular shipments or goods. The carriers can be here divided into three categories:

- with greater time tolerance,
- with small time tolerance,
- with combined tolerance – depending on the priority and characteristics of the delivered goods.

It is clear that the transport companies have very different characteristics which result also in different criteria and expectations of the companies when introducing and building the fleet management system.

2.2 Users' expectations

Although there is a wide range of different systems and manufacturers of information technology systems available on the market, the requirements of the transport companies and their priorities depend on the characteristics of single transport company. Based on the carried out research, several elements can be identified which represent the intentions and objectives in the improvement of the operation of the transport companies after introducing the fleet management system:

- increase in the revenue per travelled kilometres,
- increase of revenues per trip,
- reduction of vehicle idling,
- availability of different cargo handling and other equipment,
- reduction of operative costs,
- availability of drivers,
- possibilities of additional usage of vehicles during trips,
- quantity of cargo per single delivery,
- evidence of the points of start and end of delivery,
- stock management,
- evidence of the time of delivery,
- reduction of fuel consumption.

Taking into consideration the fact that the importance of a single objective depends on the characteristics and objectives of each mentioned carrier, further in the text a more detailed explanation will be given for each objective according to the frequency of requirements.

The most frequent requirement of the carriers refers to the possibility of communication with the driver during the performance of the tasks and a kind of control. Here, the possibility of locating the driver is required, taking into consideration the planned vehicle route and the driver's working hours. The carriers see the benefits of implementing such a measure in monitoring the working hours of the vehicle, tracking the vehicle position, possibility of rerouting the vehicle, possibility of communicating with the driver, and the possibility of using the system for vehicle routing.

The evidence on the point at which the delivery starts or ends is one of the basic elements of planning or optimizing the route of vehicle movements. Besides, the delivery points affect also other fleet management elements, e. g. the availability of cargo handling machinery or reducing the vehicle idling. This measure has been evaluated as necessary by 60% of carriers.

The reduction of the necessary time of delivery depends to a certain extent on the availability of the cargo handling equipment at the end points of delivery. The intention of this method is to reduce the vehicle waiting times for cargo handling operation at the delivery points. This measure is necessarily related to the delivery time planning, i. e. to the measures that refer to the vehicle routing and the drivers' availability.

In part which refers to the possibility of additional usage of vehicles during the trip, two elements are essential for the carriers: the first refers to the optimization of the existing routes with the aim of increasing the usability of the cargo space, and others refer to reducing vehicle idling by taking over the additional cargo which is located in the vicinity of the vehicle routes, thus reducing the number of kilometres travelled by the vehicle without any load.

The carriers expect the system to provide detailed planning of routes, travelling schedules, reduction in the number of travelled kilometres in relation to the quantity of the transported goods and increase their own profit through similar procedures. A relatively small number of carriers think that the reduction of transport costs is the priority objective in the fleet management. There is a relatively small possibility of saving within the category of operative costs. The carriers tend to reduce the costs by increasing the time intervals in maintaining the vehicles, reducing the waiting times of drivers, and reducing the fuel consumption in various ways. It should be mentioned that the majority of the mentioned data is available by using different designs of board computers.

Stock management within which the carrier forms a part of the logistic supply chain is a measure consid-

ered as important by 30% of carriers. This refers mainly to the companies whose basic activity is the transport of goods, which are part of the logistic chain of other companies for which transport is performed. The transport companies in this case are a very important element of the logistic chain of individual enterprises – service users. Therefore, in order to respond as fully as possible to the users' requirements, the carriers tend to meet the users' requirements by introducing the information technology support.

Some carriers have the need of additional usage of vehicles since they have given determined routes independent of whether the vehicle is travelling these routes empty or loaded. The carriers doing business in this way tend to additionally use the vehicles on these routes, thus increasing the revenues.

The quantity of cargo per single delivery is one of the fleet management elements. The importance of rationalization of the delivery depends first of all on the size of the fleet of a single carrier, type of transported cargo, time slots for the delivery and the strategy of single carriers regarding the method of reducing total costs.

Reduction of fuel consumption. Fuel consumption can be reduced by improved planning of routes, with different software versions of route planning available on the market. According to the experiences of different carriers largest savings are achieved by the driver control or travelling optimization.

3. TYPES OF INSTRUMENTS ON THE MARKET

The needs for information support in fleet operation have led to careful consideration of the offer of systems of the same type on the market. Today, there is a wide range of different devices based on the GPS technology. There are devices that can be classified as entertainment electronics, all the way to professional solutions, and yet for different purposes, from vehicle navigation to aircraft instruments. Because of the wide range of functional offer, the decision on the best suitable device is not a simple one and depends on a series of elements.

The market of devices and systems can be divided into three groups:

Narrowly specialized surveillance devices have a very limited functionality and with the location of the object offer few additional possibilities and mainly do not provide communication technologies.

Middle class surveillance devices have a very narrow selection of additional possibilities of combining data, they provide locating of objects, they include simple communication technologies.

Professional class of surveillance devices includes the most advanced technology in the field of fleet management and offers the latest communication technologies, various possibilities of connecting with peripheral electronics and internet protocol standards.

3.1 Narrowly specialized surveillance devices

This class of devices is intended first of all for personal use. The device has the possibility of local connecting with a personal computer, which allows loading of various maps and transfer of stored locations to the personal computer.

The devices do not offer additional possibilities of connecting to electronic devices, such as e. g. sensors, actuators, etc. The devices from this class have no possibility of integration, i. e. connecting to the group of equal devices with different users.

The characteristics of this group of devices:

- allow monitoring of GPS parameters,
- contain local system of displaying the current location,
- local connection to the personal computer,
- do not enable connecting of additional sensors,
- personal use.

Regarding the characteristics, this group of devices is not suitable for the needs of companies. By including the offer on the market in this first group, it has been found that it accounts for about 60% of the offerers' market.

3.2 Middle class surveillance devices

The devices included in the middle class have the possibility of mutual communication and the possibility of connecting additional electronic devices (sensors). The communication technologies are relatively simple (SMS), and allow transfer of a limited number of data.

Connecting of additional electronic devices is limited to digital inputs and outputs. In the majority of cases it is possible to display messages on the user terminal and to display the current position by means of the GPS system. The monitoring of the GPS system parameters was used to determine the location. Data storage during a shorter period of time is possible in the majority of devices of this class. Important for this class is simple communication technology, which allows transfer of data from different units in the field and acceptance in the surveillance centre. The volume of data is limited due to narrow throughput capacity (low throughput capacity) of the communication technology (UKV) or due to commercial reasons (SMS), because data transfer would represent excessive cost compared to savings.

In a large number of devices of this class there is a possibility of connecting to personal computer.

The characteristics of this group of devices:
- allow monitoring of GPS parameters,
- contain local system of displaying the current situation,
- local connection with the personal computer,
- allow a limited number of connecting additional sensors,
- limited number of input/output parameters,
- simple communication technology.

The devices from this group allow communication between the devices in the field and the surveillance centre. It is possible to establish a surveillance system over the vehicles, meeting the requirements of surveillance over geo-location parameters, and smaller number of surveillance parameters (sensors). This group of devices is suitable for smaller systems in which locating of vehicles represents the priority. By classifying the offer on the market it was found that this group accounts for about 30% of the offerers' market.

Regarding the characteristics of single carriers, one may say that this group of devices has limited implementation possibilities.

3.3. Professional class of surveillance devices

The highest class devices provide advanced communication technologies (GPRS) with the implementation of INTERNET protocols (TCP/IP), which basically allows the openness of the system for further upgrading. The usage of such technology allows a wide range of possibilities for monitoring of vehicle parameters, uses an expandable number of input/output parameters, communication with the vehicle electronics, several standard serial ports. The processing power and the memory of the device are based on the criteria necessary for professional processing and storing of data, which allows a high level of automation of the procedures and the use of various additional in-vehicle devices (printer, palmtop...).

The characteristics of this group of devices:
- allow monitoring of GPS parameters,
- contain local system of displaying the current location,
- local connection with the personal computer,
- usage of additional electronic equipment (printer, palmtop...),
- a large number of additional connecting sensors,
- large number of input/output parameters,
- advanced communication technologies (GPRS, INTERNET),
- INTERNET protocols,
- voice communication,
- communication with the vehicle electronics,
- the system is open to upgrading or expansion.

Due to their adaptability, this group of devices is principally suitable for differently dimensioned systems.

3.4 Technologies in application

Various fleet management technologies are implemented within the transport companies. Generally, the mentioned technologies may be divided into the following categories:
- routing systems,
- portable computers and board computers related instruments,
- systems which use various protocols within GSM or related networks,
- systems for automatic vehicle locating.

Routing systems. The majority of routing systems are ready-made products which are available on the market, whereas other systems are customized to individual needs of single companies. The general purpose of these systems is to help carriers in the selection of the routes, in the optimization of the number of vehicles, insurance of timely delivery, control of drivers, and flexibility of the carrier to possible user requirements.

Board computers and related instruments. Some of these carriers use only the basic functions such as recording of the driving method through various driving parameters, whereas other carriers use also other available possibilities, e. g. monitoring of the driver's working hours, engine running time, times of arrivals and departures of vehicles, time of loading and unloading, maintenance intervals, duration of single trips, etc.

Systems that use different protocols within GSM or related network represent the widest use of FM. This refers mainly to systems that use as the basis of communication some of the protocols for mobile communication, increasingly using also the technologies that connect internet protocols and mobile communications. The type of communication affects also the quantity of information that can be transferred within a certain period of time as well as the concept of the entire system.

Systems for automatic locating of vehicles are used in a relatively smaller number of vehicles. However, some of the carriers are planning to introduce the system for automatic locating of vehicles in the near future. It should be noted that the vehicle locating systems today often represent a component of the entire software packet for fleet management, so that they are rarely considered as a separate unit. The general purpose of these systems is the monitoring of the position of single vehicles and, using the obtained information, adaptation of the vehicle routes, monitoring of the goods delivery, insurance of delivery, etc.

4. RECOMMENDATIONS FOR INTRODUCING FLEET MANAGEMENT SYSTEM

The analysis of various experiences of carriers makes it possible to make certain general recommendations related to the introduction of information technology systems for fleet management.

Regarding the fact that carriers have different characteristics starting from the fleet size, scope of operation, type of transported cargo and method of delivery, it is not possible to implement equal FM systems for each carrier. Each fleet management system needs to be adapted to the characteristics of the individual carrier in order to achieve the desired results. Also, the requirements faced by the carriers are becoming increasingly complex and require an ever higher level of organization for the company to operate successfully. Therefore, it is precisely the information technology systems for fleet management that are used as one of the tools that improve the organization level of a company.

Before introducing FM into the fleet, the carriers need to be informed in detail about their possibilities and restrictions. The companies also try to learn the advantages and innovations which will result from the introduction of FM in the future. The failure to introduce FM is often not the consequence of the shortage of information on the advantages of FM, but the consequence of the orientation towards careful and gradual investing into FM.

The carriers install FM usually after having assessed that the introduction of such a system will increase the efficiency and competitiveness on the market. Also, the usual investments into FM are the targeted investments. The carriers who did not introduce FM, did not do this because the existing systems do not satisfy them completely, and thus do not justify the potentially invested means. Even on the markets with extremely fierce competition, the carriers tend to introduce FM into their fleets very carefully.

The carriers tend to introduce into their operation the systems which fulfil several requirements and prefer introducing such systems rather than the systems oriented towards only one segment of FM (e. g. the carriers prefer systems which can monitor the work of the driver, create the vehicle routes and plan vehicle maintenance, and that function as a unique system, rather than introducing the systems which can perform some of the mentioned operations individually).

The carriers need detailed information on how to make full use of the FM systems and how to take the highest possible advantage. FM helps the carriers in understanding and control of many elements that influence the operation of the fleets, by supplying them with the data. Many carriers emphasise the significance of the availability of data in real time, which particularly refers to data on the conditions in traffic on a given route. Integration of these types of data into FM systems for fleet management is planned as the next step in the development of FM.

4.1 Methodology in introducing fleet management

The introduction of the FM system into a certain transport company depends on a number of elements. On the one hand, there are characteristics of the carrier systems, their requirements and operation methods. On the other hand is the operation technology of FM, its architecture and limitations. The achievement of the expected results in introducing the FM system is possible if during the system introduction all the common elements important for the optimal operation of the system are taken into consideration, considering the characteristics of the carriers and the characteristics of the FM systems themselves.

In introducing the information technology support system the following elements are important:

- analysis of the existing condition of the fleet and its organization,
- defining of the priorities in fleet management within the company,
- analysis of the existing costs per single vehicle,
- evaluation by the equipment supplier in compliance with the previously defined criteria and priorities in fleet management,
- analysis of the possibilities of the adjustment of the software to specific characteristics of the company,
- analysis of the possibility of further upgrading of the system in the future,
- performing of the test phase on a certain vehicle sample with the possibility of comparing the costs per vehicle before and after introducing certain programme packages,
- full implementation of the programme package after all the company requirements have been fulfilled.

The harmonization of requirements and methods of individual companies with the architecture and concept of FM is a precondition of successful FM system introduction. Therefore, it is necessary to define in advance the objectives and expectations in introducing FM, but on the other hand, it is necessary to get to know the possibilities of individual information technology system, solutions that are offered and the possibilities of adaptation. Next phase sees the transition to the analysis of the costs and estimation of the equipment suppliers in compliance with the priorities of the company in fleet management. The last phase before the final selection of the solution is the testing of the

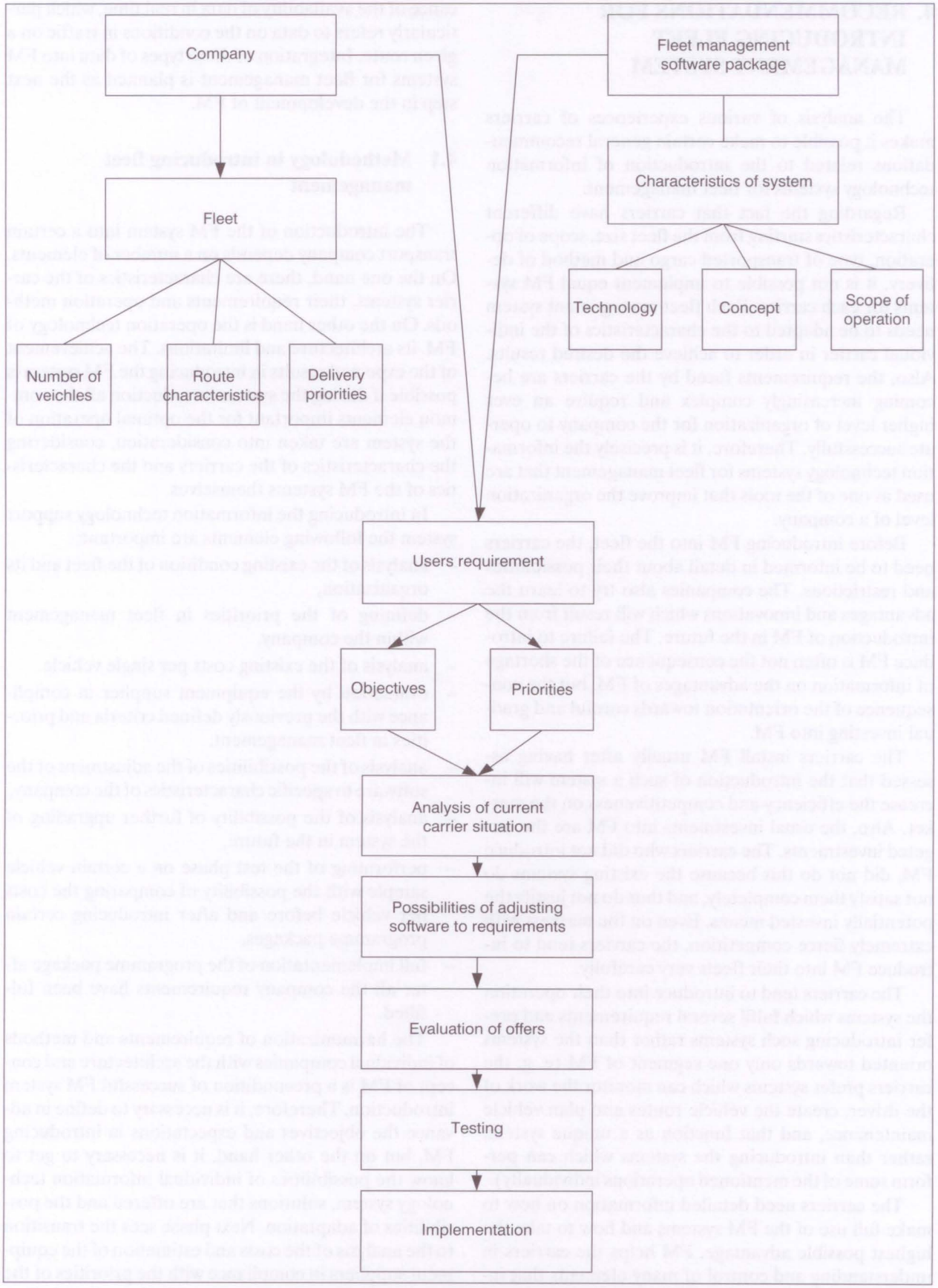

Figure 1 - Procedure of FM software implementation

solution on a certain vehicle sample, with the possibility of analysing the individual hidden elements and technical support (e. g. method, speed, and the quality of equipping vehicles with the measuring and communication instruments). Here the solutions of one or several producers can be tested.

5. CONCLUSION

The implementation of the fleet management system depends on a series of factors which are related first of all to the characteristics of the carriers. The analysis of the carriers' operation method and their fleet is the first step in introducing the fleet management system. The needs and priorities of the carriers are very different. Regarding the very wide range of the transport of goods in road traffic and the method of organizing delivery, it is necessary to analyze the needs and priorities of the carriers, as well as of their position in the distribution chain.

The needs and expectations of the carriers depend first of all on their priorities and objectives in organizing the transport. Almost all the carriers have the common need for the possibility of continual communication (contact) with the driver.

Apart from the characteristics of the carriers, the method and level of implementation are also affected by the characteristics of the fleet management system. There are several levels of system which respond to the carriers' requirements of different characteristics and needs.

The saving is one of the most important motives for the introduction of the fleet management system. There are several levels of savings. The level of saving varies and depends again on the characteristics and organisational level of individual company.

The successful introduction of the fleet management system requires adjustment of the system to each individual carrier entity, according to their needs and specific features. In this way it is possible to achieve improvement in the fleet operation and savings in the fleet management system usage.

Dr. sc. **KRISTIJAN ROGIĆ**
E-mail: rogick@fpz.hr
University of Zagreb,
Faculty of Transport and Traffic Sciences
Vukelićeva 4, HR-10000 Zagreb, Republic of Croatia
Mr. sc. **BRANISLAV ŠUTIĆ**
E-mail: branislav.sutic1@gs.t-com.hr
Veleučilište Nikola Tesla u Gospiću
Bana Ivana Karlovića 16, 53000 Gospić,
Republika Hrvatska
GORAN KOLARIĆ, dipl. ing.
E-mail: goran.kolaric@mzos.hr
Ministarstvo znanosti, obrazovanja i športa
Trg hrvatskih velikana 6, 10000 Zagreb, Republika Hrvatska

SAŽETAK

METODOLOGIJA UVOĐENJA SUSTAVA ZA UPRAVLJANJE VOZNIM PARKOM

Sustavi za upravljanje voznim parkom sve se više mijenjaju u različitin prijevozničkim tvrtkama. Iako se prema navodima različitih proizvođača, korištenjem takvih sustava mogu postići velike uštede u poslovanju, istraživanja pokazuju da je za optimalno funkcioniranje takvih sustava nužno provesti vrednovanje tvrtke i samih sustava prema više kriterija. Metodologija prema kojoj je moguće izvršiti implementaciju FM-a unutar prijevozničkih tvrtki polazi od analize značajki prijevoznika, značajki programskih paketa, nakon čega slijedi vrednovanje prema više kritarie koji utječu na konačan izbor. Cilj ovakvog pristupa je prilagodba zahtjevima korisnika koji u konačnici rezultira unapređenjem i uštedama u poslovanju.

KLJUČNE RIJEČI

cestovni prijevoz, upravljanje voznim parkom

LITERATURE

[1] **J. Susman**: *Introduction to Transport systems*, Artech House, London, 2000.

[2] **J. de D. Ortuzar, L. G. Wilumsen**: *Modelling Transport*, John Wiley&Sons ltd., Chichester, 1994.

[3] *Commercial Veichle Fleet management and Information Systems*, Summary of Case studies, Cambridge Systematics, Cambridge, 1997.

[4] **E. Taniguchi, R. G. Thompson, T. Yamada, R van Duin**: *City logistics*, Pergamon. 2001.

[5] **Van Goor, Ploos van Amstel**: *European distribution and supply chain logistics*, Wolters-Noordhoff bv groningen/Houten, 2003.

[6] **A. Langevin, D. Riopel**: *Logistics Systems-Design and Optimisation*, Springer, Montreal, 2005.

[7] **J. Šamanović**: *Logistički i distribucijski sustavi*, Ekonomski fakultet Split, Split, 1999.