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COST OPTIMIZATION IN INDUSTRIAL ENTERPRISE WORKING CAPITAL CIRCULATION STAGES IN TERMS OF INTEGRATED PROCESSES[1]

ABSTRACT

During intensification of integration processes key enterprise adaptation and efficiency reserves consist in use of supply chain management concept tools. The article concerns the method of industrial enterprise cost optimization in dynamic and lean supply chains.

***Key words**: supply chain, supply chain management, cost optimization, industrial enterprise*

1. INTRODUCTION

At the beginning of the 21st century integrated management paradigm created a new ideology of business administration – supply chain management (SCM). This paradigm reflects a new understanding of the business: separate companies are treated as total supply chain units, which either directly or indirectly involved in the single (integrated) process of resource flow management for the most complete and quality satisfaction of customers needs. The classic approach in the management is of a local nature – only within a single company. Today, however, this is not enough, and a natural extension, development of an integrated approach beyond the focal company in terms of cross-functional and inter-organizational coordination of different players is SCM [2].

In the paper we use the following definitions. Supply chain is a global network used to deliver products and services from raw materials to end customers through an engineered flow of information, physical distribution, and cash [4]. Supply chain management – an integration of key business processes, starting from the end user, covering all providers of goods, services and information that add value to consumers [3].

In this article we consider the author's method of industrial enterprise cost management in dynamic and lean supply chains.

2. METHOD FOR INDUSTRIAL ENTERPRISE COST OPTIMIZATION

Industrial enterprise cost dynamics is determined by a complex interaction of a set of factors. Most factors such as experience, technology used, scale of activity, are described in domestic and foreign literature in detail. However, some factors receive little attention. In our study we analyze the influence of conditions of cooperation with suppliers and customers on cost level of industrial enterprise.

There is a specific cost management system for each factor. An integral part of each system is the composition of the investigated cost types. The composition of costs we propose is presented in Fig. 3. It is based on separation of costs according to responsibility centers. In addition, we offer to complete the list of classic costs by transaction and logistics costs. The reason is that we do not examine one firm separately, but a group of companies and these are transaction and logistics costs that better characterize real economic situation of industrial enterprise from the perspective of its interaction with counterparties in the supply chain.

There are two basic types of supply chains: dynamic (fast delivery of products from the warehouse to a consumer with a deferment of payment) and lean (production after receiving order from a customer and prepayment). Their schemes are shown in Fig. 1 and 2, respectively.

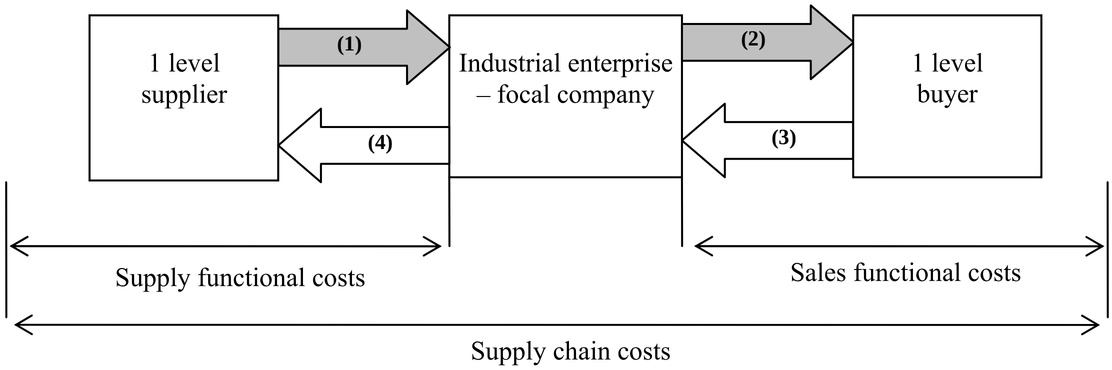

Figure 1 – Dynamic supply chain costs: (1) – raw materials flow; (2) – flow of semi-finished and finished products; (3), (4) – payment

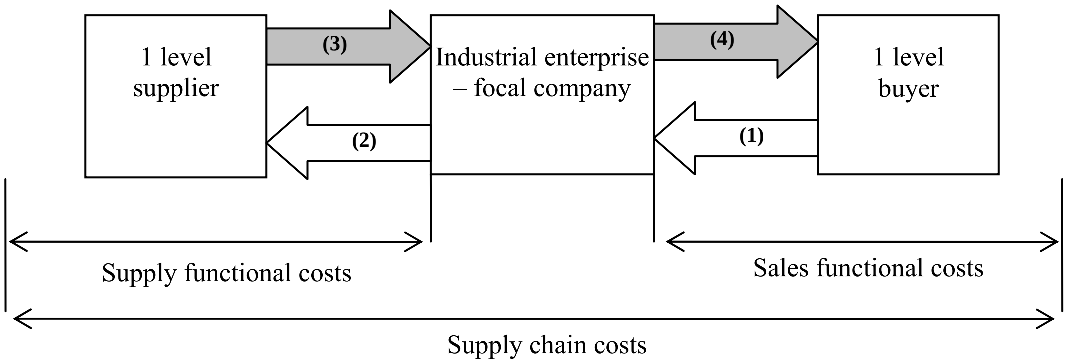

Figure 2 – Lean supply chain costs: (1), (2) – prepayment; (3) – raw materials flow; (4) – flow of semi-finished and finished products

In the first case products are sold with a deferment of payment, and the demand is satisfied by using existing stocks. This causes a double effect on the focal company of the chain. On the one hand, soft sales policy helps to increase sales, but requires to increase selling prices to compensate losses from immobilization of capital and to borrow to eliminate lack of funds. On the other hand, the request of immediate payment reduces transaction costs, but leads to “buyer’s refusal to deal” effect.

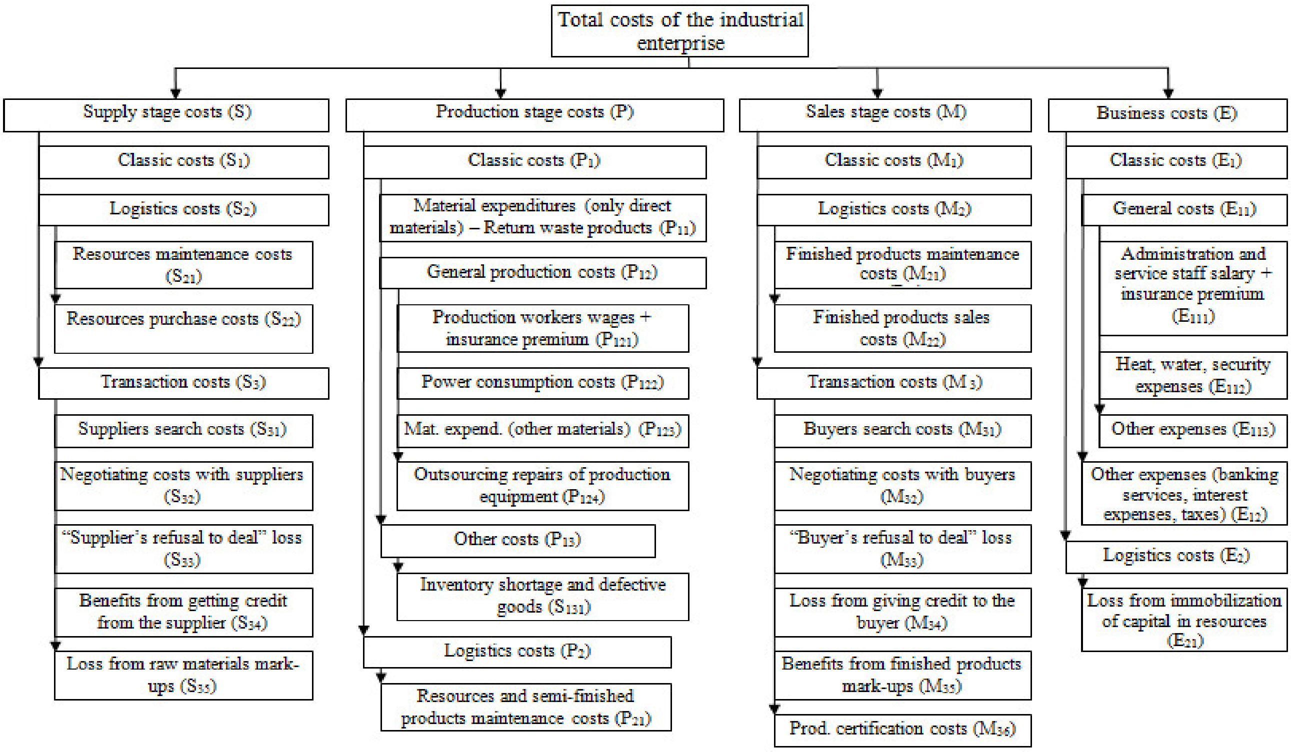

Figure 3 – Total costs composition in dynamic supply chain of the industrial enterprise

In the second case (case of delayed delivery) it is not required to have significant stocks and related costs. However, the number of clients is significantly restricted, and a company loses profit as it should give a discount to consumers.

Under cost management we mean cost optimization, i.e. searching for the values of cost-forming factors at which cost level will be optimal. In our study we assume that the optimal cost level is minimum cost value at which the company is able to satisfy all demand from its consumers.

$$\text{Total costs} = f\left(t_{\text{delay}}^{\text{sup}}, t_{\text{delay}}^{\text{buy}}\right) \to \min, \text{ when} \qquad (1)$$
$$\text{Satisfied demand} = f\left(t_{\text{delay}}^{\text{sup}}, t_{\text{delay}}^{\text{buy}}\right) \to \max,$$

where $t_{\text{delay}}^{\text{sup}}$ – the delay between delivery and payment at the supply stage, $t_{\text{delay}}^{\text{buy}}$ – the delay between delivery and payment at the products' sales stage.

Industrial enterprise cost dynamics depending on the conditions of cooperation with suppliers and customers was analyzed by means of simulation modeling in MATLAB programming language.

3. SIMULATION MODELING RESULTS

The initial data for the models were specified as:

- the structure of assets and liabilities of industrial enterprise;
- the conditions of cooperation with suppliers (the price of raw materials, the amount of credit, the value of discount or mark-ups);
- the production process (stages, equipment, its efficiency and power, manufactured products, its formulation);
- the conditions of cooperation with customers (the price of the finished products, the amount of discount or mark-ups);
- the monthly demand for the company's products.

The structure of demand for the company's products is presented in Table 1. In Fig. 4 you can see total costs that appear in a dynamic supply chain. In Fig. 5 and 6 – customers demand satisfaction.

Analysis of graphs (Fig. 5, 6) revealed three main reasons of customers demand dissatisfaction:

– “buyer’s refusal to deal” effect;
– “supplier’s refusal to deal” effect;
– cash shortfall.

Area outside the influence of these effects is an area to search for the solution. The optimal level of costs corresponds to their minimum value in the same area of graph 4. Thus, the optimal cost-forming factors values are: deferment of payment to supplier – 2 days, deferment of payment to customer – 24 days. The minimum cost level is 44 373 218 rubles, satisfied demand – 476 488.8 kg.

The total costs in lean supply chain are presented in Fig. 7. Customers demand satisfaction – in Fig. 8 and 9, respectively.

Analysis of graphs (Fig. 8, 9) revealed three main reasons of customers demand dissatisfaction:

– “buyer’s refusal to deal” effect;
– “supplier’s refusal to deal” effect;
– the zone where further activities of the company are impossible.

Area outside the influence of these effects is an area to search for the solution. The optimal level of costs corresponds to their minimum value in the same area of graph 7. Thus, the optimal cost-forming factors values are: prepayment to supplier – 11 days, prepayment from customer – 14 days. The minimum cost level is 41 689 464 rubles, satisfied demand – 472 509 kg.

Table 1 – Monthly demand for the company’s products, kg.

Type of customer \ Products		Packing bags	Plastic film	Printed plastic film	T-Shirt Bags	Printed T-Shirt Bags	Products from recyclable materials	Total
1	Roofing manufacturer		48 000	18 000				66 000
2	Large wholesaler	23 000			8 000	12 000	14 000	57 000
3	Small wholesaler (retail)	2 000			2 500	1 000	6 000	11 500
4	Consumer of flexible industrial packages		7 000	2 000				9 000
5	Consumer of custom printed products			1 200		5 000		6 200
6	Cereal manufacturer		5 000	800				5 800
7	Supermarket				1 200	300		1 500
8	Meat processing plant	800					200	1 000
9	Bakery		800			200		1 000
10	Confectionery		800			200		1 000
Total		**25 800**	**61 600**	**22 000**	**11 700**	**18 700**	**20 200**	**160 000**
Price (rubles./kg.)		115	100	150	110	130	97	

Source: The authors’ own research, based on the company’s data

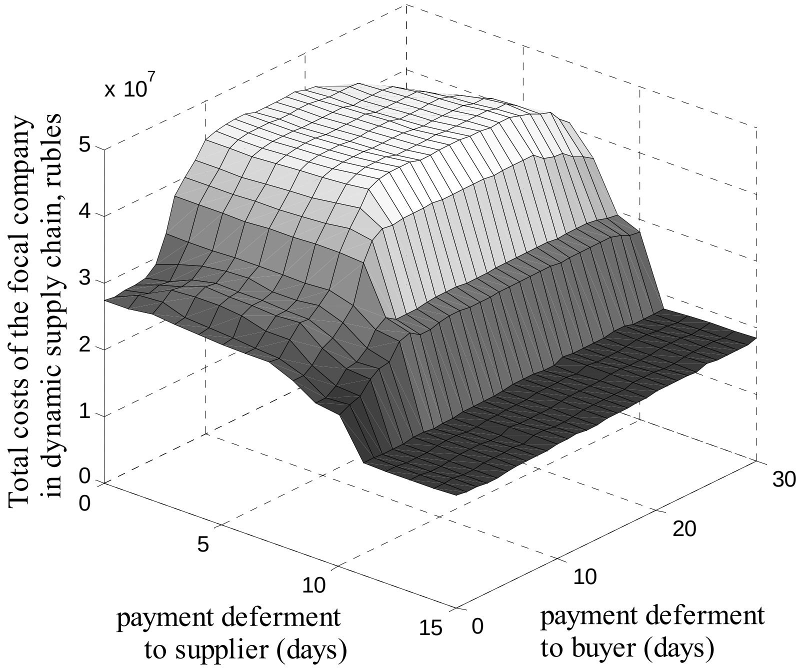

Figure 4 – Total costs of the focal company in dynamic supply chain depending on the conditions of cooperation with suppliers and customers

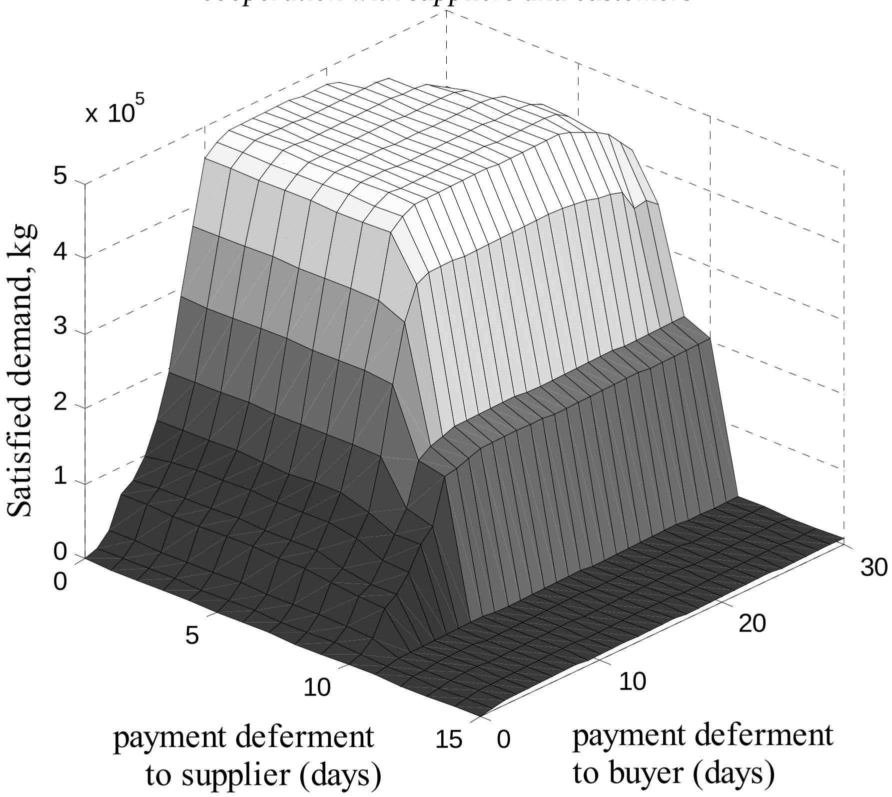

Figure 5 – Satisfied demand depending on the conditions of cooperation with suppliers and customers

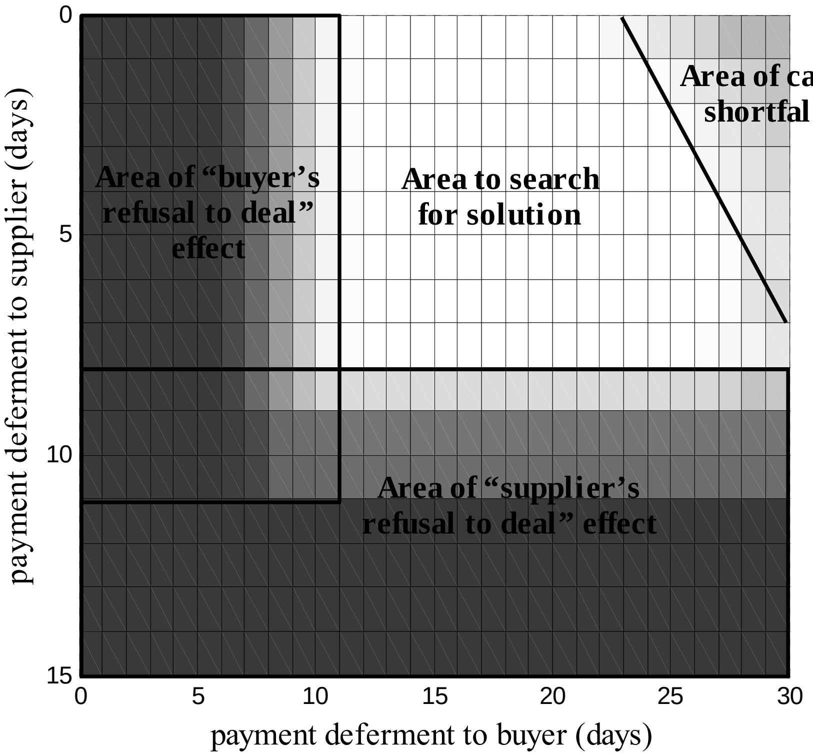

Figure 6 – Satisfied demand depending on the conditions of cooperation with suppliers and customers (top view)

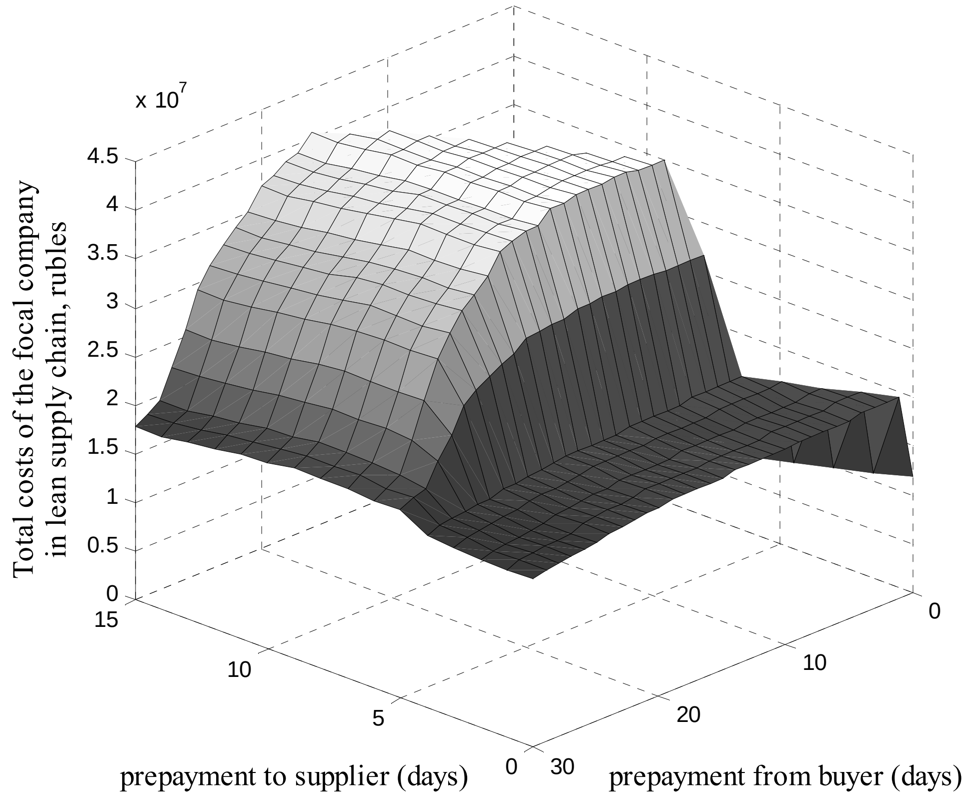

Figure 7 – Total costs of the focal company in lean supply chain depending on the conditions of cooperation with suppliers and customers

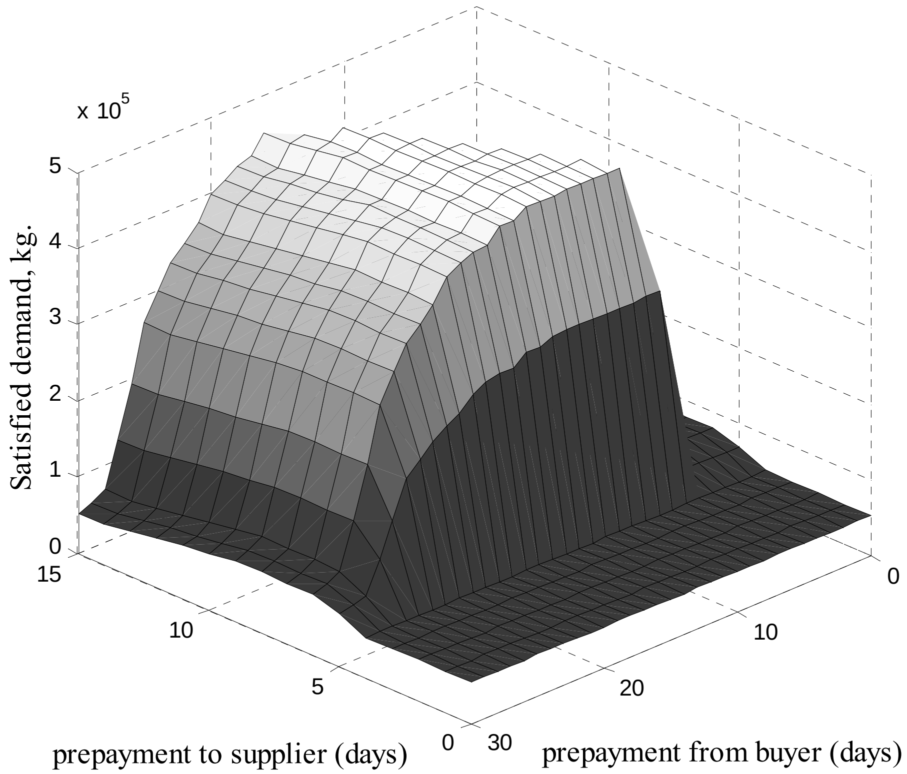

Figure 8 – Satisfied demand depending on the conditions of cooperation with suppliers and customers

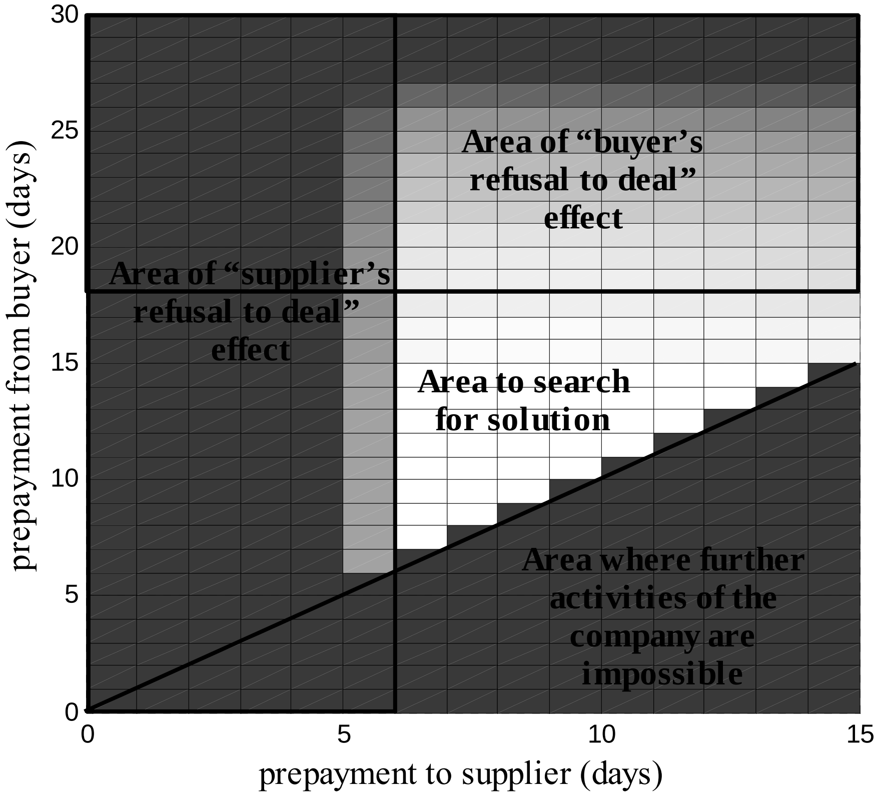

Figure 9 – Satisfied demand depending on the conditions of cooperation with suppliers and customers (top view)

The model also allows us to analyze costs dynamics at responsibility centers. To make this we should build separate models for each working capital circulation stage. Optimal values of factors got at different stages can differ from those got at the level of whole enterprise. Last ones have priority.

4. SUPPLY CHAIN EFFICIENCY

Supply chain efficiency can be determined by calculating the correspondence rate of supply chain members to each other.

$$\text{К}_{\text{C}} = 1 - \frac{\left| t_{\text{delay}} - t_{\text{delay}}{*} \right|}{t_{\text{delay}}{*}}, \tag{2}$$

where t_{delay} – the actual delay of flows; $t_{\text{delay}}*$ – optimal delay; $\left| t_{\text{delay}} - t_{\text{delay}}* \right|$ – the mismatch of the participants [1].

Two factors are determined: one – for the lag of flows at supply stage and the other – for the lag of flows at sales stage. It is possible to determine the integral coefficient by calculating the geometric mean of particular indicators:

$$\text{К}_{\text{C}}^{\text{Int}} = \sqrt[2]{\text{К}_{\text{C}}^{\text{supplier}} \times \text{К}_{\text{C}}^{\text{buyer}}}. \tag{3}$$

The closer integral coefficient to 1, the more efficient supply chain is. The factor has some limitations. In particular, the actual lag should not exceed the optimal value by more than twice. In this case the coefficient is negative, and the chain is inefficient.

5. CONTINUATION OF RESEARCH

The study examined two extreme types of supply chains: dynamic and lean. However, in practice we often observe mixed types of supply chains (Fig. 10). The logical continuation of the study is to analyze the industrial enterprise costs dynamics in hybrid supply chains.

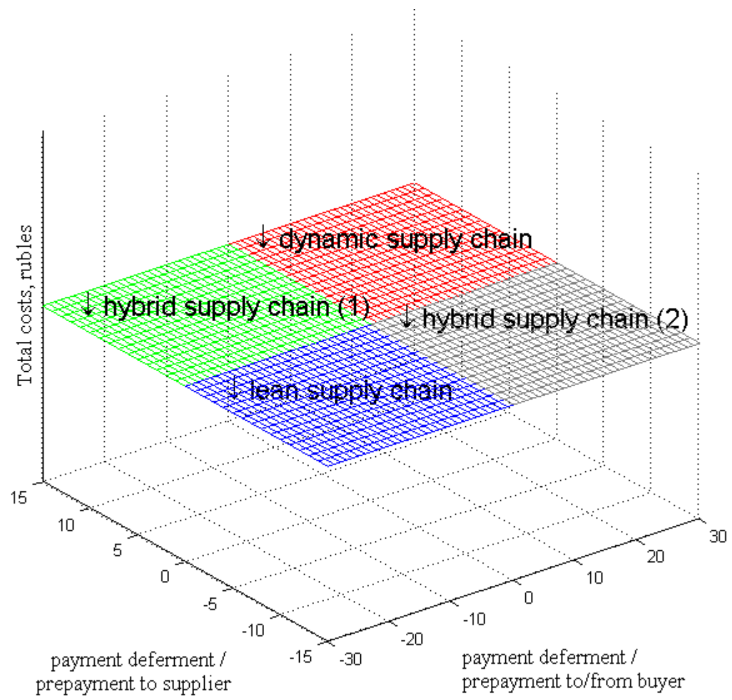

Figure 10 – Types of supply chains

In our research integral costs of the company act as a function of two variables: $t_{\text{delay}}^{\text{sup}}$ – the delay between delivery and payment at the supply stage, $t_{\text{delay}}^{\text{buy}}$ – the delay between delivery and payment at the products' sales stage. However, in practice the lag of payment/delivery for each buyer/supplier is individual and depends on many factors. Therefore, a logical extension of this study is the complication of the objective function to:

$$\text{Total costs} = f\left(t_{\text{delay}_i}^{\text{sup}}, t_{\text{delay}_{i+1}}^{\text{sup}}, t_{\text{delay}_{i+2}}^{\text{sup}} \ldots t_{\text{delay}_n}^{\text{sup}}, t_{\text{delay}_j}^{\text{buy}}, t_{\text{delay}_{j+1}}^{\text{buy}}, t_{\text{delay}_{j+2}}^{\text{buy}} \ldots t_{\text{delay}_m}^{\text{buy}}\right), \quad (4)$$

where $t_{\text{delay}_i}^{\text{sup}}$ – the delay between delivery and payment at the supply stage for the i-th supplier; $t_{\text{delay}_j}^{\text{buy}}$ – the delay between delivery and payment at the sales stage for the j-th customer.

The proposed method of the industrial enterprise costs optimization is based on the fact that the conditions of cooperation with suppliers and customers in the supply chain are initially set. However, the company can and should improve relationships with key suppliers and customers. Thus, the model not only provides an answer, what is the optimal level of costs and at which values of the cost-forming factors it is achievable, but also indicates the main causes of customer demand dissatisfaction and the direction of improving relations with contractors. So, with the help of the model it is possible to estimate the level of total costs in the absence of the "buyer's refusal to deal" effect or "supplier's refusal to deal" effect (the assumption that the relationships with contractors will improve in one direction or another), or in the absence of cash shortfall (if we include a financial structure to the model). And if the calculated level of costs without any effect mentioned above is lower than the optimal level under the initial conditions, this area of cooperation can be considered promising.

6. CONCLUSION

Thus, the proposed system of cost management allows us to identify optimal conditions of cooperation with contractors that maximize the economic efficiency of industrial enterprise in the supply chain. The deviation of actual values of the factors from optimal allows us to find the value of economic loss, and use internal and external reserves to eliminate them. In addition, the proposed method of cost optimization is the basis for further research in improving relations with suppliers and buyers in supply chain.

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INTERNATIONAL LOGISTIC OUTSOURCING AGENTS: 4PL OPERATORS SPECIALISED IN LOGISTIC OUTSOURCING ON THE FAR EAST

ABSTRACT

During economic growth and opening of the large production capacity in China, the need for a specific type of 4PL operators, who could integrate different resources, know-how and technology, was created. Most major world producers have opened their manufacturing capacities in China, however small and medium sized enterprises are unable to do such investments. International logistic outsourcing agents emerged as a solution for this issue. Modes of outsourcing depend on the business policy of the principal company and the capabilities of the nominated logistics outsourcing agent.

1. INTRODUCTION

In 2009, China made exports worth 746 billion euros according to statistics, and, with a record amount surpassing German exports worth 734 billion euros, it (China) has become the world's largest exporter[1]. Moving production to the cheap-labor countries initialized the emergence of a new type of 4PL (Fourth Party Logistic) operator **[1]**, logistics outsourcing agent. A new type of collaboration between foreign and Chinese companies is mushrooming in the established manufacturing regions.

The main drivers are small and medium sized enterprises in the developed countries, facing with global competition, attracted by lower costs of labor and high standard technology offered by Chinese manufacturing companies. The new form of international outsourcing is now normally carried out through the cooperation of principal companies agents (import and export companies) and Chinese manufacturers, yet operational modes of outsourcing can be various.

The geographic distance, culture difference and unfamiliarity with Chinese industry constitute communication problems. Some companies are too small to be able to send their representatives to China to organize and control the production. They need a strategic partner,a 4PL operator, to integrate their supply chain in terms of production, quality control, transportation, customs and other value added services required. The international outsourcing agents appeared to be the most suitable party for this role.

2. SUPPLY CHAIN MANAGEMENT ISSUE

The main distribution goal is to meet the market demand while minimizing distribution and production costs. The products are transported via maritime container transport to European ports (Hamburg, Koper, Rijeka…) . Products of lower mass and volume, but higher value (electronic equipment) are transported by aircraft to European airports.

Small and medium sized companies from western countries are facing serious competition and are affected by the much lower costs and maturing capabilities offered by Chinese manufacturing companies. As for the problem of managing the supply chain at a long distance (due to limited resources), the international outsourcing agents appear to be a potential solution. A new form of outsourcing is based on the original partnership of principal companies, 3PL (Third Party Logistic) operators, logistic outsourcing agents in China and Chinese manufacturers. Some principals (big international corporations) mostly decide to set up their own manufacturing facilities, whereas others (smaller or medium sized companies) mostly prefer logistic outsourcing and partnership with local manufacturing companies [2].

3. QUALITY CONTROL ISSUE

The manufacturing process can be divided into three stages, purchasing raw materials; production; assembly and packing. Due to the distance and cultural differences, principal can't fully control the production processes in the Chinese factories under this new type of international outsourcing arrangement. Problems and risks exist in each stage of the manufacturing process. In terms of raw material purchasing, the factory may use cheaper materials than specified or copied components instead of imported original ones. The detection of this problem is very difficult as other materials or copied goods may look the same but are definitely of inferior quality. For the production process, principles can be worried that the product may differ from the sample.

The final stage, assembly and packaging, might be in a dirty environment with non-comprehensive quality controls causing a high rejection rate when shipments are delivered [1].

With the help of outsourcing agents, principals expect the process to become more secure and effective. They look for agents who can help find the right manufacturers to control each stage of production with good system protection. In the raw material sourcing stage, all key imported goods and materials are expected to be checked or bought by agents. The goods will be checked and supplied to one of the audited production units. This will lessen the risk of the manufacturer using inferior unqualified materials. Agents are charged for quality control, too.

4. SELECTION CRITERIA FOR OUTSOURCING LOGISTICS AGENTS

When looking for logistics outsourcing agents, principals need criteria to select the most appropriate one. The research methodology was developed from the complexity of the selection of agents. Its detailed objectives are to identify current situation and development of agents, to make a detailed analysis and comparison on business models of the agents and to create an ideal model and give implementation suggestions. By searching related websites such as Chinese manufacture or websites which provide company lists within a region, sufficient information was gathered. Each website of the candidate companies was read , regarding its service, location and function.

Companies often choose agents who have some work experience in related jobs but avoid hiring agents who have worked for competitive companies. Confidentiality agreement was signed in the event of terminating the cooperation. China, as the largest exporter and manufacturer in the world, has a problem of industrial espionage, employees who work for two competitive companies – to collect information about products from the first one and to sell that information to the other competitive company. Industrial espionage is most pronounced in the textile industry, where Chinese manufacturers make falsification of famous European brands, resulting in direct financial losses. In such situations, the original manufacturers also employ outsourcing agents whose main task is to discover which manufacturers deal with such business, to gather evidence and contact the original manufacturer.

After determining which of the candidates meet the requirements of the company, what follows is the interview. The major methods are face to face interviews, and also internet and telephone interviews, depending on the company. Theoretical problems facing the candidates must be solved in certain time. One of the important terms is the knowledge of foreign languages (English, French, German – depending on the company).

It is common for Chinese agents to take the names of English-speaking people for easier communication, because of a general lack of understanding of Chinese language [2].

5. MODES OF LOGISTIC OUTSOURCING

Four basic modes of operating can be defined at logistics outsourcing agents in China . They differ in terms of doing business and in terms of ownership, as illustrated by the following examples. [4].

Example one

Logistics outsourcing agent is a Chinese company founded in 1983. The company was previously managed directly by State-owned Assets Supervision and Administration Commission of the State Council. It is located in Beijing and Shenzhen which import and export non-metallic materials, machines and chemical products. Company searches for clients, small and medium sized western companies.

Step one: preparation

Attracting clients is the first stage of doing business with western clients. Normally the company contacts potential clients directly via Internet, telephone and fax, or through exhibitions such as Canton Fair, the largest Chinese fair held twice a year in spring and autumn time. The company has also set up sales and marketing department in US and Japan, exploring and making ~~f~~ forecast of the overseas market.

For western clients who are looking for certain products from China, the requirements will include design, production line and quality standards.

Step two: first round selection

With more than twenty years of experience and close relationships with major material manufacturers in China, the company can quickly select potential factories that have the capability to manufacture products.

The company sends people to audit the production line in factories. They then check and make comparison between clients' requirements and current situation of the factory. If the production system and technology is appropriate, the factory may be taken into consideration. If not, suggestions will sometimes be made to invest new equipments or to change certain production lines, which depend on the experience of the manufacturer. After the first round of factory auditing, normally two **or** three manufacturers are selected.

Step three: second round selection

When the clients' requirements or OEMs' design is sent to the candidate manufacturers, they build prototypes accordingly. The agent then compares the sample with the one provided by the clients and to their original demands. The western clients would usually also be involved in this stage. At the same time, quotations are given by each factory. The manufacturer who produces the most satisfactory prototype, at the most reasonable price, is approved by the customers and then further cooperation can take place.

Step four: manufacture

After confirming the prototype and cost, the clients then send order to the agent that includes product name, specification, volume, price, date, means of payment, ways of transportation and other requested data. The contract is signed with other legal documents and the production will start under the supervision of the agents.

The agent sends the order to the selected factory, who then manufactures the product according to the technique, volume and time requirements. The agent is involved in the production arrangement, inspection, quality control and packaging. Detailed quality testing resports are kept and sent to the clients.

Step five: shipping and feedback

When the order is completed, finished products are shipped to the clients. The agent is in charge of booking and sending products. Ports and methods will be chosen accoriding to clients' preference. Size and volume are also taken into consideration during transportation. Legal documents are required at customs when exporting the products. In addition, a testing record provided by Chinese quality and inspection authority is also needed, especially when the volume is large. Other loading bills and invoices are sent to the clients who can then pick up the products from the assigned port.

The import and export company then contacts the clients for comments. If they are satisfied, further cooperation may be possible, if not, the agents research the problem so as to avoid future mistakes.

Example two

This company is founded in 2003, foreign trade corporation with import and export license, which is located at the centre business district of Beijing. Originally, it has two factories of its own, and as more businesses with western orders took places, it decided to establish a trading company.

Step one: preparation

Normally they use websites and exhibitions to attract foreign clients or OEMs, who will in turn provide design drawing and samples. The start of the business is similar to the previous model, but the other processes are much simpler, because the only factories they do business with are their own. Once the production line meets the western OEMs' requirements, or can achieve them by slightly modifying the equipment, orders will be sent to the factories.

Step two: manufacture

Manufacturing is completely done within the factory. The agent does not send people to monitor the production, nor does it control quality. Final testing and packing is done by the agent.

Step three: shipping and feedback

The biggest advantage of this company is that they have their own products and factories. They have the capability to design and make product**s** by themselves. They are most keen on advertising and attracting more clients. However, production and quality inspection is all done in their own factories and the scale of their business is very small due to limited manufacturing partnerships. The management team is still under development. The company's long term strategy is to expand and make more deals with cooperative production businesses, processing foreign parts according to foreign samples, assembling of foreign parts, compensation trade and consultancy of foreign trade. In order to meet customer requirements, manufacturing environment and technological issues are also taken into consideration.

Example three

Case three company was established in 2003 (UK) originally as an agent who helps western OEMs outsource production overseas. In Beijing site, there are eight Chinese staff and three UK people, mainly –related to trade, environment, engineering and social relation. To ensure technical excellence of the programs, they partner with short-term experts and specialist consultancies in order to achieve the necessary balance between specialist know-how and management capabilities. The services include match making, prototype development, establishing quality assurance systems and ongoing project management.

Step one: project specification

The way of contacting clients is a project specification which includes the following information in the enquiry template form.

Step two: project proposal documents

A tailor-made proposal will be provided to clients. It contains all the major concerns of the western OEMs, as well as legal and commercial agreement. When the document is created, the company begins to look for possible manufacturers. They have established a database covering quality producers across many production categories in China. The database contains information about their history and background, financial status, partnership with other companies, quality standards, location, environment, which is provided by local industrial communities. The agent asks for the clients' opinion and preference and then assigns marks to each of the manufacturers. After this process three or four factories are chosen.

Step three: prototype development

The screening process ensures that only the best manufacturers are invited to produce prototypes of required products. Only then, the final selection of a manufacturing partner is possible. A second more in-depth review aids the selection process, and the factors they measure are raw materials sourcing management, product process quality, costing and long term sustainability.

Step four: production inspection test and quality assurance

The agents spend time on the on-going inspection and the long-term sustainability of the production. It is measured against criteria for quality, cost and trading, inspection and testing, and sustainability. They cooperate with consultants and research centre. Production is carried on under the inspection of the project management group, including people from the agency and outside consultancy companies.

Step five: sustainable investing

Since there are many problems such as enviromental and natural resources, that can affect company's or country's development in the long term. The company cares much about these issues, and has a service of improving, environmental solutions, transportation and communication development.

Example four

The company is a 4PL operator with full scale of services, cooperating with clients in terms of logistic outsourcing, product design and manufacturing of both consumer and industrial products. Founded in 2000, they are able to co-ordinate process from initial design through to manufacturing and production, quality control, assembly, packaging, logistics, and ultra-fast delivery. The company has over 200 full-time staff in central Shangai, and a sales group in Hong Kong. Most of them are design engineers, industrial engineers and quality experts. The company does not have an overseas office, so the business starts with finding as many clients as possible. In some cases, the components are manufactured in factories, and assembly is done by the agent. When selecting a manufacturer, the three factors they are most concerned about are human and environmental, then, capacity including price and quality, as well as the performance and process. The company has thirty quality experts who take charge of the production.

6. CONCLUSION

The trend of outsourcing production to the countries with cheap labor has created a market niche for a specific type of 4PL operators, the international outsourcing agents. Their role is to manage international supply chains on behalf of the prinicipals who are not localy present.. State-owned Import and Export Companies are familiar with the cooperation process**,** based on traditional roles of import and export of raw materials and finished products. State-owned companies also deal with logistical and legal issues, and prefer doing business with Chinese manufacturers. Privately-owned international trading companies are generally newly developed agents who have small businesses and services. They have their own factories or closely related manufacturing partners, so the service focuses upon existing techniques and production line. International logistic outsourcing agents owned by the the global corporations based in UK, US and mainland Europe also share the market Although history and location vary, the business models are similar in many aspects. From western background, they know exactly what clients want, and thus pay much attention to developing manufacturer selection processes and quality assurance systems.

Not necessarily every model is the same as the ideal one. For state-owned companies, the major task is to sustain the selecting and inspecting system. Chinese privaely owned companies need to focus on finding more customers. Western-owned companies need to focus on developing relationship with manufacturers. Also other factors such as to have more communication with governments and research centres are helpful. Outsourcing logistics is an area that requires further research.

ENDNOTES

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INFLUENCE OF THE ADRIATIC TRANSPORT CORRIDOR ON THE SUSTAINABLE DEVELOPMENT OF THE CROATIAN ECONOMY

ABSTRACT

Powerful interaction processes of market globalization and liberalization influence considerably on the world flow of goods, thus directly affecting the transport system, generating economic and transport growth. Maritime transport, as the cheapest segment of transport, is becoming the most important instrument of the globalization process, considering total transported goods amount and value.

This article represents an overview of preliminary outcomes from ongoing research, resulting in the Adriatic Transport Corridor concept as a significant part of the intermodal transport corridor Baltic-Adriatic. Authors' research is directed towards defining strategic guidelines for the integration of intermodal transport system comparative advantages, important environment protection potentials and coordination with European transport network organizational concepts and achieving sustainable growth as the most important strategic challenge for Croatia. Owing to its compatibility with the environment, maritime transport is the least harmful to climate, thus gaining importance in the European intermodal transport system with a bright future ahead.

Key words*: intermodal transport, corridor Baltic-Adraitic, concept of the Adriatic Transport Corridor, sustainable economic growth, environmental aspects*

1. INTRODUCTION

The phenomenon of market globalization and liberalization has a significant influence on the formation of the world flow of goods, and thus on the transport system. Transport systems in the region are unevenly developed. EU member countries have the most developed transport system, with the road transport being the most dominant in all countries. In addition, there is a difference between the industry and development of national economies of surrounding countries, their national policies, strategies and guidelines for planning infrastructural capital investments. Specialization in production, volume economy and competition, as basic market features, have an extremely important function of continuous transport development as a process. The development of the transport system directly interacts with the development of economy; therefore, it directly conditions the economic growth and an enviable level of local, national and international mobility, and in the end, increase of the quality of life. The need for sustainable growth and environment protection, as well as the development of traffic safety, ensuring energy supply and finding and applying alternative sources of energy are particularly emphasized as important goals of sustainable growth.

There is without doubt a strong interactive influence of the transport system and globalization, especially maritime transport and globalization, as a developed transport system presupposes the integrity of the global market, so it is precisely the process of globalization and liberalization that has a positive influence in the decrease of transport costs by sea. More than 65% of the total international transport of goods takes place by sea, therefore the significance of the flow of goods by sea for the transport and economic growth on the global, regional and local level is thus greater. The intensity, structure and dynamics of the flow of goods by sea in the context of world transport are relevant indicators of the concentration of European transport and the tendencies of its economization. In contrast to the competitive road transport, transport system is trying to contribute to the implementation of efficient integrated system of intermodal transport by sea, rail and inland waterways by introducing a series of measures. The tendency of intermodal system is to reach such a level of organizational and financial simplicity and efficiency in the transport system that will make it a logical choice. Therefore, the value of results obtained through analysis of the mentioned indicators of the movement of goods, both by sea and by land, shows the purposefulness of their monitoring.

In the framework of thus determined scientific problem, the subject of research in this paper is to diagnose, on scientific basis, the current transport development possibilities in Croatia within the EU transport network, especially when it comes to intermodal transport, and the forecast of sea and overland flow of goods as important accelerators of European and Croatian transport and economic growth.

The goal of the research is to define the basic characteristics of the Croatian transport system development, maritime flow of goods on the Adriatic considering: the connection of Scandinavian countries to the European transport system and economy, or the possibility of direct land connection with the Adriatic; ecological aspects and significance of the Baltic-Adriatic corridor and intermodal transport in the world trade; development of the Adriatic ports, especially the port of Rijeka and transport infrastructure of Croatia, the leading region of maritime transport; the cargo structure in maritime transport and global changes in the world economy which reflect upon the global changes in the EU economy and Croatian economy.

2. DIRECT MULTIMODAL CORRIDOR BALTIC-ADRIATIC AS AN IMPORTANT STRATEGIC RESOURCE

The areas along the Baltic and the Adriatic have significant geographical, historical, economic and transport similarities. Recently, the intensification of economic growth and the dynamics of the flow of goods between the Central European zone and pre-Asia areas, that is the zone between the north and the south of Europe, has enabled a more progressive growth trend of both zones [2]. The development of multimodal transport network and its connection with the TEN-T[1] corridors (Picture 1.) in the overland transport sectors (road and rail), inland waterways, sea ports and airports, represents a precondition for strengthening national economies.

Figure 1 - Potential corridor V of north Adriatic sea ports association (NAPA) and the interconnectivity with the TEN-T land network
Source: East Mediterranean Master Plan of the Motorways of the Sea, 2011, pg. 2-117 [5]

Profiling a direct multimodal corridor Baltic-Adriatic connects the north and the south of Europe, with a more progressive intensification of the economic growth of Baltic and Central European countries. Reviving the flow of goods dynamics and the trend of development of port and rail transport within and between the Baltic and the Adriatic basin creates a prerequisite for land transport connection of all countries from the Baltic to the Adriatic. Rail and road transport connection of the Baltic and the Adriatic establishes inter-relations with the existing corridors of the European transport network. The concept of the transport connection Baltic-Adriatic should reintegrate navigable ways of the Danube waters and the construction of the canal for connecting river basins. The construction of the canal from the Danube towards the Elbe, the Oder and the Vistula enables the navigation by river and river-sea vessels to all ports of the North Sea and the Baltic Sea. The construction of the canal Vukovar – Šamac and the regulation of the river Sava to Sisak and Zagreb, as well as the river Kupa to Brod na Kupi and Tunnel Channel to Bakar covers the shortest navigable connection of the Danube region to the Adriatic [3]. The Baltic was dubbed the Sea of Opportunity, and the Adriatic in the concept of the Ionian-Adriatic corridor has become an extremely significant strategic resource and economic challenge for the Republic of Croatia.

3. IDENTIFYING INTERMODAL TRANSPORT AS A STRATEGIC GOAL OF THE REPUBLIC OF CROATIA

Besides the pronounced potential in environment protection, intermodal transport system has the ability to generate and intensify the economically sustainable growth. Without doubt, there is a true need for economic growth and transport system in the Republic of Croatia, within which intermodal transport would have particular significance as a strategic program and certainly as one possible way of solving the economic crisis.

Strategic planning of the Croatian transport development must be in the service of the overall economic growth and dynamically adjusted to objective investment possibilities of the public sector, whereby the conceptual approach should not be nationally limited, but in the context of the development of the entire region.

3.1. EU Guidelines

As a part of the European Union development strategy, the European Commission has brought and adopted a series of long-term development plans and projects [4], extremely important for the development of Croatian economy. A large number of international projects and strategic documents relates to the research of the flow of goods, as well as transport and industrial routes. Essentially, these documents emphasize the key role of a sustainable transport system development in the context of the European transport policy and logistics, as an important component of the transport system, in ensuring a sustainable and competitive mobility in Europe [7].

The EU emphasizes the need for developing a transport network in Croatia in complete agreement with the development of the Trans-European network and the South-East Europe Core Regional Transport Network, and greets the treaty achieved between Croatia and the European Commission about the future (TEN-T) network in accordance with the Decision 1692/96/EC, as amended, and about the priority project of European interest within this TEN-T network, fulfilling the requirements proscribed for closing Chapter 21 of Croatian pre-accession negotiations for the entry into the EU membership, in the Joint Position of the European Union (CONF-HR 31/07).[2] In that context, the European Commission adopted the Directive 2004/54/EC related to the Trans-European Road Network – TEN-T which has been obligatory for all EU members since 19 November 2011.

The European Commission designed the Freight Transport Logistics Action Plan[3], whereby it determined the support for the development of intermodal transport as one of the main priorities of the European transport policy. In the context of that plan, the European Commission set out a frame and guidelines [7] which would ensure the modernization of European ports, and thus raise the level of competitiveness of maritime transport, attract investors and analyze progress in sustainable mobility development, and in that context, develop and stimulate competition of intermodal transport system.

Precisely for that reason, after signing the pre-accession agreement in the preparation process of the Croatian entry into the EU, defining the strategic guidelines for integrating comparative advantages of intermodal transport system, and coordinating the organizational concepts of the European transport network, Croatia has an opportunity to achieve a high level on the transport market and enable the integration of the Croatian transport system into the European transport network.

Realizing the intermodal transport system represents a strategic issue as intermodality is of essential importance for the development of a sustainable transport system. The basic goal of the intermodal transport system is the creation of competitive alternatives to road transport, reducing bottlenecks and jams on roadways, increasing the safety and protection in traffic, and especially reducing the negative influence of transport on the environment.

3.2. Intermodal Transport as the Generator of Transport and Economic Growth in the Republic of Croatia

The Republic of Croatia, geographically situated between the east and west Europe, as a country extremely oriented towards the sea, with an already well-built and developed road infrastructure and developed rail infrastructure, should intensify and integrate maritime traffic and inland waterways traffic into the sustainable Croatian transport system, which represents a precondition for the development of the transport system. Transport system, with all its subsystems, represents an important segment of economic growth. The goal of sustainable transport system growth, and intermodal transport as its important constituent, is the establishment of an efficient integrated system which could satisfy the needs of all participants and which could generate a strong economic growth, with the condition of the safety and sustainability of environment.

The Croatian transport system should as soon as possible become an important and irreplaceable constituent part of trans-European intermodal transport network, from the aspect of possibilities of integration of the Croatian transport system and transport systems of neighboring countries. Thus, the east Adriatic coast systems will be included into the EU development programs. This especially concerns the parameters of intermodal maritime transport in the Republic of Croatia, established according to available transport resources and defined transport corridors. For the purpose of enhancing transport networks compatibility and competitiveness, as well as increasing the safety of traffic and environment protection, the integration of the intermodal sea and inland traffic in the European transport networks represents an important segment of the development of the Croatian economy. Another extremely important issue lies in the fact that the so called short sea shipping[4] represents a major form of intermodal transport in Europe.

The development of an intermodal system, with the main center in the port of Rijeka and a transport-logistic center "Miklavlje" in Matulji near Rijeka, may lead to realization of significant strategic goals for the purpose of economic recovery, progress and possibility of solving the Croatian economic crisis. Possible strategic goals may be summarized as follows [13]:

1. Realizing >8,5 billion EUR of new foreign currency annual revenue,
2. Opening >90.000 of new productive working positions,
3. Reducing imports and increasing exports >35% in relation to the present,
4. BDP growth by 4.5 - 6% in relation to the present,
5. BDP growth >15.000 EUR per capita,
6. Increase of dry cargo traffic by 40 mil. tons per year until 2025,
7. Increasing the profit of the state budget and the budgets of local self-government units situated on the major transport routes >3.5 mrld. EUR per year,
8. Reducing the foreign debt and settlements of the due installments,
9. Various other economic effects.

4. CONCEPT OF THE ADRIATIC TRANSPORT CORRIDOR IN THE CONTEXT OF BALTIC-ADRIATIC CORRIDOR

4.1. Adriatic and Croatian Transport Corridor as the Center of EU Projects Interest

On the basis of implemented development projects in the area of international public transport, industry, energetics, economy, finances, IT and other, the European Union has redefined pan-European corridors and has given up from the strategy of connecting the North Sea and the Black Sea through the corridor North Sea-Rhine-Main-Danube-Black Sea, but has adopted a new one – Baltic-Adriatic. Insight and analysis of the database, using the most modern methods and technologies for economic effects assessment, the European Commission has conducted a research of the flow of goods and transport and industrial routes through international projects IMONODE, NADOK-X, ECO4LOG, INTERIM. The project Imonode [15] established strategic justifiability of north Adriatic ports, Rijeka, Koper, Trieste, integration into the system which would strengthen the European corridor V and directly introduced the junctions of Rijeka and Zagreb into that corridor. In that sense, it is necessary to construct a lowland double-track electrified railroad Rijeka-Koper-Trieste, the railroad from Rijeka over Pivka to Austria, and along the Adriatic coast from north Italian ports to Greek ports with branch lines towards Zagreb and Hungary (Rijeka-Zagreb-Botovo), all of that at the maximal above-sea level of 200 m. This modern railroad would connect

Croatia with the European railroad network, thus becoming a key factor for connecting the EU with the Adriatic-Mediterranean sea transport route, or over-seas areas of Africa and the Near and Far East - Asia. In addition, with this new rail, the EU would like to technologically integrate north Adriatic ports into a key intermodal center, which would strategically connect the EU and Asia [22]. For that reason, in March 2010, the ports of Trieste, Rijeka, Venice, Ravenna and Koper, jointly founded the North-Adriatic Ports Association (NAPA). The European Union evaluated the NAPA project "ITS Adriatic Multi-Port Gateway" as extremely significant for the potential of port infrastructures and European market services, granting the NAPA ports funds in the amount of € 1,442,500 at a European Union public tender for co-financing development projects in TEN-T fund (European Transport Network) (Picture 1.). Co-petitiveness (cooperation and competitiveness) will in the future favor the creation of a unique information platform, which would manage services directed towards Far East, as well as central and eastern European markets. The project will last 30 months, with the expected implementation period up to 30 June 2013. The expansion of port community system will also reflect on the Rijeka Port Authority, a member participating in the project as "Observer" until Croatia becomes an EU member [10]. NADOK-X project (North Adriatic Danube corridor-ten) has designed a transport infrastructure for traffic-industrial connection of the Adriatic with the trans-European corridors X and VII, for a modern transport of goods on the route Adriatic – Danube (central and eastern Europe). ECO4LOG project has designed logistic goods services in international public transport as a value added service or economic multiplicators bringing great benefits to countries where the flows of goods pass, and there are as many as 6 international transport corridors passing over the territory of Croatia [13]. INTERIM project has designed a modern intermodal transport system ensuring the participation of sea, rail and inland traffic with 85% share, the other 15% being road transport, in order to achieve the 3Es (Ecology, Energy and Economy) [10].

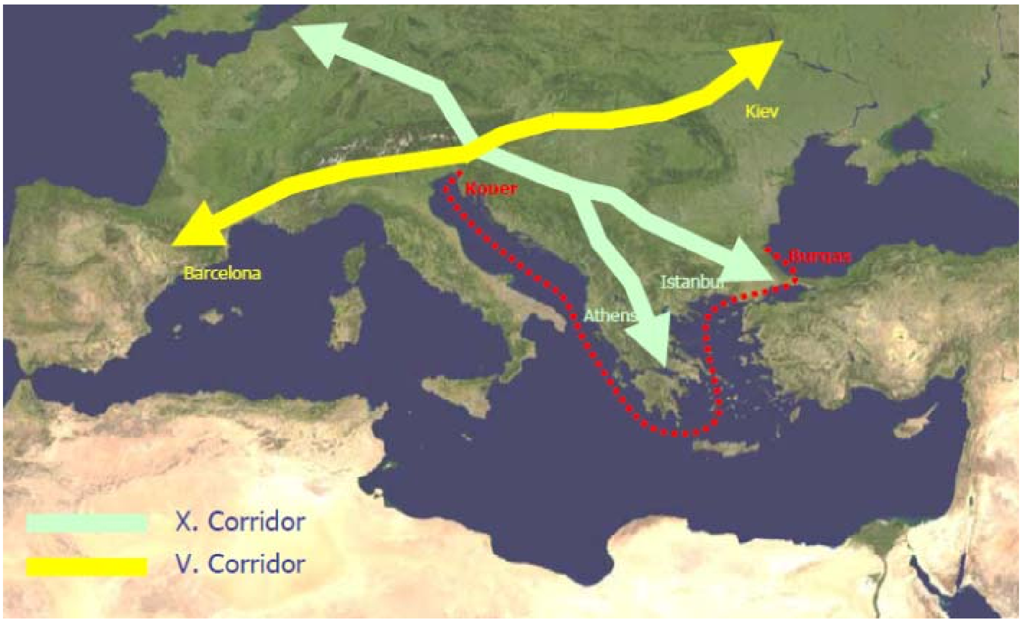

Figure 2 - Corridors V and X, maritime Adriatic corridor
Source: East Mediterranean Master Plan of the Motorways of the Sea, 2011, pg. 8-206 [5]

The EU adjusted its long-term development strategy and has adopted a new one, Baltic-Adriatic, with the Port of Rijeka as the principal intermodal center and the main transport route ensuring maximal satisfaction of EU strategic interests. As much as 90% of the EU foreign trade is directed over the sea, because of which the European Commission considers that great cost-effectiveness might be achieved with a new and significantly shorter corridor passing through Croatia. Croatia should recognize and take advantage of this strategic interest of the EU as a fantastic opportunity for economic recovery and growth. European Commission's evaluation that transport in the countries of this region (Croatia, Italy, Slovenia, etc.) will rise by 50% until 2020 speaks in favor of that. The fact that of about 700 million tons of cargo, which annually passes through the Suez Channel by ships, only 10% comes to the north-western Adriatic ports should not be neglected [19], although this transport corridor would reduce the cargo transport time by about five to seven days in relation to north European ports (Picture 3.).

Adriatic transport corridor has become the center of interest of both European and world shippers, who base their choice of this transport route on the transport costs reduction and decreasing navigation duration. As the basic advantage of its suitable geostrategic and geotraffic position, Croatia should use current trends of the shippers' and the EU transport policies and ensure all the necessary transport logistics and capacities along the main land, sea and inland transport routes. Therefore, the need of investing into the transport infrastructure and transshipment capacities development in the Port of Rijeka and other Adriatic ports represents an obvious challenge to Croatia, in order to realize strategic national interests, along with the EU's strategic interests in the long run.

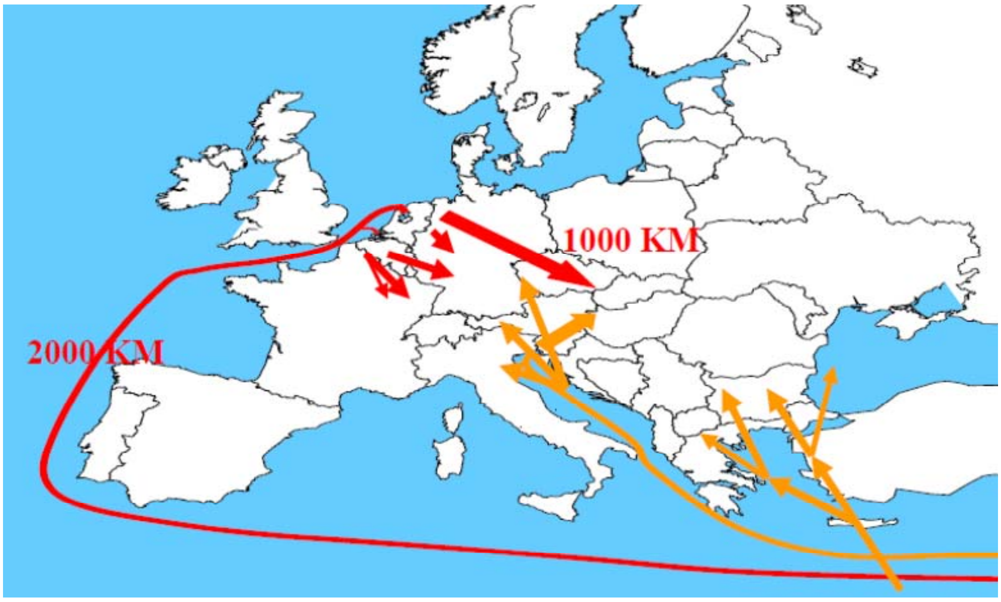

Figure 3 - Illustration of the navigable route length from the East Mediterranean (the Suez Channel) until the northern sea ports through the Adriatic corridor in relation to the longer route through the Gibraltar
Source: East Mediterranean Master Plan of the Motorways of the Sea, 2009, pg. 9-240 [5]

In the context of a wider transport approach, or adopted trans-European (TEN-T) network program and Common Transport Policy[5] program, the emphasis was put on considering environmental and safety aspects, transport routes management efficiency supported by the application of intelligent transport systems, as well as on interoperability of transport branches and forms of transport.

As a part of the EU's TEN-T program, Cyprus, Greece, Italy, Malta and Slovenia conducted the Eastern European transport system development project and made a Master Plan with a detailed analyses and plans for necessary modifications and investments into infrastructure, with the Croatian ports being included into consideration.

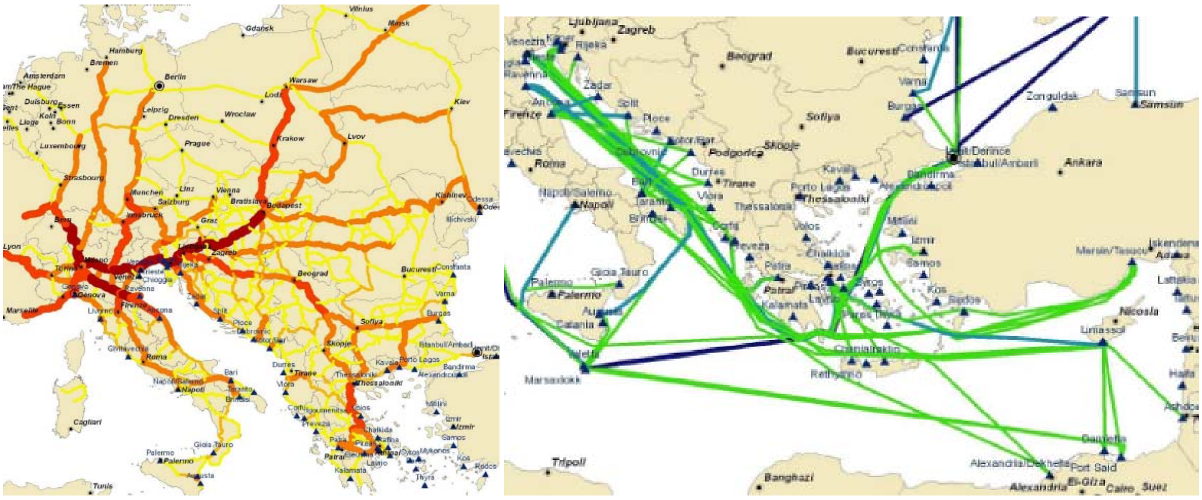

Figure 4 - Illustration of transport overland and overseas corridors connecting Central Europe and pre-Asian areas, or the zone between the north and the south of Europe
Source: East Mediterranean Master Plan of the Motorways of the Sea, 2009, pg. 7-185 [5]

This document will serve the European Commission to make development strategies and plan the related financial programs, stimulating investments and transport infrastructure development. As Croatia is not yet an EU member, it still cannot use the TEN-T program financial means. After the accession to the EU in July 2013, Croatia will have access to the financial means for the investment into sea and intermodal transport system on the Adriatic, whereby it will be possible to include Adriatic east coast transport systems into the EU development programs.

The European Commission expects Croatia to nominate its strategic transport projects to the Cohesion Funds, which should enable outright use of about €3.5 billion after Croatian full membership in the EU.

4.2. Rijeka – an Important Strategic Intermodal Logistic Center and Junction

During research in the INTERIM project, strategic partners (ten larger world investors) for investing capital into the main Croatian transport route through Rijeka, evaluated the results of transport demand research as realistic, which stimulated them to express their interest in concrete investment into concrete programs and projects, aware of the fact that a market of about 7.5 mil TEUs, or 70 mil tons of cargo, is assessed for the area of northern Adriatic until 2025, or about 4.5 mil TEUs or 42 mil tons of cargo through the principal terminals of Rijeka port and its hinterland.

All kinds and sized of vessels may sail into the Rijeka port, because as opposed from other north Adriatic ports in which the draught is limited to 14 m, it has unlimited draught, or the depth of the sea along the wharves without any need for additional construction of the so called port basins, as is the case in most EU ports. Owing to its existing infrastructural and port capacities and obviously good geographic and transport characteristics, Rijeka will become the main intermodal center, with the extension of Brajdica with a 50,000 square meter wharf and the construction of 330 meters long new coast with 14.5-meter draught and intensive continuation of construction and releasing into operation of the Principal Container Terminal Zagrebačko Pristanište, with an 18-meter draught and a 1200 meter wharf, whose capacity will amount to 3 mil TEUs annually. The favorable geographic position of the lowland railroad Rijeka-Zagreb-Botovo-central Europe, with the maximal level above the sea of 200 m, certainly contributes to the above mentioned, as opposed to the height above sea level of railroads in the hinterland of other north-Adriatic ports, which amounts to 800 m.

Transport-logistic center “Miklavlje” in Matulji is an excellent location with an overall area of 250 acres, which integrates public transport industrial functions of the ports of Rijeka, Koper and Trieste with an electrified two-track railroad, highway and state road. Besides that, the center “Miklavlje” enables the strategic partnership for the development of international public transport, as well as small and middle entrepreneurship in Croatia and neighboring countries. The possibility of direct integration of internal Croatian navigation into the developed internal navigation system of central European countries is also significant.

Rijeka Gateway project, or the Project of Rijeka Transport Route Restoration, is a complex development program with the goal of coordinating port operative demands with the urban part of the city area and transport connection of port area with international road and rail corridors. Rijeka Gateway (1 and 2) project, besides port modernization and restructuring (previously described construction of the container terminal “Brajdica” and the Principal Container Terminal), encompasses the construction of eastern part of Rijeka bypass from Orehovica to Križišće, connector roads Draga – Brajdica (D-404) and Čavle – Križišće, as well as the reconstruction of Krčki Bridge. Thus Rijeka obtained a good connection to the highway Rijeka – Zagreb – Budapest, which is a part of European transport corridors. The World Bank has a significant role in the realization of the Rijeka Gateway project by means of its loans RGP I and RGP II, granted in a few stages in the period between 2003 and 2009, financing the implementation of the project. Besides these projects, an overall development of the Port of Rijeka, as an intermodal center and junction, and the development of the Rijeka transport route[6], and thus indirectly the economic growth of Croatia, requires some other strategic projects as well. This relates to the construction and design of logistic centers “Miklavlje” and “Škrljevo” and their connection by two-track railroad with the Principal Terminal and enabling the transport of containers between the wharves and logistic centers in the hinterland, to the construction of the IMONODE [24] railroad Trieste-Koper-Rijeka-Oštarije – further towards the south, and to the construction of the new container terminal on the island of Krk – Omišalj near JANAF, as well as the construction of the LNG terminal in Omišalj, the construction of a frigo-container terminal as the world junction of air-conditioned cargo, as required by the development of air cargo terminal in the existing Rijeka airport [13].

All of the above are key reasons owing to which the Republic of Croatia and the Port of Rijeka have true potential to become a strategic transport industrial corridor and an intermodal center of the European Union and great countries of Asia.

The significance of Rijeka transport route, or the significance of Rijeka port as an intermodal center and junction for Croatia and this part of the EU, reflects through the expected increase of port’s share in the Croatian GNP until 2020, when the share would amount to 12.7%, which is ten times greater than today [10]. **On the level of Croatia, it is estimated that GNP would increase by 4.5-6% in relation to the current state.**

5. ECOLOGICAL ASPECTS OF THE ADRIATIC TRANSPORT CORRIDOR IN THE CONTEXT OF THE CORRIDOR BALTIC-ADRIATIC

By intensifying industrial production and expenditure, the relation between environment and economy has become an obligatory component of sustainable growth. The share of maritime transport in the overall foreign trade of EU member states in 2007 amounted to 71.3%, which represents the value of trade of goods by sea amounting to 48.5% of the total value of the EU’s trade [6]. Analogously, by intensifying sea transport through the Adriatic, especially by establishing a strategic intermodal corridor of the European Union and great countries of Asia, navigational burden of the Adriatic will constantly be on the increase, and therefore, all the efforts for its preservation represent a definite need for transport and environment interaction in the context of natural laws and the awareness of limited resources and absorption of the Adriatic area.

More than 7000 ships arrive into Croatian ports in international navigation per year, and an average of 7000[7] ships come to Adriatic ports annually, with about 30,000 ships which transport about 70 mil. tons of oil in the Adriatic, along with the other types of cargo per year. In view of all this, it is obvious that traffic through the Adriatic, especially in some areas, is extremely heavy. Navigational burden in the Adriatic is unstable in certain areas, while at every moment the radars in the Adriatic register from 250 to 300 ships, 50 of which are tankers (about 20%), and 10 – 20% ships report dangerous cargo to the AIS system [14].

The area of the Adriatic is an ecologically sensitive area with a large concentration of people, activities and interests, so environmental issues may appear suddenly and quickly reach their peak, while their recovery would represent a long-term process, which would require considerable financial means and would have a negative economic effect on the entire area and wider. Only with integrated instruments of spatial, environmental, economic and social planning, as well as suitable mechanisms of plan implementation and implementation control, can it be directed towards sustainable growth. The transport route represents a cleaner, more cost-effective solution for the transport of goods, which would reduce the emergence of bottlenecks on Croatian and European roads. The implementation of well-established and reliable sea route network in the Adriatic may have a more effective influence on the protection of the Adriatic environment. In order to neutralize the positive effects owing to the change in the type of transport, infrastructural interventions directed towards the navigable sea route should be planned with the goal of minimalizing the negative effects on the environment. For that purpose, infrastructural interventions included in port authorities' developmental plans are subject to detail assessments of effects on the environment according to national and EU regulations.

In view of all that, a logical basic "task" suggests itself – preservation of ecological integrity of the Adriatic coastal area ecosystem, or preventing the devastation and degradation of ecological resources of the coastal and sea Adriatic area by application and implementation of an **environment protection model**, as well as planning and managing sustainable growth.

It is suggested to follow the **Adriatic Environment Protection Model** (currently developed by the authors), which will contain a strategic ecological assessment of the Adriatic navigable way (corridor) on the basis of the regulations defined by Annex I of the EU Directive 2001/42 about the assessment of effects of certain plans and programs on the environment. The suggested Model should identify the relevant aspects of the current environment condition in the Adriatic, ecological characteristics and main issues to be solved. Adriatic Environment Protection Model, containing suggestions of key technical-technological solution methods for sustainable growth, should strengthen the contribution of reducing acidification, eutrophication, endangering human health, climate change and ozone destruction as a consequence of pollution from ships in national and international navigation through the Adriatic.

6. CONCLUSION

Strategic planning of intermodal transport corridor development in the Adriatic and through Croatian overland route, as a part of the transport development in Croatia and the wider region, should be in the purpose of overall economic growth, dynamically adjusted to objective investment possibilities of the public sector, but also to the interest of foreign investors. Besides current financial means from pre-accession EU funds and world bank credits from the European banks, after the accession into the EU in July 2013, Croatia will have access to the financial means for investing into sea and intermodal transport system in the Adriatic, which would enable the inclusion of Adriatic east coast transport systems into the EU development programs.

The need for investing into the development of transport infrastructure and transshipment capacities of the main intermodal center and junction in the Port of Rijeka, but also in other Adriatic ports, with the goal of long-term realization of strategic economic and transport national interests, parallel to satisfying the EU interests, is one of the most important state priorities.

Considering its potential, the current transport system in the region is insufficiently developed, characterized by individual countries and important ports' development strategies. One of key solutions of their adequate development is the integration of activities, strategies and resources of the ports in the region, with their joint appearance on the market. For that strategic purpose, the ports Trieste, Rijeka, Venice, Ravenna and Koper have founded the North Adriatic Ports Association (NAPA). The European Union evaluated the NAPA project "ITS Adriatic Multi-Port Gateway" as extremely significant for the potential of port infrastructures and European market services, granting the NAPA ports finances in the amount of €1,442,500 at the public tender by the European Union for co-financing development projects in the TEN-T fund (European Transport Network).

Owing to comparative advantages, competitiveness and compatibility of the intermodal sea and inland waters transport system in integrated European transport networks, this transport system has a bright future ahead. The Republic of Croatia and the Port of Rijeka, geostrategically, geographically and traffically well-positioned, with all their natural resources and economic potentials, may become a strategic transport industrial corridor and intermodal center and junction between European Union and great countries of Asia.

A systematic approach to integrated management of intermodal transport corridor through the Adriatic will generate a dynamic process of sustainable management and utilization of sea and coastal areas, encompassing all relevant entities (social, economic and ecological relations) with an influence on the process itself, as well as interacting with one another, including all sea and coastal elements which form a part of it. **The preservation of environmental integrity of the Adriatic coastal area ecosystem, or the prevention of devastation and degradation of ecological resources of the coastal and sea area of the Adriatic is particularly important, because the area of the Adriatic has limited resources and absorption. In that context, the ecological aspects of the transport corridor through the Adriatic implemented by the Adriatic Environment Protection Model, and the technical and technological innovative solutions predicted and suggested by the mentioned model, aim at realizing strategic economic development processes in Croatia, provided there is a significant contribution to the preservation of the irreplaceable spatial, economic, environmental and social resource of the Adriatic Sea and its coastal area as a natural privilege of the Republic of Croatia and its citizens.**

ENDNOTES:

[1]TEN-T development program of trans-European transport network

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[3] Freight transport logistic action – in 2007, the European Commission adopted a plan suggesting a series of measures with the goal of stimulating competitiveness of the intermodal transport system, raising the level of maritime transport competitiveness, creating a framework which would ensure the modernization of European ports, promoting transport

logistics and attracting investors, as well as analysis of sustainable mobility development progress.

[4] Short Sea Shipping – term for the transport of cargo and passengers among European ports and nearby non-European ports. This transport uses waterways which partly include the sea or the ocean which is never completely crossed. Geographically, short sea shipping transport is applied on the area from Iceland, Scandinavia, and Baltic region over western Europe all the way to the Mediterranean, including north Africa and the Black Sea.

[5] CTP – joint transport policies of the EU.

[6] The traffic position of the Rijeka port on the Vb branch of pan-European corridor, connecting it into the European road and rail network, is very significant for the development of Rijeka transport route and the connection of the Rijeka port with the European countries in its hinterland. The connection with the corridor X and the Danube corridor VII, passing through Croatia, enable a better transport connection with the market in its hinterland.

[7] HAZMAT – hazardous material

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4D TRAJECTORY FLIGHT IN AIR TRANSPORTATION OF PASSENGERS AND GOODS

ABSTRACT

Due to the anticipated trend of continuous growth, significant changes are required in the organization of air traffic. This is primarily related to air traffic flow management and conceptual design of the airspace. This article presents development and implementation of the new generation of air navigation system called 4D navigation. This concept is primarily focused on the safety of civil aviation and the increase of airspace capacity in accordance to the European regulations. The purpose of this article is to explain the concept of 4D navigation methods, as well as its application. This paper elaborates the need to change the conventional air navigation system. It will also list the predictions and expectations of the European Organization for the Safety of Air Navigation – Eurocontrol, which should ensure the effective implementation of the system. Finally, it will explain the influence of 4D flight paths of air traffic management and the benefits that are equally important to the system of air traffic control as well as aircraft carriers.

Key words*: 4D navigation, air space, reference business trajectory*

1. INTRODUCTION

It is expected that in the ECAC region (The European Civil Aviation Conference), by the year 2015, the increase in air traffic will be 35% in comparison to the year 2007 [1]. Globalization has completely changed the lifestyle and ways of doing business of the modern man. Consequently, it imposed the need for greater transport links in the world and thus greatly influenced the increased demand for air transport. Therefore, the existing system of air traffic and air traffic control system will have to undergo significant change and adjust to the demands of a new era.

Today, for each commercial flight, which has its point of origin or departure point and its arrival point, the flight dispatcher or the pilot himself, announces the optimum flight path of the aircraft in the flight plan, depending on the flight operations of aircraft in accordance with the management of the business operator. After the flight plan was processed and distributed in the Central Flow Management Unit (CFMU) in Brussels, the aircraft receives its final and the default path by which it should fly. Information on the planned route are: initial flight speed, flight level, information on changing speeds and / or flight levels, as well as possible transition from instrument flight rules to the visual flight rules, or vice versa, and segments of routes that can be displayed in two ways – by appointing defined ATS route or the appointment of a defined aerial points [2].

Flight plan controls the existence of the appropriate equipment in an aircraft that is needed for navigation, communication and monitoring of air routes that planes fly through. Also, the existence of a flight plan helps to monitor individual flights and to predict potentially dangerous situations and conflicts. However, the greatest importance of the flight plan is that it gives the information on time availability of the certain routes within the airspace in order to predict the amount of traffic and possible excessive traffic that should be redirected. Such data is important because air traffic demand is growing and airspace capacity is not sufficient to submit that amount of traffic.

2. EUROPEAN REGULATIONS IN THE ROLE OF AIR TRANSPORT DEVELOPMENT

Large financial losses in the airlines are generated due to the continuous increase in traffic demand, which initiates delays, traffic congestion in the air and on the airport maneuvering areas. Also, due to the fragmentation of the air space, Eurocontrol has urgently demanded for new technical and technological solutions that would allow greater traffic flow. In order to increase the capacity, these solutions should provide joint air traffic management, reorganization of the area and the new structure of the area by establishing new routes and sectorization of the airspace, regardless of national borders, and by establishing a new division of land use for civilian and military aviation that will provide greater efficiency. Thus, in 2004 Eurocontrol published the regulation "The Framework for the Creation of Single European Sky" (SES I) [3], in which the main objective is the enhancement of the existing safety standards and efficiency of air traffic in Europe in order to optimize the capacity, taking into consideration user requirements and reducing delays to a minimum measure. Moreover, it is highlighted that the single sky should exist without limits of airspace, with the same rules and regulations, and will provide increased capacity of air traffic control systems [4]. Four years later, in 2008, the new regulation "Towards more sustainable and better performing aviation" (SES II) [5] is issued. It highlights four key developments of the Single European Sky: regulation performance, a unique security framework, new technologies (single European Sky ATM Services Research - SESAR) and management capacity at airports. The goal of SESAR is to find and develop new technologies that will allow increased air traffic demand in the coming years. Currently, Europe is in the second phase of development by SESAR, which lasts from year 2008 and is assumed to be completed 2013, and which enables the development of basic technologies that will support the introduction of a new generation of air navigation. In the next and final phase, which should finish by the year 2020, it is expected that the new system will be implemented [6]. In order to increase the capacity of the air space, establishment of the new generation of the air traffic system is unavoidable, and it will be the first major change in system planning, implementation and control of air traffic after the introduction of RVSM's (Reduce Vertical Separation Minima) in 1992.

3. IMPLEMENTATION OF THE NEW NAVIGATION SYSTEMS

With the reorganization of the airspace, the introduction of Functional Airspace Blocks (FAB) and the Flexible Use of Airspace (FUA), as well as the concept of a new navigation system that allows a more precise way of keeping the aircraft on routes – the introduction of 4D navigation should contribute to increased capacity of airspace [7].

4D navigation is a method of navigation which determines aircraft position in the horizontal (position) and the vertical (height) plane with the addition of time as an essential component. This means that each aircraft is expected to follow the path defined in the default data from the flight plan as they will follow the flight profile and trajectory identified with a number of segments that collectively make the path. The concept of 4D navigation will enable accurate monitoring of aircraft engines from the start until they stop after landing. Therefore, the optimal flight will be ensured, on their own chosen routes which allow efficient management of the operators and which are protected from conflicts with other aircraft. Keeping the aircraft in the horizontal plane (Lateral Navigation - LNAV) involves positioning in two dimensions 2D (Figure 1). It is expected that the aircraft will fly with less lateral deviation from the default path. The accuracy of the lateral deviation from the default path is based on the curve of normal distribution and is defined by the value 2σ. In other words, the aircraft has to be within defined maximum deviation from the default path the 95% of the total flight duration. The aircraft navigation system compares all predicted positions with the required positions on the route contained in the database of airline routes and continuously calculates the distance and direction of the flight from the current position towards the required position as the corresponding corrections. The difference between these two positions is visible on the flight deck (Attitude Director Indicator, Horizontal Situation Indicator, and Electronic Flight Instrument System).

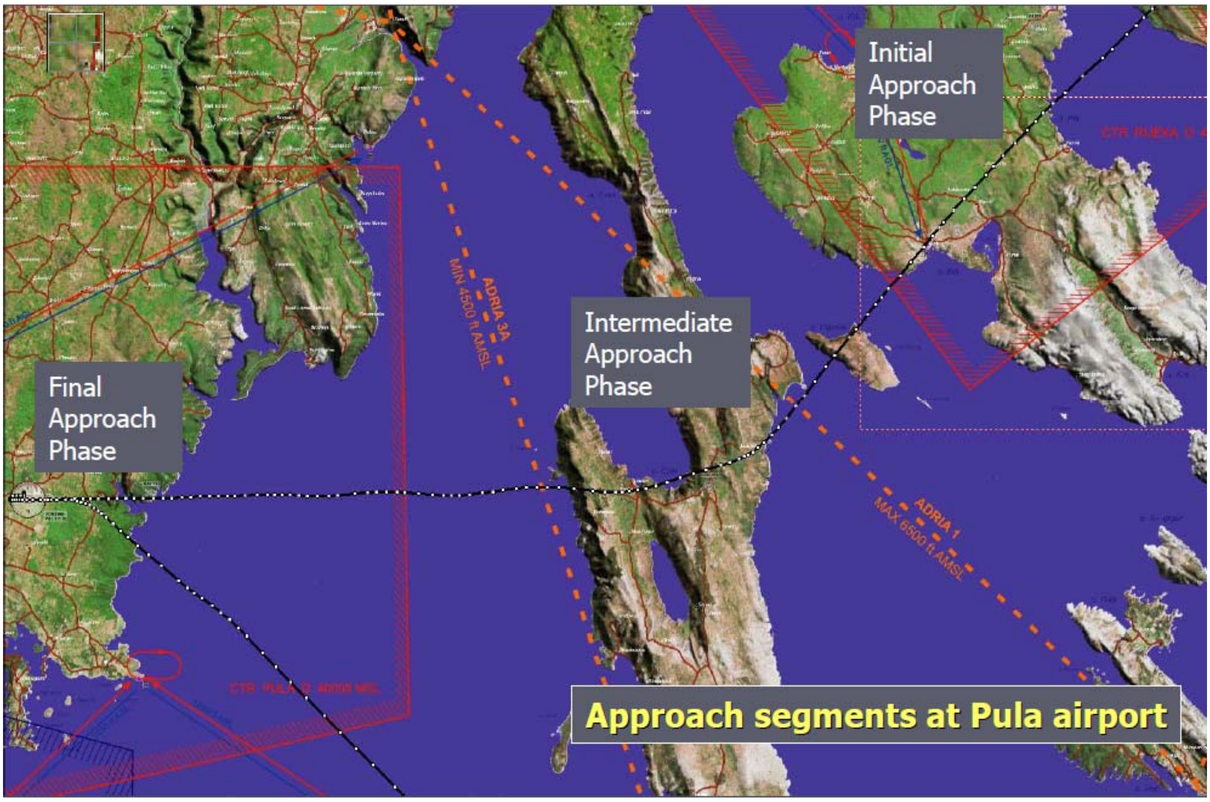

Figure 1 - Showing LNAV in various stages of the landing approach to the airport Pula

The described method of determining the position of the aircraft has been extended by leadership of the aircraft in the vertical plane (Vertical Navigation -VNAV). During the flight, aircraft must frequently change its height due to take off and involvement in regional traffic, landing and shutdown of regional traffic, aircraft separation, avoidance of unfavorable meteorological conditions, due to the step climb in order to reduce fuel consumption on large distances, due to the procedure of continuous landing to minimize noise, etc. The vertical flight profile of aircraft is made of all changes of height from the takeoff to the landing. Combining LNAV and VNAV, it is possible to display the flight path of aircraft in the area (Figure 2). Precise information about the vertical plane relative to the ground allow simultaneous flight of the aircraft on parallel routes that are located below each other and setting up more routes with smaller mutual vertical distance.

Figure 2 - The flight path of aircraft in VNAV in the approach at the airport Varaždin.

Satellite navigation system (Global Navigation Satellite System - GNSS) allows the determination of aircraft position with a high level of accuracy without the use of ground navigation aids. The position is determined as the intersection of several pseudo ranges of the satellites. For such a position, the minimum of four satellites is required, where three are used for obtaining the position, and the fourth for the correction of errors in the measurement of time. The availability of four satellites is possible because the receiver receives a signal from at least five to eight satellites at any time. The orbits of the satellites are distributed so that the positioning is possible at all times. In the ICAO regulations it is established that safe navigation can take place only if the information about the position of the receiver is received from at least five available satellites, to reduce the possibility of errors [9]. If none of the five satellites are available to the receiver in the aircraft, the device will warn about potential errors in positioning.

Each satellite provides a possible position based on measured time that elapses between the transmitted and received signals between satellites and receivers, so that each satellite gives a possible position at a certain height and in that way describes a circle around him. The intersection of two circles gives two possible positions, and the intersection with the third circle reduces the area of possible positions. With the help of the fourth circle the correct position is obtained. Most accurate position of the aircraft in the vertical plane is given by the barometric altimeter. The combination of data from GPS and barometric altimeter determines the 3D position of the aircraft in space.

Aircraft which have the option of calculating its trajectory and its 3D display on a screen, as well as displaying variations of the trajectories in space are considered as the aircraft equipped with area navigation (RNAV). 4D navigation method offers the possibility of positioning the aircraft in the horizontal and vertical plane, with the addition of the time component (time function). Therefore, the aircraft will be expected to operate at a given flight path defined by waypoints in the route that are specific geographic coordinates and altitude, and the new data associated with them will be the time at which the aircraft should occur at a particular point.

4. AIRSPACE IN THE FUNCTION OF 4D NAVIGATION

Introduction methods of 4D navigation require an adjustment of the airspace infrastructure which needs to possess certain capabilities in terms of accuracy, integrity, availability, reliability and functionality needed for the intended flight operation. The adjustment of air space is expressed by an ICAO PBN concept (Performance Based Navigation - navigation flying abilities of the aircraft) which is described in detail in the Performance Based Navigation Manual which specifies requirements of the capability that a RNAV system (area navigation) should possess [10]. In this respect the PBN concept is an important change because it transfers from the navigation based on the specific navigation sensors to navigation based on the capabilities of the aircraft navigation equipment.

Functional requirements of the mentioned concept should be identified and described according to navigation specifications and defined as a particular navigation application together with the data on the navigation infrastructure. Using the PBN concept reduces the need to design routes and procedures in accordance with the appropriate navigation aids on the ground, enables better utilization of airspace (flexibility in the design of routes, reducing fuel consumption, and thus air pollution, noise) and simplifies the use of the RNAV systems [11].

Navigation specifications define in detail the performance that a navigation system should possess in terms of required accuracy, integrity, availability, reliability and functionality. The navigation specification can be a RNAV or a RNP. Basically they are both a RNAV concept, with the difference that the RNP specifications additionally require that the aircraft navigation system has a built-in alerting function and a monitoring function for defined performances. Applying these two system components as a part of the airspace concept to ATS routes and instrumental aviation procedures creates the third component of the PBN concept that represents the application of a PBN concept. The application of the navigation specification on a specific route, an incoming or outgoing segment, or the access procedure is called a navigation application. Navigation applications for an incoming route (STAR) developed as a draft of the procedure for RWY 05 Airport Zagreb – Pleso is shown in Figure 3.

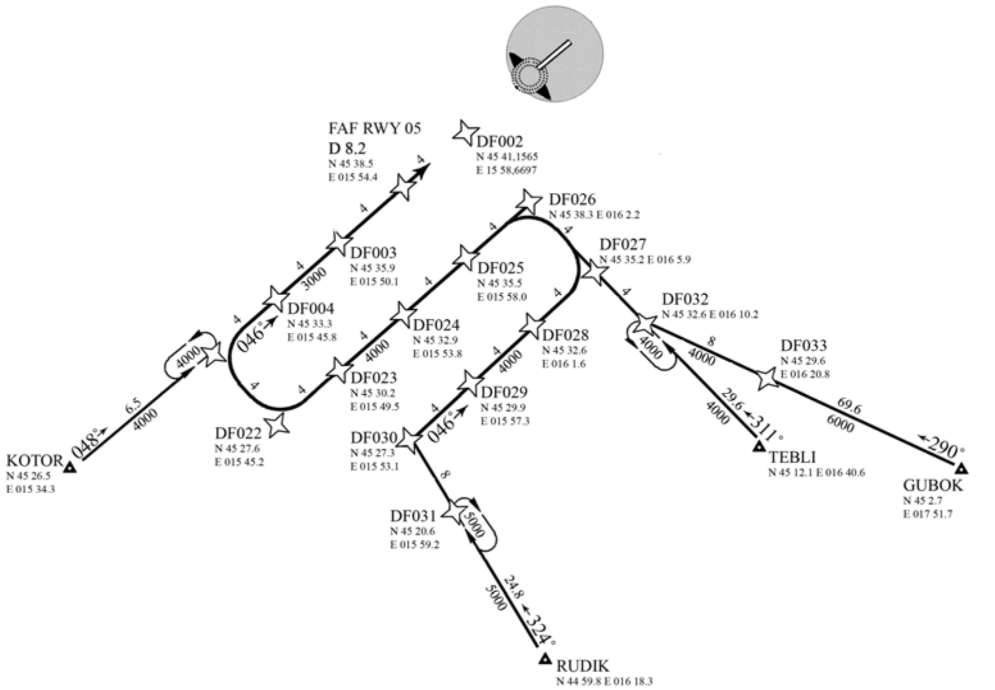

Figure 3 - Proposal incoming (STAR) procedures for RWY 05 airport Zagreb – Pleso

5. INFLUENCE OF 4D FLIGHT TRAJECTORIES ON AIR TRAFFIC MANAGEMENT

The novelty brought by 4D navigation includes the Free Flight Concept [12]. This concept implies that the airplanes that are equipped with RNAV equipment have the ability to plan route segments regardless of the existing network of air routes. This allows the operators of an aircraft the freedom to choose their own routes, altitude and flight speed in real time within the airspace where the aircraft is located. Simply put, the aircraft would be given a default entry and exit point for airspace with assigned coordinates and time that an aircraft must respect. Within that airspace the aircraft would be able to plan routes as they wish, respecting the default limits. In case of conflict situations with other aircraft, the pilots themselves would undertake the appropriate measures. This would also change the role of the air traffic controllers, but would not minimize their importance. The controller's primary task would be to intervene in case of violation of flight safety (safe separation), to prevent an unauthorized entrance of an aircraft in the airspace of special purposes and to respond in the event of overcrowding an airport or an integrated system in an airspace. Also, air traffic controllers will retain the primary role in the separation of aircraft during takeoff, approach to landing and landing. Because of the new and adjusted roles of the air traffic controllers, air traffic control system as we know it would become the system of air traffic management because air traffic controllers will become the managers of the airspace.

Systems of area navigation which use the concept of 4D provide precise guidance of the aircraft in accordance with pre-defined trajectory (Figure 4). This enhances the capacity of the airspace because the boundaries separating the horizontal and vertical plane are reduced.

The Reference Business Trajectory which uses ACARS (Aircraft Communications and Reporting System Addressing), CIES (Collaborative Information Exchange System) and FMS (Flight Management System) is another innovation which would be brought by the 4D navigation. The ACARS system is a digital transmission system for short, relatively simple messages between aircraft and ground stations via satellite. The protocol was designed by Arincom wanting to replace their VHF voice service from 1978 and start using new Telex-format [14]. SITA (Societe Internationale de Telecommunications Aéronautiques) has improved the communication network by establishing new radio stations for providing ACARS services. Studies of Eurocontrol predict that ACARS could completely replace today's means of communication within the airspace telecommunications network (ATN - Aeronautical Telecommunication Network) over the next ten years [15]. The CIES system (Collaborative Information Exchange System) is a system for detecting potential conflicts in the air. The modified FMS is an integrated electronic flight management system supported by a computer, which allows management of performances and resources of aircraft systems, navigation and automatic control of the aircraft and the display of status messages and warnings, including meteorological data.

Such routes are called business-travel routes because they include all the parameters that an airline company indirectly demands from air traffic control systems by using the aircraft which operates in an airspace for its own more efficient business transactions, that is to reduce costs in accordance with the cost index. At the request of the route, the controller checks whether there is an overlap in Required Time of Arrival – RTA and some other approved route in the initial approach fix – IAF or are there any other limitations. RTA is a key figure in planning routes and aircraft separations. In the event that there is no overlap or limitations, the required route is immediately approved. However, in the event that an overlap or limitations are shown, the air traffic controller with the help of CIES has the ability to adjust the scheduled time of arrival or audit the route. One hour before landing, the controller has six minute surveillance over the aircraft, which means that by giving instructions to speed up or slow down, he makes sure that the aircraft arrives to the IAF within the scheduled time of six minutes.

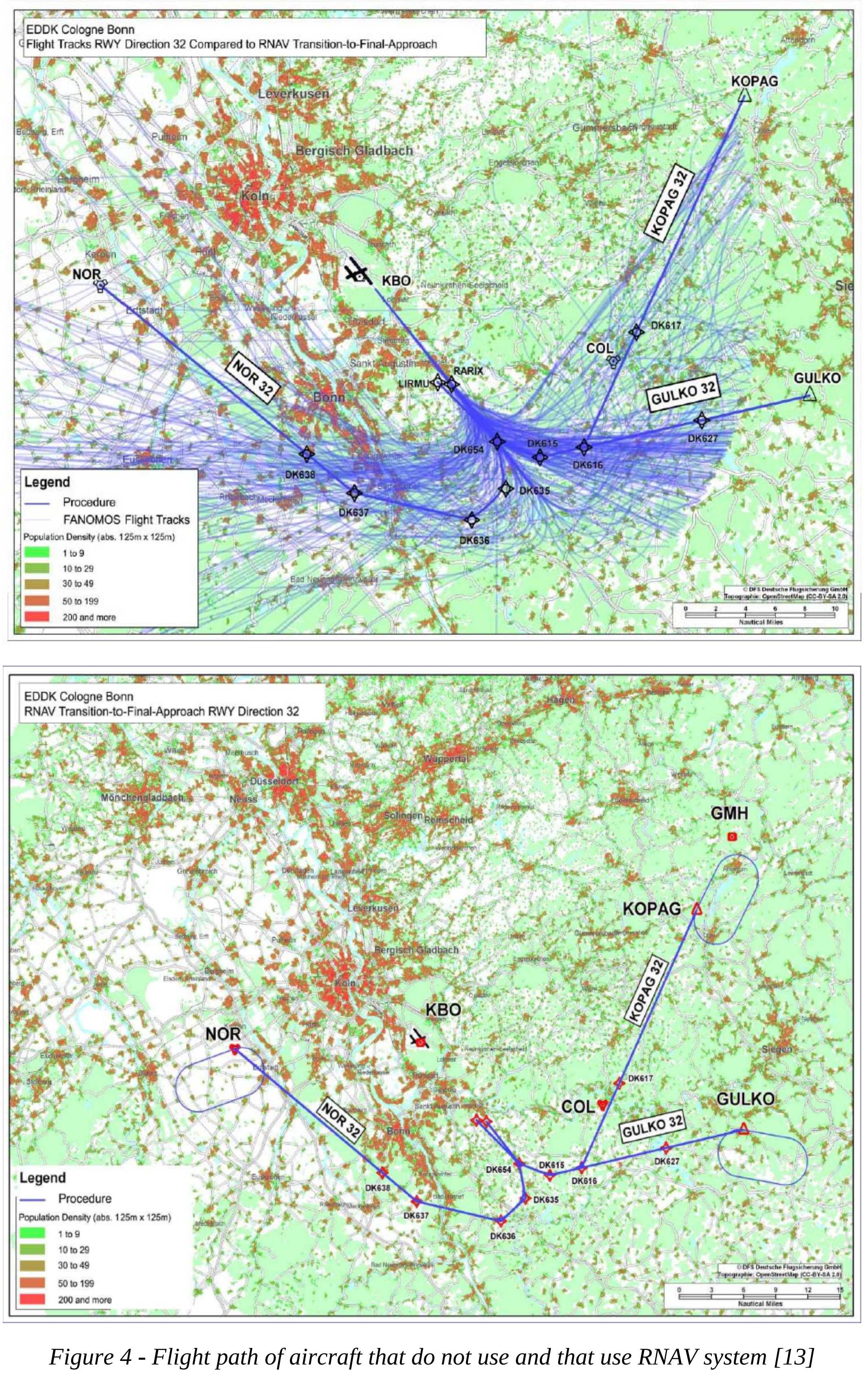

Figure 4 - Flight path of aircraft that do not use and that use RNAV system [13]

The process of sending the desired trajectory by the crew of an aircraft and conducting revisions by the controller is called the trajectory negotiation, because the crew is given the option not to accept the proposed revision or path arrival time, as well as the opportunity to propose another solution to avoid potential conflict situations. The negotiation process consists of several steps. The first step is to plan a route, which is done by the user preferred trajectory using FMS and which is sent to the air traffic control by ACARS. The second step includes checking the route and its revision, when necessary, by adding restrictions to address conflicts with other aircraft or the entrance in the airspace for special purposes and adding lags due to the separation of aircraft. Such a revised route is displayed to the crew of aircraft, which makes the third step. In the fourth step, the crew discusses the revised route and accepts or rejects it in line with the economy route, or in accordance with the business transactions of the airline. When an agreement is reached, the route is confirmed by the 4D Intent Accept function, which is sent to the air traffic control, stored in a database and simultaneously activated in the aircraft's FMS. After the agreement is reached, the route is called the agreed 4D tube or agreed 4D trajectory. The term “tube” is actually a visual concept of the flight path that can be imagined as a pipe in the sky in which the planes are passing through.

The wind can be the biggest problem in 4D navigation. With all the parameters which the crew must take into account (altitude, speed, time), the wind is an unpredictable variable parameter which the pilot must constantly take into account in real time and immediately make the correction of speed. The pilot must have accurate information about the wind at different heights up to 60 minutes before landing in order to effectively adjust the speed.

6. THE ADVANTAGES OF 4D NAVIGATION IN AIR TRAFFIC

The ultimate goal of the concept of 4D navigation is to know where in the area the aircraft will be located in the near future and at any time during the flight while respecting its flight performance and other factors, in order to increase the capacity of air space. The advantages of 4D navigation in combination with other advanced tools and concepts of ATM were noticed by the airlines and carriers, primarily because of the huge savings in time and fuel. In addition, the concept of 4D navigation should completely change the concept of ATFCM (Air Traffic Flow and Capacity Management), the role of air traffic controllers and pilots' responsibility.

Reasons for leaving a time space of six minutes at the point of initial approach are: variable wind at different altitudes, which can accelerate or decelerate the aircraft, a complicated system of planning routes, transferring large amounts of data and synchronization the time of arrival at the starting point of approach. But with advances in technology it is planned that the control time of arrival will be 30 seconds more or less than the required time.

7. CONCLUSION

In order to increase capacity, it is essential to improve the existing system of air traffic. Establishing a new generation of air traffic involves the introduction of 4D navigation, the introduction of functional airspace blocks and flexible use of air space. 4D is a navigation method which increases accuracy and allows better control of the aircraft, and for the new generation of navigation to be implemented, the adaptation of the airspace is needed. Characteristics of PBN navigation contribute to the increment of capacity, reduction in negative impacts on the environment (reduced fuel consumption due to shorter routes), saving time and generally improving the quality of air traffic.

The Eurocontrol project PHARE (Programme for Harmonised Air Traffic Management Services Research in Europe) which started in 1989 and ended ten years later cost 90 million Euros [16]. The investment paid off because the project has confirmed the effectiveness of 4D navigation, but only under the condition that all previously described elements of the system are present. The new navigation has been successfully tested in 2006 at Arlanda airport in Sweden and at Brisbane in Australia, where a total of 10 000 test flights were conducted consistent with all principles of 4D navigation methods. The theoretical and practical possibilities of the new concept of flying were then confirmed.

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APPLICATION OF QUEUEING THEORY FOR ORDER EXECUTION QUALITY ASSESSMENT IN SUPPLY CHAIN

ABSTRACT

A significant factor in increasing the competitiveness of major industrial enterprises within the supply chain is improvement of the customer service quality. The aim of this study is illustration of queuing theory methods use for estimation of the failure probability in fulfilling customer orders in the supply chain.The application of these methods and techniques will allow the integrated structures to assess the risks of failure to fulfill the order.

Key words: *queueing theory, supply chain, probability, risk management, queuing system, the channel applications*

1. INTRODUCTION

Last decade is seeing an active process of integration of enterprises into holding companies, integrated structure. This is due to development and increased competition in most markets, where individual enterprise is unable to compete and is forced to enter into a partnership through the formation of supply chains. The competition begins to take place between supply chains. Under such conditions, supply chains will inevitably have to look for methods to assess the effectiveness of their work. Theese include methods of probability theory, the theory of risk and queuing theory.

2. APPLICATION OF QUEUEING THEORY FOR ORDER EXECUTION QUALITY ASSESSMENT IN SUPPLY CHAIN

This article was prepared according to the Ministry of Education RF government order of 2012-2014, project "Organization and economic support for conservation of innovative enterprise management."

Queueing theory is a branch of mathematics that studies the systems designed to serve the mass flow of requests of a random nature. All enterprises, integrated structures including plant facilities, integrated with suppliers and customers function as queuing systems.

The application of queuing theory provides a tool for estimating the probability of risk of a rejection of order execution by industrial enterprise, integrated with suppliers and customers. Let’s adapt the terminology used in queuing theory to solve the problem within the concept of supply chain management. We assume queuing system as a industrial enterprise, integrated with suppliers and customers, which receives requests from end users.

The industrial enterprise, integrated with suppliers and customers has a range of service channels, in this case, the specific configurations of the supply chain. In the concept of supply chain management we should consider the simplest or the Poisson flow of requests from end users. This flow has the following features:

1) Stationarity - the probability of occurrence of a number of requests in the time interval depends only on the length of this interval and does not depend on where exactly is this part on the time axis;
2) Ordinariness - at any time only one request comes to the system;
3) The absence of aftereffects - all requests come into the system independently of each other.

The flow under consideration is called "Poisson", as the number of requests m, coinciding with the period of time t, distributed according to Poisson's law:

$$P_m(t) = \frac{(\lambda t)^m}{m!} e^{-\lambda t},$$

where λ – requests flux density, i.e number of requests per unit time.

At the entrance to the queuing system is calculated the input flow density (number of requests per unit time), at the output from this system the output flow density μ is calculated, which is the reciprocal of the average service time of a single request. The input flow density is constant. The internal state of the systems - is the probabilities that a particular configuration of the supply chain is unable to fulfill an order in a timely manner. The state of the industrial enterprise, integrated with suppliers and customers, of faults is described by Erlang formula:

$$P_k = \frac{\frac{1}{k!}\left(\frac{\lambda}{\mu}\right)^k}{1+\frac{\lambda}{\mu}+\frac{1}{2!}\left(\frac{\lambda}{\mu}\right)^2+\cdots+\frac{1}{n!}\left(\frac{\lambda}{\mu}\right)^n},$$

where P_k – probabilities of the system ($0 \le k \le n$), i.e.

P0 - the probability that all configurations of the supply chain are able to fulfill an order in a timely manner;

P1 - the probability that a single configuration of the supply chain is unable to fulfill an order in a timely manner;

Pn - the likelihood that all configurations of the supply chain are unable to fulfill an order in a timely manner, or the probability of failure in service.[3]

Let's consider the use of tools of queuing theory to solve the problem of estimating the probabilties of the risk order execution rejection by industrial enterprise, integrated with suppliers and customers ,case study. [1,2] There are three alternative configurations of the supply chain to fulfill the order. There are of 25 working days in the month. The system complex fulfills 50 orders a month, the average turnaround time is a day. We define the probability of the risk of failure to fulfill the order.

In this problem:

A queuing system is the industrial enterprise, integrated with suppliers and customers. Channel service is a specific configuration of the supply chain. The flow of request is the flow of orders from customers. Maintenance is order fulfillment by particular configuration of the supply chain.

The flow of requests is a simple (Poisson), then:

λ = 50/25 = 2 orders per day (the density of the input flow)

μ = 1/1 = 1 order per day (the density of the output flow).

A. Calculate the probability that during a day a system complex will receive 0, 1, 2, 3, etc. requests. The initial data: λ = 2, t = 1, m = 0,1,2,3,4 ...

The calculation results for the Poisson formula are presented in Table 1.

Table 1

Number of requests	0	1	2	3	4	5	6	7	8	9
Probabilities	0,137	0,274	0,274	0,183	0,091	0,037	0,012	0,003	0,001	0,0002

According to the table data getting of one or two applications within 1 day is the most likely, the probability of getting of 3 or 4 requestions is high, and the probability of getting of 5 or more requests is rather low.

B. According to the Elrang formula calculate the probability of the system state, i.e. industrial enterprise, integrated with suppliers and customers. The calculation results are presented in Table 2.

Table 2

Number of supply chain configurations	0	1	2	3
Probability of the state of the system complex	0,158	0,316	0,316	0,210

According to Table 2 the probability that all of the supply chain configurations can execute the order (ready for execution) is relatively low (15,8%), the probability of failure of the order execution by one configuration of the supply chain is higher (31,6%), the probability of failure to fulfill an order two supply chain configuration is 31.6%. The probability of rejection of order execution, i.e. situation of the inability of all configurations of the supply chain to execute the order is 21.0%. Thus, we conclude that the probability of the risk of order execution rejection by industrial enterprise, integrated with suppliers and customers is 21.0%.

3. CONCLUSION

The application of queuing theory allows integrated structures to assess the quality of fulfillment of customer orders in the supply chain and estimate the probability of system failure - the probability of failure of the customer order fulfillment. The above article illustrates an example of a procedure to evaluate this probability.

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ELEMENTS OF INCREASING EFFICIENCY AND ECOLOGICAL ASPECT OF RAILWAYS

ABSTRACT

Efficiency improvements and environmental protection are increasingly emphasized in all social activities. The traffic is particularly emphasized because of its large share of energy consumption and significant environmental damage. Although rail has significant advantages in efficiency and environmental pollution in relation to other forms of transportation, most railways are making great efforts to improve these aspects.

The paper deals with the elements of possible improvements in the railway system as a whole. Emphasis is given to the segments of the infrastructure, railroad cars and driving style. Possible technical solutions and improvements in theoretical terms as well as examples of concrete solutions to some of Europe's railways have been given in detail. Normally this is in the form of long-term projects which have already made significant results, some of which we are expecting a lot in the future.

Key words: *railway, increased efficiency, protection of environment*

1. INTRODUCTION

In the transport system, railway has significant advantages over other forms of transport such as road and air transport. Given the fact that in all aspects of economic activity managements are increasing energy and environmental performance, particularly there is the emphasis on traffic. In order to make railway still be in advantage over other modes of transportation it is necessary to undertake measures in order to enhance energy and environmental efficiency within itself. Possible measures to improve railway traffic are somewhat different for freight and passenger traffic.

The passenger traffic is additionally seeking for the attractiveness of potential travelers, which can be achieved by reduction in travel time, lower fares, increased frequency of train operations, good service and comfort for passengers and a high reliability and availability in all conditions of carriage.

If the carrying a large enough number of passengers at high frequency drive trains, it is essential that the lines are electrified due to the significant advantages of electric traction as compared to diesel. These advantages can be seen in the following: lower unit energy consumption (per transported passenger kilometer), lower noise, the possibility of moving the poor railways maintained, less air resistance and application of new solutions in operation.

The long distance passenger traffic is usually carried out over an hour and a half in a single run. Trips usually last a few days, and passengers carry more luggage, which requires adequate space for its accommodation. The high level of service includes transportation and dining car for an appropriate range of dishes and drinks.

The regional transport journeys are much shorter and usually take place in a single day in both directions. Therefore more space for luggage and a dining car are not necessary. Other elements of the service should be on the same level as in long distance traffic.

2. INFRASTRUCTURAL ELEMENTS

In the international rail traffic, it is necessary to respect the norms of the TSI (Technical Specifications for Interoperability) and EN (European Norm). They are often supplemented by specific requirements for each country and its railways, such as climate, terrain, available energy sources, the existing track and existing signaling-security devices.

Tracks of Croatian Railways are intended mixed passenger and freight traffic to the maximum permissible mass of 22 tons per axle. The tracks are in a very different terrain, from lowland with small gradients and large curves radii up mountain tracks with big gradients and small curves radii. Climatic conditions are changeable from winter conditions with snow and freezing temperatures to summer with very high temperatures. Added to this is often poor condition of the track with a very low speed limit driving. Depending on the track, the speed limit range from 40-160 km/h.

These infrastructure elements must be taken into account when considering options to improve rail transport, especially safe and comfortable transportation, and on some lines with increasing speed. To increase the driving speed it is necessary to have a better quality gauge. Here we think of the following:

- stricter limits permissible vertical deviation and minimum gauge
- track geometry modifications in relation to the permissible overshoot outer rails and the smallest radius of the track
- stabilization of the ground on insufficiently stable locations
- higher tension in catenary wires to reduce the vertical waves
- elimination of the crossing to roads at level
- installation of ERTMS (European Railway Train Management System)
- safety measures on platforms where the trains pass at high speeds
- introduction of passing tracks for frequent passage of trains to maximize the difference between driving speed passenger and freight trains on the lines of mixed traffic.

3. ELEMENTS OF RAILWAY VEHICLES

Each train operator seeks to reduce transport costs, and passenger transport means to reduce the cost of transport per passenger and kilometer, or the ticket price, while maintaining a high comfort and functionality. Thus, transport by rail will be more attractive for passengers and allow expansion of the market. Transportation costs can be reduced in several ways, such as:

- improving utilization of both the rolling stock and the train staff, so that vehicles and trains produce more kilometers per year

- increasing vehicle occupancy, and higher occupancy seats in passenger traffic. For example, increasing the occupancy from 50 to 60 % reduces the cost per passenger by 16 % [1]
- improve utilization of space, or increase the number of seats per meter of train. For example, increasing the utilization of space by 20 % reduces the overall cost by 10-20 % [1]
- reduce the purchase price of vehicles or trains.

For passenger transport, especially when it comes to higher-speed driving, motor trains are more suitable than conventional trains with locomotives. In their configuration, priority should be given to shorter trains with a minimum capacity of a given route. When it is necessary to have more capacity, which may change during the day, weekends, holidays or seasonal, it may be coupled two or more shorter trains into a single composition. In this way the capacity of trains adapts to the needs, as opposed to a fixed train length that can be at certain times with too high or too small capacity. This is not optimal from an economic point of view or from the standpoint of the needs of travelers.

The two coupled short trains also allow each of them to have a different destination. One of the common route drive coupled into a single composition, and at the separation station are decoupled each of them to their destinations. This increases the capacity of highly loaded tracks and allows passengers to have direct train to different destinations without the disadvantages of changing train.

The already mentioned increase in the number of seats per meter train is considerable scope to reduce prices or transportation costs. European high speed trains have average 2.2 to 2.6 seats per meter, while the Japan's Shinkansen trains have an average of 3.3 seats per meter. This is achieved by making no special restaurant cars, instead mobile catering with trolley bars is used, the seats are very rational arranged in rows like in an airplane, as well as the wider use of vehicles (about 3.4 m wide external) allowing one more seat abreast. Application of wider measures vehicles is limited clearance lines on which these trains should operate.

The most effective way of increasing the number of seats per meter is the use of wagons with two levels. However, for traction such trains are used locomotives and their efficiency is reduced.

Significant consumer of energy in passenger trains can be air-conditioning. Technical development and improvement of air conditioners can contribute to increasing its efficiency and reduce overall energy consumption. By analyzing the present situation shows that air conditioners are different possible optimization measures. The effect of individual measures to reduce annual energy consumption greatly depends on the climate zone in which trains operate, operate duration and degree of the environmental air intake.

Comparison of annual energy consumption for air-conditioning on a conventional passenger coaches and calculated expenditure of energy on the model of passenger cars with air-conditioning optimized in terms of conceived operation conditions can be estimated potential savings. Thus, for example, application of heat pumps and depending on the degree of bringing outside air, energy savings can be up to 50 % [2]. Given that the required technical improvements make additional costs, thereby minimizing the effect achieved savings in total annual costs. But it is still significant.

4. THE INFLUENCE OF DRIVING STYLE ON TRAVEL TIME AND COST

Time travel and transportation fees have a significant impact on the attractiveness of rail transport to potential travelers. They are interested in shorter journey time with the same or lower fare. Train operators are conflicting demands, because the shorter travel time at the same distance generally achieves higher speed driving. Increasing the speed increases power consumption requires better infrastructure and vehicles, which increases transportation costs and the ticket price. Compliance with such conflicting demands of a complex task and requires carriers to optimize all the parameters that have an impact on travel time and transportation costs.

Reducing costs with increased driving speed, and reducing journey time can be achieved by trains in the time margins driving more kilometers per year and achieving greater productivity.

Increasing the average speed can be achieved by increasing the maximum driving speed and increasing acceleration and deceleration. The maximum driving speed depends on both the infrastructure and on the train, while the acceleration and deceleration are dependent on the train or on the installed power and braking devices.

. Theoretically, one can determine the ideal, that is the shortest travel time by defining the velocity profile depending on the position on the track or time. For the realization of such driving style, maximum load of traction and brake assemblies are required, which is very demanding for the machinist. The exact timetable exercise require spare time, which would compensate for the extraordinary delay caused by such temporary speed limits, stopping at the signals, the subsequent departure from the station etc. The spare time depends on the quality of planning, infrastructure and reliability of trains and rolling accuracy and discipline of train crew and dispatchers.

If spare time is 5-10 %, in practice it means that this time is generally not used in full. Unused spare time, which generally ranges up to 3 %, can be used for economical driving. Recently, such a drive is called eco-driving. It reduces energy consumption and wear of brake components.

Eco-driving can be achieved in several ways, most notably:

–use of electric brake with energy recovery, that means return to the contact network

–use parts of driving without traction before braking

–from analyzing of traction characteristics it is necessary to determine the regimes that provide optimal efficiency.

Eco-driving can be achieved manually by engine driver experience, his skills and relevant education. Noticeably help computer-aided drive, or at least suggesting an optimal drive.

One example is a program for computer-aided drive train CATO (Computer Aided Train Operation) developed by the Swedish Transrail □□□. It consists of two modules, CATO-TRAIN and CATO-TCC (Traffic Control Centre), which can work separately or together. Designed to train operators and administrators of infrastructure, and is made in accordance with European EETROP (Energy Efficient Train Operation) interoperability standards.

CATO-TCC calculates an optimal real time schedule based on current train data and planned timetable. An individual schedule is then sent to each train via GSM-R radio. CATO-TRAIN calculates the optimal speed profile, and presents it to the driver for manual or autopilot operation (Figure 1 and 2) [3].

The experimental train rides to the application of this program have shown a reduction in energy consumption by 20-25 %, increasing capacity on the lines by 10 % and reducing brake maintenance costs by 30 %. Besides increasing the correctness and accuracy, reduced CO_2 emission on diesel trains, improved use of vehicles and crews, and achieved a better working environment. The program contributes to the accuracy and regularity of traffic, improving the use of vehicles and crew and working conditions.

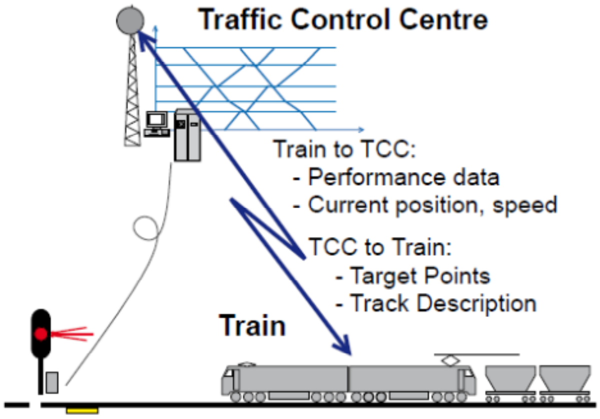

Figure 1 - Communication between the control center and train

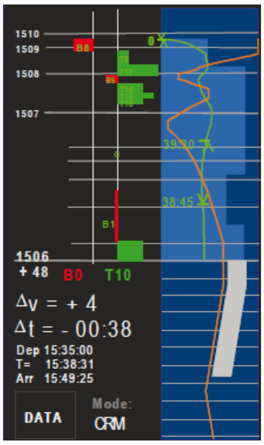

Figure 2 - Displaying the optimal speed profile

Most railways develop their programs with the same or similar goals; it is more economical and more environmentally favorable railway. For example, Deutsche Bahn (DB) has a program called DB Eco Program that has as main objective the protection of the environment [4]. Within this program there are specific projects such as finding opportunities to reduce CO_2 emission. The first task was in the period from 1990 to 2005 to reduce energy consumption and thus CO_2 emission from railway traffic by 25 %. Due to the large volume of rail traffic in Germany in this way each year reduces the discharge into the environment about 12 million tonnes of CO2. Given objective was achieved in 2002 and by the end of the planned period- CO2 emissions were reduced by 25%.

5. POSSIBILITIES OF NOISE REDUCING

When driving high speed trains, the noise is primarily caused by the increased flow velocity and air turbulence over sharp edges, protrusions and recesses and by rolling wheels on the rails due to irregularities on the mating surfaces.

The usual way to protect against such noise in residential areas is setting sound barriers. However, they are expensive and visually inappropriate for the environment. Better access to a noise reduction is at source, or on vehicles and tracks.

That means the train streamlined design of the train as a whole, especially the front part and the parts that change the transverse surface (protrusions and recesses), carefully shaping and protection of the pantograph assemblies located on the roof, proper maintenance of the rolling surface of wheels, and providing proper maintenance of the rolling surface of rails, placing absorbers in the track and setting a low sound barriers for noise-sensitive stocks.

In the freight traffic increased noise occurs during braking, as the majority of freight cars equipped with friction brakes elements of cast iron. The solution to this problem is achieved by replacing these friction elements to those of synthetic materials that significantly reduce noise. It is important that the coefficient of friction is similar in order to retain the existing structure of the braking mechanism.

6. CONCLUSION

Despite its advantages, the railway has to do and is making significant efforts to improve their operations and become more attractive for passengers and goods, and thereby make a significant contribution in reducing specific energy consumption and harmful emissions to the environment. Because of the complexity of the entire railway system, it can be said that the main areas of action to achieve these goals are: infrastructure, rail vehicles, driving and transportation organizations.

In the international rail traffic, it is necessary to respect the norms of the TSI (Technical Specifications for Interoperability) and EN (European Norm). They are often supplemented by specific requirements for each country and its railways, such as climate, terrain, available energy sources, the existing track and existing signaling-security devices.

Cost reduction can be achieved by better exploitation of the fleet, increasing the degree of availability of seats in a train, improve utilization of space in the vehicle, reducing the purchase price etc. Passenger trains should be configured as a smaller unit, and if necessary two or more such units can be connected in one unit.

Significant impact on energy consumption is driving style; so many railways are developing their own computer programs for cost-effective style of driving. They can help a machinist with manual control, or can be used for automatic train control.

To reduce noise it is important to take measures at the source of noise, or on vehicles and tracks. That means the train streamlined design of the train as a whole and proper maintenance of the rolling surface of wheels, as welol as the proper maintenance of railway rolling surface of the rails, placing absorbers in the track and setting a low sound barriers for noise-sensitive stocks. The freight train noise, when braking, may be reduced by replacing the brake blocks to those of synthetic material similar coefficient of friction.

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PRODUCTION PROCESS OPTIMIZATION BY MEANS OF WORKFLOWS REARRANGEMENT (BY THE EXAMPLE OF THE "C-AIRLAID" COMPANY)

ABSTRACT

The article introduces the mechanism helping to determine the best sequence of order production, due to which every product is processed at every stage of production in accordance with its place in a queue. The created model makes it possible to highlight bottlenecks at all production stages and assess them. Proceeding from the introduced algorithm and applying simulation modelling methods decision-maker regards such indices as the total time of order processing, the time of workshops standing idle, the time of particular parts of an order having been produced. This help to plan production process, inventory control thoroughly and define real terms of order production more accurately. The realization can be executed both in the existing ERP systems and as an individual software product.

Key words: *Manufacturing logistics, system analysis, simulation modelling, decision-support system (DSS)*

1. INTRODUCTION

Nowadays production processes require being constantly perfected to ensure success for a company and its sustainable development, due to which manufacturing logistics is being paid special attention to. For this reason, many modern companies use ERP systems. SAP, 1C: Manufacturing Enterprise Management and Galaktika are most popular ones in Russia. However, even the most well-organized modules of ERP systems do not always meet the real needs of users and are to be frequently adjusted. In addition to this, programmes' functionality does not support certain types of analytical reports making out.

The limitated functional capabilities of "1C: MEM" being used in the "C-Airlaid" company influence production process substantially, in accordance with which many alternatives of workflows arrangement are not being considered.

2. SUBJECT FIELD ANALYSIS AND PROBLEM STATEMENT

The "C-Airlaid" company produces and sells more than 1000 kinds of goods. Today "C-Airlaid" has a well-developed branch in Chelyabinsk which offers a whole range of products demanded by the medical science: disposable medical linen, disposable medical clothing and associated products. The main objective of the company is to provide enough products to the Russian market of non-woven materials, which were earlier available in our country only thanks to import from Europe [1].

Demand for this branch production is presented by discretely appearing orders which are characterized by strict contractually limited terms of execution. Each order consists of several kinds of goods.

The manufacturing process is organized in the following way. It includes three consecutive stages: cutting, sewing and packing. All the three workshops are located in one building. Figure 1 shows the aggregative representation of production business process created in compliance with IDEF0 standard.

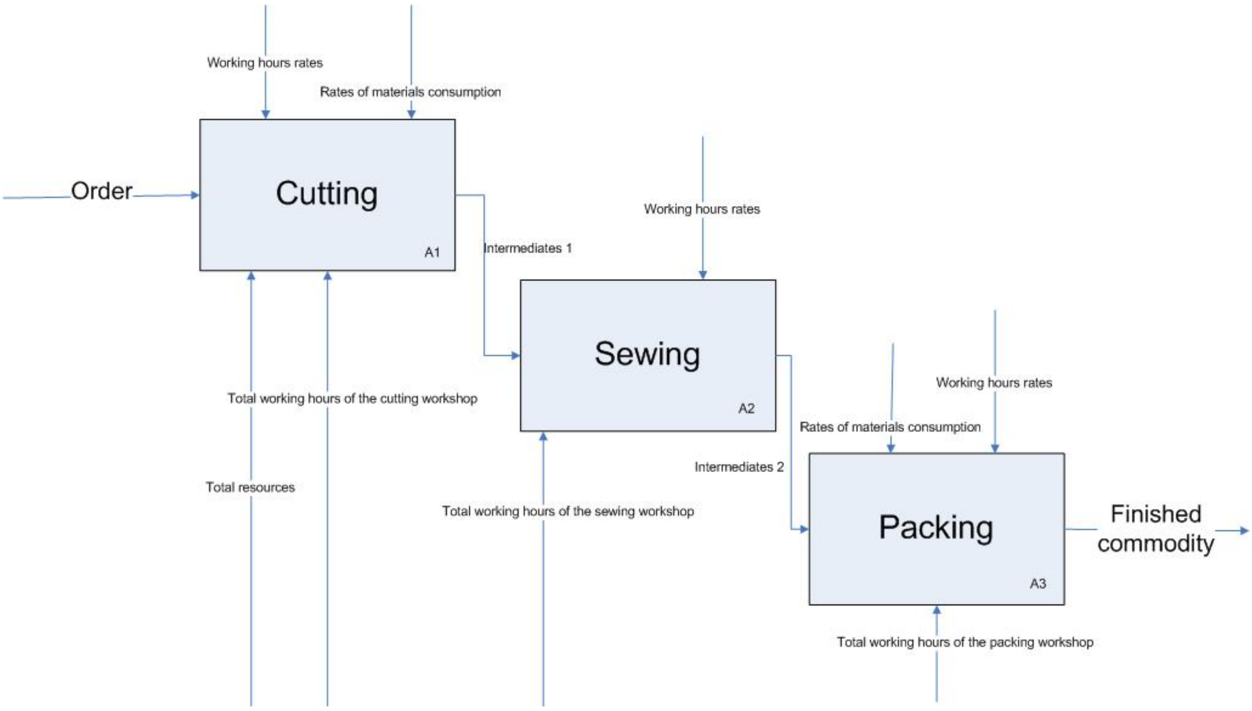

Figure 1 - The production business process

The company now uses a shift working schedule, and one shift duration is 11 hours. Table 1 shows the scheduled participation of workers in one shift of a definite workshop.

Table 1 - Number of workers in workshops

Workshop	**Number of workers in one shift**
Cutting	4
Sewing	24
Packing	7

The company's planning department is in charge of the sequence of processing, it can postpone some orders if finds it fit to do so. One part of planning work is done via ERP system "1C: Manifacturing Enterprise Management", the other requires an expert's participation, i.e. it is done manually.

However, despite this versatile approach to planning, this process is not flawless. Workshops stand idle from time to time during the manufacturing process. These idle periods can be divided into two types. The first one is idle time occuring between different orders being processed, and the second one is idle time during one order processing. The first type is quite complicated in examination and, thus, in planning, since orders appear irregularly (the main clients of the company are municipal hospitals; they organize tendering for purchases not regularly due to financing peculiarities). Hereinafter the second type of idle periods will be considered. It is assumed that their existence and time distribution influence the total time of an order processing (which is important for customers) and, consequently, the production capacity of the company (ability to process the greater number of orders).

Thereby, it is necessary to ascertain the way idle time influence the total time and create the system's model, which would make optimization of production and planning processes possible.

3. ANALYSIS OF PROCESSING SEQUENCE AND IDLE PERIOD CONCEPTS

To understand the way idle periods appear we need to analyze how the system processes orders.

An order entering the system can be characterized by inflow time, contractual term of processing, and its actual contents, i.e. by the given quantity of different kinds of goods to be produced. Consequently, we can present the order i in the following way: $x_i=(\tau_i^e;\tau_i;x_i^1,\dots,x_i^k)$, where τ_i^e is the inflow time of order i (the time when the processing starts), τ_i is the timing of order according to the contract, x_i^j is the quantity of product of j kind in order i (x_i^j >=0, j={1,…,k}). Time is to be calculated in minutes. Consider the following example. The order 1 is as follows: $\tau_1^e=0$, $\tau_1=39600$, $x_1^1=50$, $x_1^2=100$, $x_1^3=75$. Let the rates of goods processing in the workshops be specified via matrix notation (the records ratio 1:3:2 is not generated at random: it approximates the real manufacturing standards in the company):

$$\begin{pmatrix} 1 & 1 & 1 \\ 3 & 3 & 3 \\ 2 & 2 & 2 \end{pmatrix},$$

where t_i^j is processing time of j kind of product in γ workshop (j={1,…,k}; γ={1,2,3}). Then the order production can be presented on the time axis as shown in Figure 2.

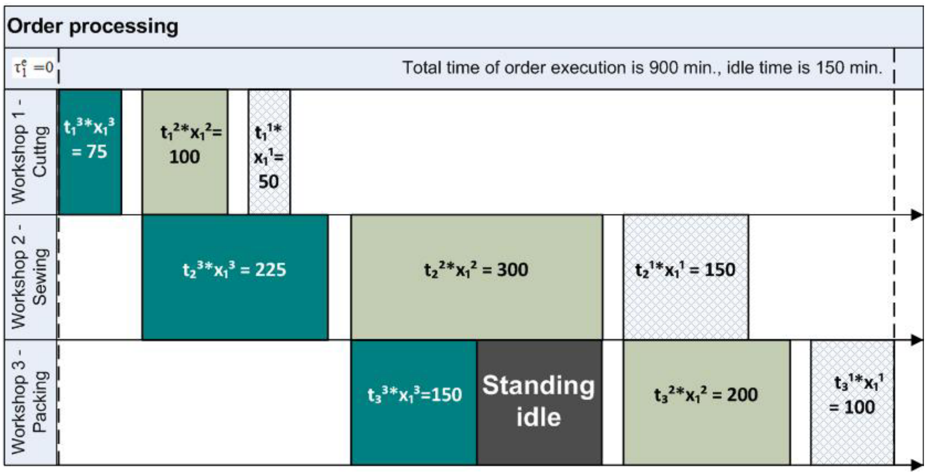

Figure 2 - Sequence version 1

The figure shows the 3-2-1 sequence of the order production; it means that the third product is cut first, then the second one and the third one; this sequence doesn't change during the whole process of manufacturing . So, the total time of production being t_1=900 and the idle time being Δ_1=150 correspond to this sequence. Consequently, the idle time is the time

when a workshop is not in operation due to the next product in the sequence being processed at the previous stage. According to this definition of the idle time (the idle period of the second type), it can appear at the second and the third stages of production process, i.e. in sewing and packing workshops.
Figure 3 shows another sequence: 2-1-3, in which the total time of production is t_1=925 and the idle time is Δ_1=75.

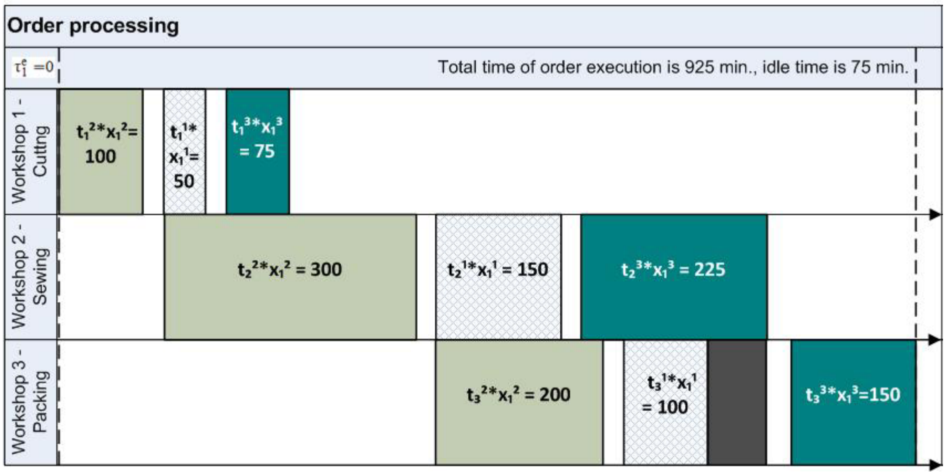

Figure 3 - Sequence version 2

One more sequence example is shown in Figure 4: 1-2-3. The total time of production here is t_1=875 and the idle time is Δ_1=225.

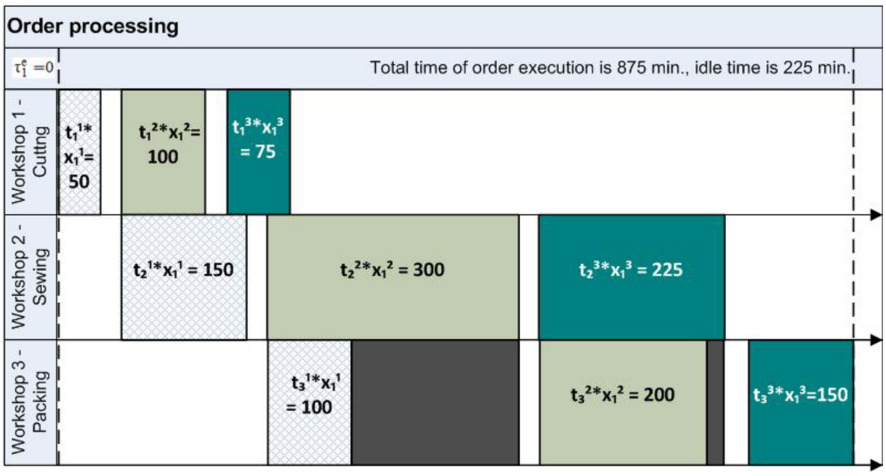

Figure 4 - The sequence version 3

Considering all the sequences of production mentioned above the order will be executed within the time limit ($\tau_1 = 39600$ minutes). However, the figures perfectly show that, first of all, the chosen sequence considerably influences the total time of order implementation and, secondly, the lesser total time does not always correspond to the lesser idle time (the given example leads to even an opposite conclusion).

Thereby, it is not the idle time minimization that is to be the main criterion in the model, as the total time or the urgent production of particular products remain first-priority.

As an experiment, many orders were generated and based on the real data of the company and studied with the help of the scheme described above. The testing was carried out in MS Excel, in accordance with which, the following conclusions can be drawn:
1) the equal total time does not guarantee the equal idle time;
2) the two types of idle periods does not correlate;
3) the lesser total time does not always correspond to the lesser idle time.

The lack of the evident optimization criterion requires designing of an algorithm that will make it possible to define all possible (or the best even) alternatives of order processing sequence and choose the optimal one in compliance with criteria currently important for a company.

4. METHODOLOGY CHOOSING AND MODELLING

As it was said above, the number and size of orders depend on the company's success in tendering. As Poisson's law does not hold for orders entering the system, the standard methods of queueing systems theory and methodology cannot be applied [2].

The lack of optimization criterion and the existence of the only restriction make it unreasonable to consider an optimization problem, which would not let a user regard various strategies.

Simulation modelling is a process of a real system model building with a set of further experiments on it aiming either to understand its behaviour or to estimate different strategies in within boundary conditions, enabling this system to function ([3]). As compared with the other methods, simulation modelling makes it possible to consider a vast number of alternatives, also to improve the quality of managerial decisions and forecast their consequences more accurately ([4]).

It is simulation modelling that decision-support systems (DSS) building is based on. DSS – is the unity of software tools, simulation, statistical and analytical models of processes for decision preparation ([3]). Within the framework of the task under examination DSS would let a decision maker compare different options of order processing sequences and work out production planning, proceeding from both his or her empirical knowledge and the values of the impartial criteria.

Since the system's components were defined above, we can consider the magnitudes influencing the process and characterize them. The classification of the system's variables is shown in Table 2.

Table 2 - Variables description

Variable	Designation	Description
Quantity of good j in order i	x_i^j	Exogenous stochastic variable
Order i inflow point (in time)	τ_i^e	Exogenous stochastic variable
Contractual (scheduled) term of order I processing	τ_i	Exogenous stochastic variable
Processing time of good j in workshop γ	t_γ^j	Exogenous determinate variable (short-term constant)
Natural delay between two consecutive goods processing	p	Exogenous determinate variable (controlled)
Order i processing time (total)	t_i	Endogenous variable
Total idle time during order i processing	Δ_i	Endogenous variable

In order to create a model of the system additional computed variables B_γ^j (initial time of product j processing in workshop γ) and E_γ^j (time when good j leaves workshop γ) are to be introduced. Their calculation is implemented recurrently, the example for 3 goods is shown in Table 3.

Table 3 - B_γ^j and E_γ^j calculation example

Variable	Calculation	Cumulative processing time	Cumulative idle time
B_1^1	$B_1^1=\tau_i^e$	$t_i=\tau_i^e$	$\Delta_i=0$
E_1^1	$E_1^1=B_1^1+t_1^1\cdot x_i^1$	$t_i=\tau_i^e+t_1^1\cdot x_i^1$	$\Delta_i=0$
B_2^1	$B_2^1=E_1^1+p$	$t_i=\tau_i^e+t_1^1\cdot x_i^1+p$	$\Delta_i=0$
E_2^1	$E_2^1=B_2^1+t_2^1\cdot x_i^1$	$t_i=\tau_i^e+t_1^1\cdot x_i^1+t_2^1\cdot x_i^1+p$	$\Delta_i=0$
B_3^1	$B_3^1=E_2^1+p$	$t_i=\tau_i^e+t_1^1\cdot x_i^1+t_2^1\cdot x_i^1+2p$	$\Delta_i=0$
E_3^1	$E_3^1=B_3^1+t_3^1\cdot x_i^1$	$t_i=\tau_i^e+t_1^1\cdot x_i^1+t_2^1\cdot x_i^1+t_3^1\cdot x_i^1+2p$	$\Delta_i=0$
B_1^2	$B_1^2=E_1^1+p$	$t_i=\tau_i^e+t_1^1\cdot x_i^1+p$	$\Delta_i=0$
E_1^2	$E_1^2=B_1^2+t_1^2\cdot x_i^2$	$t_i=\tau_i^e+t_1^1\cdot x_i^1+t_1^2\cdot x_i^2+p$	$\Delta_i=0$
B_2^2	$B_2^2=\max\{E_2^1;E_1^2\}+p$	$t_i=\tau_i^e+t_1^1\cdot x_i^1+\max\{t_1^2\cdot x_i^2; t_2^1\cdot x_i^1\}+2p$	$\Delta_i=\max\{E_2^1;E_1^2\}-E_2^1$
E_2^2	$E_2^2=B_2^2+t_2^2\cdot x_i^2$	$t_i=\tau_i^e+t_1^1\cdot x_i^1+\max\{t_1^2\cdot x_i^2; t_2^1\cdot x_i^1\}+t_2^2\cdot x_i^2+2p$	$\Delta_i=\max\{E_2^1;E_1^2\}-E_2^1$
B_3^2	$B_3^2=\max\{E_3^1;E_2^2\}+p$	$t_i=\tau_i^e+t_1^1\cdot x_i^1+\max\{\max\{t_1^2\cdot x_i^2; t_2^1\cdot x_i^1\}+t_2^2\cdot x_i^2; t_2^1\cdot x_i^1+t_3^1\cdot x_i^1\}+3p$	$\Delta_i=\max\{E_2^1;E_1^2\}-E_2^1+\max\{E_3^1;E_2^2\}-E_3^1$
E_3^2	$E_3^2=B_3^2+t_3^2\cdot x_i^2$	$t_i=\tau_i^e+t_1^1\cdot x_i^1+\max\{\max\{t_1^2\cdot x_i^2; t_2^1\cdot x_i^1\}+t_2^2\cdot x_i^2; t_2^1\cdot x_i^1+t_3^1\cdot x_i^1\}+t_3^2\cdot x_i^2+3p$	$\Delta_i=\max\{E_2^1;E_1^2\}-E_2^1+\max\{E_3^1;E_2^2\}-E_3^1$
B_1^3	$B_1^3=E_1^2+p$	$t_i=\tau_i^e+t_1^1\cdot x_i^1+t_1^2\cdot x_i^2+2p$	$\Delta_i=\max\{E_2^1;E_1^2\}-E_2^1+\max\{E_3^1;E_2^2\}-E_3^1$
E_1^3	$E_1^3=B_1^3+t_1^3\cdot x_i^3$	$t_i=\tau_i^e+t_1^1\cdot x_i^1+t_1^2\cdot x_i^2+t_1^3\cdot x_i^3+2p$	$\Delta_i=\max\{E_2^1;E_1^2\}-E_2^1+\max\{E_3^1;E_2^2\}-E_3^1$
B_2^3	$B_2^3=\max\{E_2^2;E_1^3\}+p$	$t_i=\tau_i^e+t_1^1\cdot x_i^1+\max\{t_1^2\cdot x_i^2+t_1^3\cdot x_i^3; \max\{t_1^2\cdot x_i^2; t_2^1\cdot x_i^1\}+t_2^2\cdot x_i^2\}+3p$	$\Delta_i=\max\{E_2^1;E_1^2\}-E_2^1+\max\{E_3^1;E_2^2\}-E_3^1+\max\{E_2^2;E_1^3\}-E_2^2$
E_2^3	$E_2^3=B_2^3+t_2^3\cdot x_i^3$	$t_i=\tau_i^e+t_1^1\cdot x_i^1+\max\{t_1^2\cdot x_i^2+t_1^3\cdot x_i^3; \max\{t_1^2\cdot x_i^2; t_2^1\cdot x_i^1\}+t_2^2\cdot x_i^2\}+t_2^3\cdot x_i^3+3p$	$\Delta_i=\max\{E_2^1;E_1^2\}-E_2^1+\max\{E_3^1;E_2^2\}-E_3^1+\max\{E_2^2;E_1^3\}-E_2^2$
B_3^3	$B_3^3=\max\{E_3^2;E_2^3\}+p$	$t_i=\tau_i^e+t_1^1\cdot x_i^1+\max\{\max\{t_1^2\cdot x_i^2+t_1^3\cdot x_i^3; \max\{t_1^2\cdot x_i^2; t_2^1\cdot x_i^1\}+t_2^2\cdot x_i^2\}+t_2^3\cdot x_i^3; \max\{\max\{t_1^2\cdot x_i^2; t_2^1\cdot x_i^1\}+t_2^2\cdot x_i^2; t_2^1\cdot x_i^1+t_3^1\cdot x_i^1\}+t_3^2\cdot x_i^2\}+4p$	$\Delta_i=\max\{E_2^1;E_1^2\}-E_2^1+\max\{E_3^1;E_2^2\}-E_3^1+\max\{E_2^2;E_1^3\}-E_2^2+\max\{E_3^2;E_2^3\}-E_3^2$
E_3^3	$E_3^3=B_3^3+t_3^3\cdot x_i^3$	$t_i=\tau_i^e+t_1^1\cdot x_i^1+\max\{\max\{t_1^2\cdot x_i^2+t_1^3\cdot x_i^3; \max\{t_1^2\cdot x_i^2; t_2^1\cdot x_i^1\}+t_2^2\cdot x_i^2\}+t_2^3\cdot x_i^3; \max\{\max\{t_1^2\cdot x_i^2; t_2^1\cdot x_i^1\}+t_2^2\cdot x_i^2; t_2^1\cdot x_i^1+t_3^1\cdot x_i^1\}+t_3^2\cdot x_i^2\}+t_3^3\cdot x_i^3+4p$	$\Delta_i=\max\{E_2^1;E_1^2\}-E_2^1+\max\{E_3^1;E_2^2\}-E_3^1+\max\{E_2^2;E_1^3\}-E_2^2+\max\{E_3^2;E_2^3\}-E_3^2$

Cumulative processing time and cumulative idle time for E_3^3 in Table 3 show, correspondently, order i processing time (if it is done for three goods only) and total idle time in compliance with the sequence 1-2-3. Calculations made in Table 3 enable us to deduce the formula for total idle time (for the predetermined sequence):

$$\Delta = \sum_{\gamma=2}^{3} \sum_{i=2}^{k} (\max\{E_{\gamma-1}^{i}; E_{\gamma}^{i-1}\} - E_{\gamma}^{i-1}$$

where γ is the workshop number and k is the number of goods in the order.

All calculations connected with a certain order consisting of k number of goods can be presented in the way Table 4 shows.

Table 4 - Matrix form of calculation

Exogenous variables				Endogenous					
x_i^1	t_1^1	t_2^1	t_3^1	B_1^1	E_1^1	B_2^1	E_2^1	B_3^1	E_3^1
x_i^2	t_1^2	t_2^2	t_3^2	B_1^2	E_1^2	B_2^2	E_2^2	B_3^2	E_3^2
x_i^3	t_1^3	t_2^3	t_3^3	B_1^3	E_1^3	B_2^3	E_2^3	B_3^3	E_3^3
…	…	…	…	…	…	…	…	…	…
x_i^k	t_1^k	t_2^k	t_3^k	B_1^k	E_1^k	B_2^k	E_2^k	B_3^k	E_3^k

In Table 4 E_3^k value corresponds to total processing time, the order of records in the matrix shows the chosen sequence.

Method of total and idle time calculation via the table was applied to many sets of real data in MS Excel and perfectly suits examination of orders which include goods being processed at all the production stages.

5. THE MODEL'S IMPLEMENTATION AND DEVELOPMENT

The main purpose of the model is the calculation of total time of an order processing and idle time for different sequences of goods of one order production. The number of alternatives is quite large, as to estimate all possible strategies of order processing including 10 goods the system will have to build 10! (the number of permutations) tables measuring 10*10.

Proceeding from the results a user will be able to estimate the total and the idle time for an order, which will help choose the most fitting processing sequence, or reject order executing due to the lack of time or capacity.

With the help of this a planning department worker in "C-Airlaid" company will be able to assess the resources of the company unequivocally, that will let the company reject participating in tendering providing orders impracticable fo her.

In addition to this, the introduced model will help highlight workshops functioning poorly in the chosen sequence or accurately define periods of workshops standing idle.

MS Excel realization is possible as applied to relatively small number of goods in one order but becomes unwise in the different cases. An individual software application for ERP system could be designed on the basis of the introduced model and would increase data processing speed helping to individualize functionality concerning analytical reports making.

Thereby, the introduced model can be realized in compliance with many companies' needs making it possible for planning and production departments to get multicriterion analysis of company's strategies.

6. CONCLUSION

"C-Airlaid" company's production business process and a new order inflow process are studied in the paper. The research revealed that the correlation between the total time of order processing and the idle time of workshops cannot be definitely described, and consequently the task cannot be considered as an optimization problem. Simulation modelling methods use makes it possible to design a decision-support system. A DSS would prepare all necessary information on total and idle time of different processing alternatives for final decision maker. Realization of the introduced model (the peculiarities of every specific company being considered) as an individual software application for ERP system, used in the company, will let users to get analytical reports on multicriterion assessment of different processing sequences for further planning decisions.

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THE FLOWS OF OIL IN FUNCTION OF SUPPLY AND DEMAND CHAIN OPTIMISATION

ABSTRACT

Over the last forty years, one of the most difficult transportation policy questions has been the issue of the price of oil and its associated impact on transportation systems. Oil drives a large part of the costs of the production of agricultural, manufacturing, and service industries. Furthermore, as industries have globalized over the last thirty years the low price of oil has been critical in allowing logistics chains to become more and more elongated. The main characteristic of world oil flow lies down in a fact that the line directions for these types of flows are conditioned by formation of oil sources in the world, with reference to the largest producers, exporters and importers of oil. In other words, the most important flows of oil are formed on a direction from a large producer or exporter states, to the major consumer countries. In geographical analysis of world oil flows, data on the largest exporters and importers countries of oil are representing the important indicators of the intensity and the main directions of these types of flows.

***Key words**: oil prices, demand for oil, maritime flows of oil*

1. INTRODUCTION

Transportation and maritime affairs are important economic sectors, perhaps most important in today's economic and social development of the world. The sea has always been a source of prosperity of maritime nations, and the basis of development and international reputation of the maritime-oriented countries. It is a transport media that is not necessary to build or maintain. The construction and equipment of ports, as a hubs of land and maritime transport, is only required.

Since the largest share belongs to maritime transport, the role of ports comes to expression in international trade. About three-quarters of international commodity exchange is carried out by sea because it is often the most convenient, but the only possible transport way. Sea ports provide easy access to the world market, favoring the development of trade with many countries, which certainly indicates their important role in the economic development of maritime countries and provides a predisposition for faster integration into the world's logistics and transportation system.

A primary factor in the projected increase of energy demand for transportation is steadily rising demand for personal travel in both the developing and mature economies. In the developing economies, with gains in urbanization and personal incomes, demand for air travel and motorized personal vehicles increases. In addition, strong GDP growth in the non-OECD economies leads to modal shifts in the transport of goods, and freight transportation by trucks leads the growth in non-OECD demand for transportation fuels. In addition, as the volume of international trade grows, fuel use for freight transportation by air and marine vessels also increases in the projection.

2. AN IMPACT OF THE OIL PRICES ON TRANSPORTATION

Energy use in the transportation sector includes energy consumed in moving people and goods by road, rail, air, water, and pipeline. Over the next 25 years, demand for liquid fuels will increase more rapidly in the transportation sector than in any other end-use sector, with most of the growth projected among the developing non-OECD nations and consumption among the developed OECD nations remaining relatively flat or declining. In 2008, non-OECD countries as a group consumed 34% less energy for transportation than OECD countries. In projection for 2035, non-OECD energy use for transportation exceeds that in the OECD countries by 19%.

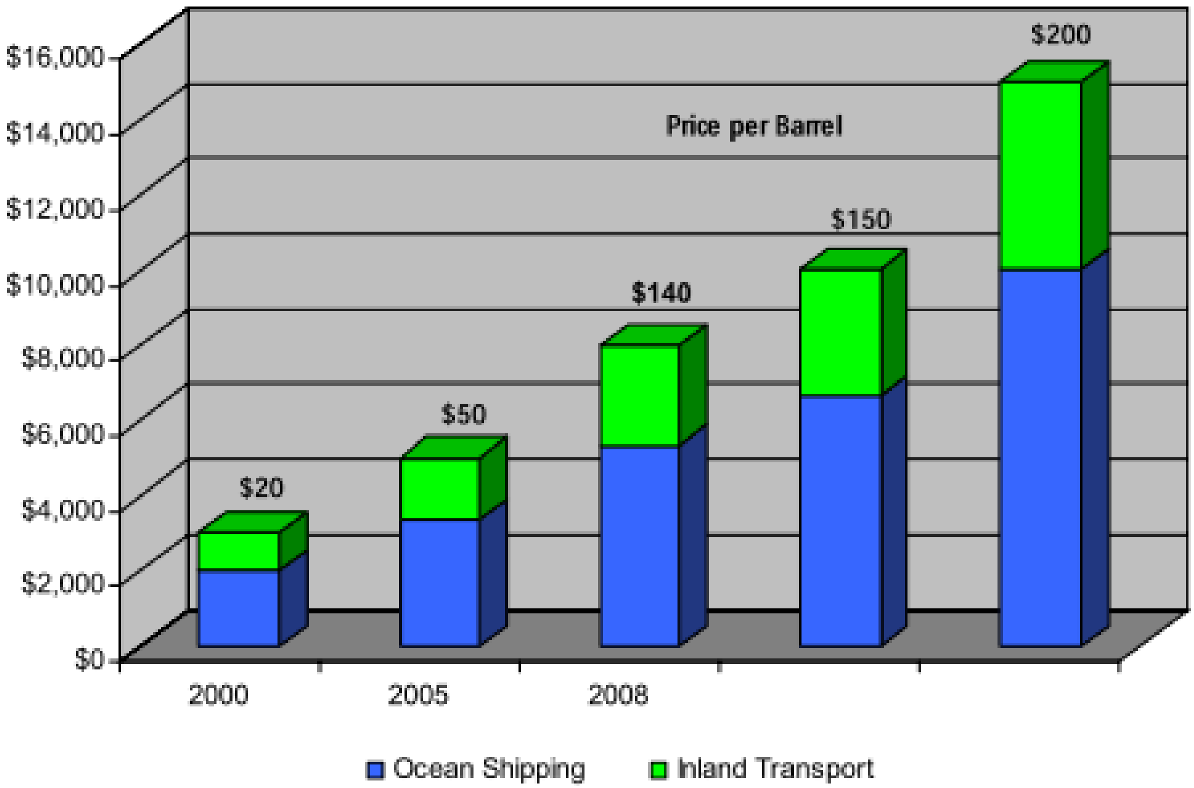
Since the first commercial exploitation in Pennsylvania in 1859 the importance of oil was increased significantly in the global economy. In 1920, worldwide 95 million tons of oil has been produced. This number has reached 500 million tons to 1950, one billion tons in 1960, the average annual production was around 3 billion tones in 1990 and 4 billion tons in 2008. Oil production is constantly increasing in the second half of the 20th century with the goal to meet growing demand. In 2008 on average, 82 million barrels were produced each day and the average consumption of oil per day in 2008 amounted to 83.7 million barrels, compared with 31.2 million barrels in 1965. Such strong growth is based largely on the availability of oil resources and “low” price. [5]

In the short run, higher oil prices will undoubtedly have an impact on the rate of growth of the global economy, as oil has such a significant role as a factor of production in agriculture, basic raw materials, manufactured products, and service industries. For agriculture, oil impacts as much as 20-50% of total costs, for raw material industries 20-30%, for manufacturing industries 10-20%, and for service industries 5-10 %. However, while increased oil prices will slow the growth, and in the short term may limit or cut production, there are in many cases a wide range of substitutes for oil that could replace oil in given time. For example, in the generation of power, the electricity supply can within the short or medium term switch from oil to natural gas, coal, nuclear, solar, and even wind alternatives.

Overall, the worldwide expanding demand for oil is likely to be a consistently upward pressure on oil prices, and result in oil prices stabilizing at far higher levels than were experienced in the 1990’s or before 2005.

In the last ten years the transport industry has experienced a five to eight fold increase in the price of fuel for marine and inland shipping (i.e., as a result of a price increase in crude oil from \$20 to \$140 per barrel). In the year 2000 fuel represented only 20% of transport operating costs, recently at \$140 per barrel it represents over 50%, and were the oil price to rise to \$200 a barrel, it would be over 70% of operating cost. Transport prices have risen by nearly 100% between 2002 and 2008, and could increase by almost another 300% if oil prices increase to \$200 per barrel. A one-dollar rise in world oil prices leads to a 1% rise in trade transport costs. In terms of the marine and inland transport movement of a 40-foot container from Shanghai to Columbus, Ohio (*Graph 1*), the total transport cost was \$3,000 when oil prices were \$20 per barrel in the year 2000. Today at \$140 per barrel, the cost is \$8,000, and should oil prices rise to \$200 per barrel transport cost would rise to \$15,000 per FEU. [4]

Graph 1 - Cost of transporting a container (FEU) from Shanghai to Columbus, Ohio at different oil prices (in $)



Source: Impact of high oil prices on freight transportation: modal shift potential in five corridors, Technical report, Transportation economics & management systems, Inc. October 2008

The prices of food, consumer goods (e.g., electronics, furniture, and clothes), and capital goods items like cars and houses are all likely to suffer from continuing oil price shocks. It is estimated that the realignment of prices will result in a significant setback in the growth of the world economy and both suppliers and consumers will face a change in "equilibrium" of the economy, with suppliers having to increase prices to pay for the increased production and transport costs, and consumers having to reduce demand as prices rise. A good example of the impact of increased oil prices on transportation is shown by the change in the supply and demand conditions for steel production. Chinese exports of steel to the U.S. are now falling on a year over year basis by more than 20%, while U.S. steel output is rising by 10% a year. While production costs in China and the U.S. are very similar at $600 per ton of rolled steel (due to exchange rate changes), the extra shipping cost faced by Chinese steel of $100 per ton is making it uncompetitive in U.S. markets.

The new equilibrium will result in a short to medium term change in the market. In effect, the elongated supply chain from China has been neutralized by higher oil prices. As the market had become reflective of transport conditions 10 to 20 years earlier in terms of volumes transported and supplied to the market, the result should be a short-term shakeout among producers, and a more competitive market as demand falls. Lower cost producers will gain market share at the expense of high cost producers. All producers will look for cheaper ways to supply the market, and consumers will look for competitively priced goods. Clearly pressure will be on the transport supply industry to find more cost-effective alternatives.

In the marine transport system, the higher costs of oil and its market impacts will put tremendous pressure on carriers to become more and more competitive, and to seek both operating savings and "economies of scale" to offset higher fuel prices. For example, in terms of operating savings, it is estimated that over the last 15 years the increase in speed of the world fleet from 20 to 29 knots has doubled fuel consumption per unit of freight. As such, it is not surprising that the increased cost of oil is now slowing the fleet.

In terms of "economies of scale" this would suggest an even more intense drive to larger ships as a mechanism to offset higher oil prices per unit of freight. As a result, there may well be a new round of tanker, bulk, and container ship development as carriers seek to be more and more competitive. Equally, given the higher costs of the inland distribution system, shippers may well seek to maximize marine movements and minimize inland distribution costs.

Inland distribution costs are much higher per ton, TEU, etc., than maritime costs. As a result, higher oil prices could:

- increase the maritime trip length, which favors Atlantic and Gulf ports instead of West Coast ports for Asian traffic,
- shift traffic from truck to rail and water for inland distribution.

In terms of inland distribution, the increase in oil prices has significantly impacted the relative advantage of the lower cost modes rail and water. The truck industry has been badly damaged, and in particular, many small owner-operators have been forced out of the market by increased oil prices.

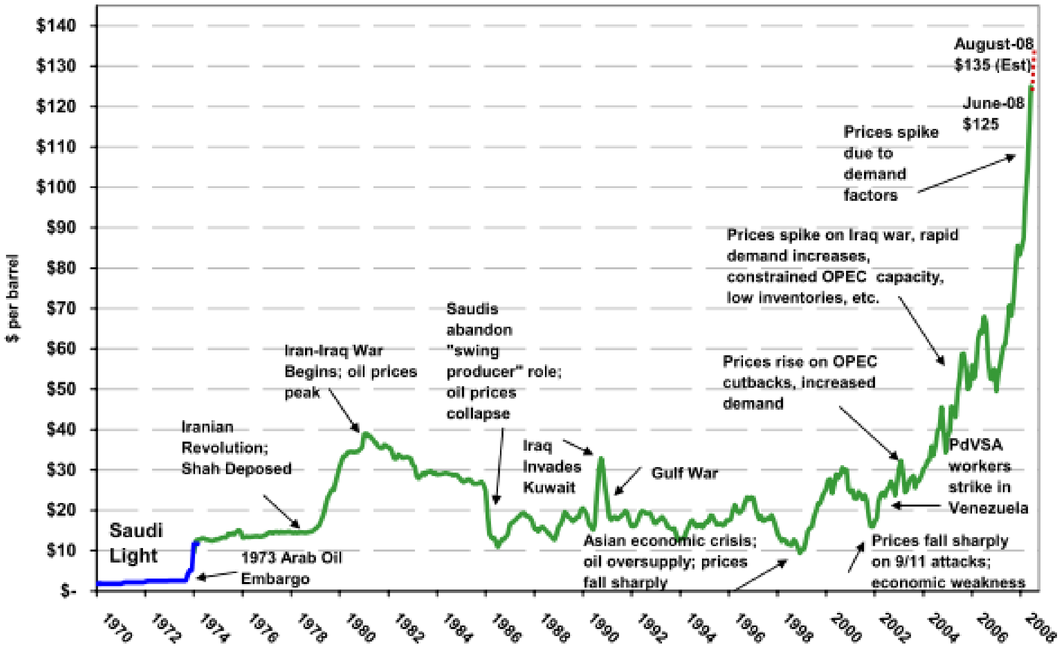
The history of oil prices. Since 1970 and prior to 2004 the world has suffered a number of oil price shocks largely due to the actions of OPEC, and Middle East wars (*Graph 2*). However, the recent oil crisis has resulted in the nominal price of oil far exceeding any previous crisis at $140 per barrel. In nominal terms, the refiner acquisition cost of oil (which is typically 95% of domestic market price) did not exceed $40 per barrel, prior to 2006 and major price spikes were largely due to Middle East wars, such as the Arab oil embargo (1973), Iran/Iraq War (1982), and Arabian Gulf War (1992). That situation changed after the year 2000 when non-supply issues like the growth in world oil demand (2003 to 2007) began to impact oil prices. From a low of $10 per barrel in 1999, oil prices rose quickly in nominal terms to nearly $70 per barrel in 2006 and to $140 per barrel in 2008.

Even in real terms oil prices (adjusted for inflation) remained within historic norms up to 2006, when the oil price per barrel was at $70. The price was lower than that in the 1982 Iran/Iraq war when the oil price peak at over $90 per barrel in 2006 dollars. However, after 2006 it is clear that there is a major change in the market with the average 2008 price rising dramatically to $125 in 2006 dollars, and peaking at over $140 per barrel in 2008 dollars.

According to the International Energy Agency (IEA) [5], the recent rise in oil prices reflects the impact of global demand factors. For the first time world demand is considered to have become a significant influence on oil prices and heralded new oil price equilibrium.

In 2010, world oil prices responded primarily to expectations about demand, with producers, consumers, and traders looking for some indication as to when the world's economy would recover, what shape the recovery would take, and how strong the corresponding increase in oil demand would be. While stronger than expected regional growth led many market players to expect a buoyant return of global liquids demand and an increase in oil prices, the financial crises in several European nations served as a caution about the still fragile global economy and the potential negative impact of higher oil prices on demand.

Graph 2 - Major events and nominal world oil prices, 1970 - 2008



Source: Impact of high oil prices on freight transportation: modal shift potential in five corridors, Technical report, Transportation economics & management systems, Inc. October 2008

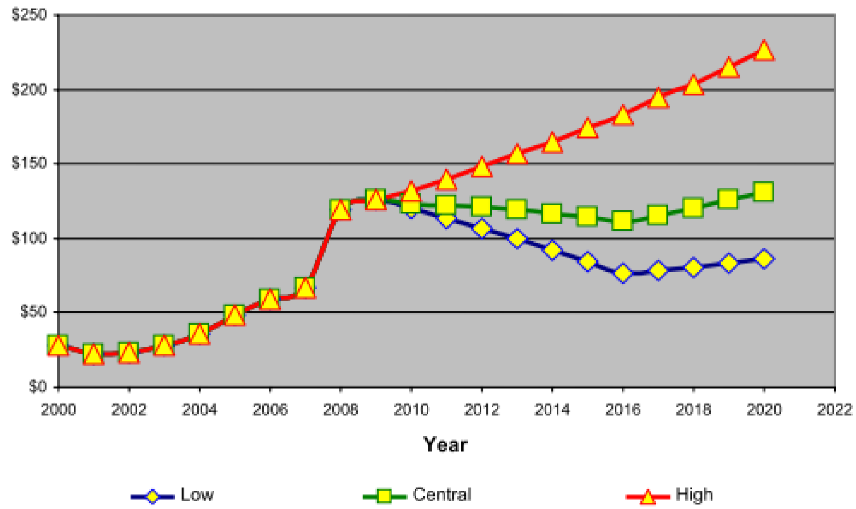
The future range of oil prices. From the review of discussion and historic data on oil prices, it is clear that there is much uncertainty about how oil prices may change in the future. To evaluate how the potential range of oil prices might affect the transport industry, three potential scenarios [4]: a low (optimistic) case, high (pessimistic) case and a central case were developed. In order to prepare these scenarios, historic data from years 2000 to 2009 were derived from the EIA database [8]. The EIA average annual growth rates were linked directly to the July 2008 short term values, and forecasts were generated to 2020 for the central, high, and low case scenarios. To develop the nominal dollar estimate for the prices of oil, the constant 2008 dollar values were inflated by an inflation rate of 3% per year.

Under the optimistic view or low price scenario (*Graph 3*), new oil supplies and substitutes are gradually brought on line (i.e., over 2-3 years) and then oil prices fall to a new higher equilibrium level of $60-80 per barrel. This reflects the fact that supply conditions improve and that an increase in supply will return the economy to a moderate or high growth strategy. While conditions will not be as advantageous as they were in the 1990’s, increased oil supplies and improved energy use productivity result in a new equilibrium level for the economy that will operate very efficiently with oil costs only double or triple what they were in the 1990’s. This scenario assumes that OPEC would expand output so that it’s nearly keeping pace with the expanding demand in China and India so that while world demand is high, so is supply.

Under the pessimistic or high price scenario, the expansion of world demand is so strong that the new equilibrium level will be consistently rising to over $200 per barrel, and that this change is likely to be permanent, and specifically, due to the growth of Asian and Latin American markets. In this scenario, it is envisaged that despite OPECs best efforts to expand production, the use of supply substitutes, and efficient energy use, it is still not possible to keep world oil production up with expanding world demand for oil.

A third, central scenario would be a stable or slightly falling set of oil prices based on the idea that increasing world demand will strain existing oil supplies, but that new substitutes would gradually become available (e.g., ethanol based on sugar cane/biomass), and new oil finds will be brought on line. This suggests an intermediate course that would fall between the optimistic and pessimistic cases. However, this scenario will see long term oil prices at least quadruple in nominal terms what they were in the 1990's. In this scenario, the pace of the economy quickens after two or three years of very low growth reflecting the current slowdown.

Graph 3 - Crude oil nominal prices – annual averages



Source: Impact of high oil prices on freight transportation: modal shift potential in five corridors, Technical report, Transportation economics & management systems, Inc. October 2008

This middle-case equilibrium price for oil reflects the balance between OPEC and the world oil production capability, and the expansion of world demand. It assumes major gains in energy supply, the development of substitute fuels, and improved energy use productivity (e.g., higher fuel-efficiency standards for cars), not just in the U.S., North America and Europe but in Asia as well.

3. POTENTIAL TRAFFIC DEMAND FOR OIL IN THE WORLD

The demand for transport arises from the need to organize daily activities, to supply cities and towns, and due to dislocation source materials, of production and consumption of places in the world economy. Traffic demand is a need for transportation that occurs at a given time and on a certain relation. It can be met only at a specified time and at a particular relation. This fact comes from the essential features of transport as a service activity, and is a source of many difficulties that follow transport operators in satisfying the expressed needs.

Oil industry is oligopolistic in supply, demand, control and in its functional and geographical concentration. Demand is controlled by a few large multinational conglomerates, each of which has a production and distribution system consisting of refineries, warehouses, distribution centers and at the end of the supply chain of gas stations.

The supply is controlled by several countries where the oil industry was nationalized or under the OPEC organization which regulates about 37% of world oil production.

Economic systems that include industry, housing, energy and transport, have become dependent on cheap oil prices, where the United States are the best example. Although the United States are ranked as the world's leading consumer of oil (20.1 Mb/d), the rapid growth of Chinese economy in the last ten years has led this country in second place of oil consumers (5.5 Mb/d), surpassing even Japan (5.3 Mb/d).

China has about 40% of global growth of oil consumption in recent years. Approximately 52% of the total amount of oil is consumed in transport. Demand for oil is characterized by the appearance of seasonal effects, since the requirements for heating oil in the winter are higher, whereas demand for gasoline is higher during the summer. An increase of traffic and a higher degree of industrialization automatically implies larger circulation of oil as well as higher traffic demand and flows of oil worldwide.

Although world liquids consumption actually declined in 2008 (to 85.8 million barrels per day) and again in 2009 (to an estimated 84.1 million barrels per day) as the global economic recession deepened, it is expected to recover in 2010 and beyond as economic growth resumes. In the long term, world liquids consumption increases despite world oil prices that remain above $90 per barrel (in real 2008 dollars) after 2014 and rise to more than $130 per barrel by 2035.

More than 80% of the increase in total liquids consumption is projected for the nations of non-OECD Asia and the Middle East, where EIA expects strong economic growth.

The most significant non-OPEC contributors to production growth are Russia, the United States, Brazil, and Canada. Total non-OPEC liquids production in 2035 is nearly 13 million barrels per day higher than in 2007, representing 51% of the total world increase.

Liquids consumption in OECD regions generally grows more slowly over the next 25 years, reflecting slowly growing or declining populations and relatively slows economic growth as compared with non-OECD nations. In addition, growth in demand for liquids in many OECD countries is slowed by government policies and legislation aimed at improving the efficiency of personal motor vehicles. This includes increased automobile efficiency standards. In Japan and OECD Europe, liquids consumption declines by average annual rates of 0.7% (0.9 million barrels per day) and 0.4% (1.6 million barrels per day), respectively, from 2007 to 2035.

The different growth trends for the non-OECD and OECD regions mean that, by 2025, non-OECD regions consume more liquids than OECD regions. Despite significant country-level consumption growth, China still consumes less liquid fuel than the United States in 2035.

As of January 1, 2011, proved world oil reserves, as reported by the Oil & Gas Journal [10], were estimated at 1,471 billion barrels – 115 billion barrels (about 9%) higher than the estimate for 2010. According to the Oil & Gas Journal, 51% of the world’s proved oil reserves are located in the Middle East. Just under 79% of the world’s proved reserves are concentrated in eight countries, of which only Canada (with oil sands included) and Russia are not OPEC members.

4. THE MARITIME FLOWS OF OIL IN THE WORLD

Oil, by the market and capital, was the main tool of globalization. Political control of the richest and most profitable areas of oil and gas reserves is important geopolitical and strategic goals. Difference in oil production and consumption has affected the development of global trade. Oil is now one of the most important strategic product in the world ("black gold"), which is why oil-producing nations have great power in geopolitical relationships and that control over sources of oil is the most important cause of the crisis in the world [2].

The largest oil producers (Algeria, Indonesia, Iraq, Iran, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates and Venezuela) are merged in the interest organization of OPEC (Organization of Petroleum Exporting Countries), which together produces about 40% of total world oil production, and on its stock has three quarters of the total of confirmed reserves in the world. The largest oil-producing countries in particular stand out: Saudi Arabia (10.37), Russia (9.27), United States (8.69), Iran (4.09), Mexico (3.83) and Iraq (2.60) all in million barrels per day. [11]

Table 1 - Imports and exports of crude oil in the world

No.	Crude exports (thousand barrels/day)		Crude imports (thousand barrels/day)	
1.	Middle East	16642	Europe	9341
2.	Former Soviet Union	6386	US	9159
3.	West Africa	4443	China	4710
4.	S. & Cent. America	2635	Other Asia Pacific	4528
5.	North Africa	2260	Japan	3711
6.	Canada	1990	India	3254
7.	Mexico	1362	Singapore	800
8.	Other Asia Pacific	796	Australasia	583
9.	Europe	387	Canada	580
10.	East & Southern Africa	326	S. & Cent. America	419
11.	Australasia	325	North Africa	247
12.	Singapore	42	Middle East	226
13.	China	41	East & Southern Africa	101
14.	US	28	Mexico	7
15.	Japan	6.4	Former Soviet Union	1
16.	India	-	West Africa	1
	Total World	37670		37670

Source: www.bp.com

The main oil producers, including OPEC countries of Western Asia, are the richest areas of crude oil from which some countries with economies in transition. These are South and East Asia, Central Africa, Northern and Eastern coastline of South America, North Africa, and Western Africa, the Caribbean and Central America and the European countries at the North Sea (Norway and Sweden). The above classification is by regions.

Table 2 - Trade movements of oil in the world in 2010

	2010 thousand barrels daily	change 2010 over 2009 %	2010 share of total %
Imports			
US	11689	2.1	21.8
Europe	12094	-3.1	22.6
Japan	4567	7.1	8.5
Rest of World	25160	4.3	47.0
TOTAL WORLD	53510	2.2	100.0
Exports			
US	2154	10.7	4.0
Canada	2599	3.2	4.9
Mexico	1539	6.2	2.9
S. & Cent. America	3568	-4.8	6.7
Europe	1888	-7.2	3.5
Former Soviet Union	8544	7.2	16.0
Middle East	18883	2.6	35.3
North Africa	2871	-2.3	5.4
West Africa	4601	5.5	8.6
Asia Pacific	6226	10.6	11.6
Rest of World	637	-51.9	1.2
TOTAL WORLD	53510	2.2	100.0

Source: www.bp.com

The main import regions are North America, South and East Asia, Europe and Japan. There is strong growth in oil demand from China, India, Western Asia and Latin America. The United States are by far the largest consumer with nearly 20 million barrels of oil consumption per day, which cannot be compared to any other country. This is the reason that the United States (as the main market for oil and petroleum products), represent one of the most influential force in the world. Saudi Arabia, which is the biggest oil producer (followed by Russia and United States) is placed at the bottom by consumption of 1.36 million barrels per day.

The main oil trading directions in 2010 shown on the *Map 1*, confirm that Saudi Arabia is a central world source of oil. Majority of oil flows from that part of the world to consumers is carried out through the maritime routes whereat the one of the most important directions of above mentioned line points is one eastward, meaning the one towards Japan and China, United States, and the line towards Europe. Russia is also quite important source of oil flows, and it supplies a big part of Europe, as well as the U.S. and China.

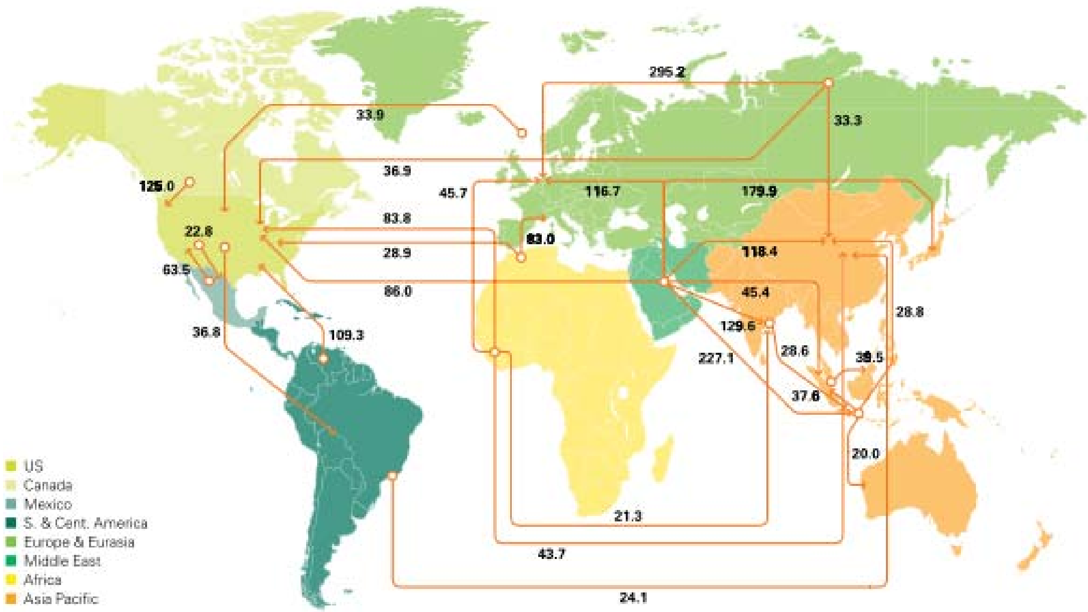


Figure 1 - Major trade flows of oil in 2010 (million tons)
Source: www.bp.com

After two consecutive declines, global oil trade grew by 2.2%, or 1.2 million b/d, with net Asia Pacific imports accounting for nearly 90% of the growth. Net imports grew robustly in China (+14.6%, 680,000 b/d) and Japan (+7.1%, 280,000 b/d). Net export growth was largely from the Former Soviet Union (+7.2%, 570,000 b/d) and the Middle East (+2.6%, 470,000 b/d).The growth in global trade was roughly split between crude and refined products, though crude still accounts for 70% of global oil trade. [1]

5. CONCLUSION

Oil industry is oligopolistic in supply, demand, control and in its functional and geographical concentration. Demand is controlled by a few large multinational conglomerates, each of which has a production and distribution system consisting of refineries, warehouses, distribution centers and at the end of the supply chain of gas stations.

The supply is controlled by several countries where the oil industry was nationalized or under the OPEC organization which regulates about 37% of world oil production.

The three world oil price paths in IEO2010 are consistent with those in EIA's Annual Energy Outlook 2010 [8]. The IEO2010 projections for total world liquids consumption in 2035 range from 90 million barrels per day in the high oil price case to 120 million barrels per day in the low oil price case. This range indicates the substantial uncertainty in the oil market projections. The three price cases are distinct scenarios, each reflecting alternative assumptions about the sources and costs of world oil supplies.

There are still a lot of known oil reserves in the world, but there are also some basins that have yet to be discovered at greater depths with a new, more powerful technology. There is large demand for oil in the world and with the development of the economy in poor countries it will become even greater.

Flows of oil in the world will remain much the same with minor changes to new fast-growing economies, where the attention should be paid to China, whose economy is growing rapidly fast.

The main characteristic of world oil flow lies down in a fact that the line directions for these types of flows are conditioned by formation of oil sources in the world, with reference to the largest producers, exporters and importers of oil. In other words, the most important flows of oil are formed on a direction from a large producer or exporter states, to the major consumer countries. It should be noted that the largest oil producers and the countries that have that energy wealth available, should not always be the largest exporters of it. Consequently, in geographical analysis of world oil flows, data on the largest exporters and importers countries of oil are representing the important indicators of the intensity and the main directions of these types of flows.

ENDNOTES

[1] OECD - Organisation for Economic Co-operation and Development

[2] *Organization of the Petroleum Exporting Countries* (OPEC) is an international organization formed by Algeria, Indonesia, Iraq, Iran, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates and Venezuela

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STOCHASTIC ONE-NOMENCLATURE INVENTORY CONTROL MODEL OF TRADE ENTERPRISE WITH THE HIGH VARIATION OF DEMAND

ABSTRACT

The stochastic one-nomenclature inventory control model of trade enterprise with the high variation of demand is described. Algorithms, which allow defining the size of the order, at which the enterprise expected profit is maximized, are offered. The computational experiment defined the best algorithm.

Key words: *inventory management, demand variation, commercial enterprise, profitability of a working capital, the computational algorithm*

1. INTRODUCTION

Inventory management in commercial enterprises is important because many of them have invested a significant part of working capital in the stocks and their reasonable reduction leads to significant cost savings [1, 2].

There are many methods that enable to solve the inventory management problem in various conditions [3, 4]. The most common model of inventory management, represented in studies, is an EOQ model [5].

If the demand variation is low, then various forecasting methods can be widely applied to solve the inventory management problem [6, 7, 8].

The difficulties in planning appear, when goods are characterized by high demand variation. One of the approaches to solve problem in this case is to use a stochastic approach in the analysis of the demand [1].

In practice, various probability distributions can be used. In the case when the law of the probability distribution of demand is unknown, sometimes we can assume that it is uniform.

2. PROBLEM DEFINITION

Let us consider a stochastic one-nomenclature inventory control model of trade enterprise with high variation of demand, in which the goal is to maximize the expected profit for a finite number of planning periods T. We assume that the order is placed at the beginning of the period and received immediately.

The main parameters of the model:

x_t – the size of the order in period t, $x_t \geq 0, t = \overline{1,T}$;

ξ_t – the demand in period t, a random variable with probability density function $\varphi(\xi_t)$,
$\xi_t \in [0,\infty]$, $t = \overline{1,T}$;

y_t – the inventory level (the excess inventory or the shortages) at the end of period t, $t = \overline{1,T}$.

Dynamics of inventories is described by the equation $y_t = y_{t-1} + x_t - \xi_t, t = \overline{1,T}$.

Let p – sale price of the good, then the sales revenue in period t can be written as $\mathrm{p} \cdot \min\{y_{t-1} + x_t, \xi_t\} = \mathrm{p} \cdot \min\{y_t, 0\} + \mathrm{p}\xi_t$.

If c – the proportional direct item cost (which include cost of purchase and transportation), then profit in period t can be represented as $\pi(x_t,\xi_t) = \mathrm{p}\xi_t + \mathrm{p}\cdot\min\{\mathrm{y}_t,0\} - cx_t$. The total expected profit over T planning periods is as follows:

$$\int_0^\infty \ldots \int_0^\infty \left(\mathrm{p}\xi_t + \mathrm{p}\min\{\mathrm{y}_{t-1} + \mathrm{x}_t - \xi_t, 0\} - cx_t\right)\varphi(\xi_1)d\xi_1 \ldots \varphi(\xi_T)d\xi_T \to \max_{x_t \geq 0, t=\overline{1,T}}.$$

One can show that if x^* is the maximum value in the inventory management problem in the case of one time period

$$\pi(x) = \int_0^\infty \left(\mathrm{p}\xi + \mathrm{p}\min\{\mathrm{x} - \xi, 0\} - cx\right)\varphi(\xi)d\xi \to \max_{x \geq 0},$$

where $\varphi(\xi)$ is a continuous probability density function of the random variable ξ, p > c, then $\Phi(\mathrm{x}^*) = \frac{p-c}{p}$, where $\Phi(\xi)$ – the probability distribution function of the random variable ξ.

It can be also shown, that the inventory management problem in the case of one time period for a uniform probability density function

$$\varphi(\xi) = \begin{cases} \frac{1}{\xi^{\max} - \xi^{\min}}, \xi \in [\xi^{\min}, \xi^{\max}] \\ 0, \xi \notin [\xi^{\min}, \xi^{\max}] \end{cases}$$

has a maximum value (when p > c) at $\mathrm{x}^* = \xi^{\max} - \frac{c}{p}\left(\xi^{\max} - \xi^{\min}\right) - y_0$.

3. INVENTORY MANAGEMENT ALGORITHMS

The following inventory management algorithms have been proposed.

Algorithm 1. Based on available information on the volume of sales upper and lower bounds of sales $\xi^{\max} = \overline{\xi} + k \cdot s(\xi)$ and $\xi^{\min} = \max\{\overline{\xi} - k \cdot s(\xi), 0\}$ are calculated, where $\overline{\xi} = \frac{\sum_{i=1}^n \xi_i}{n}$ is the average demand, $s(\xi) = \sqrt{\frac{\sum_{i=1}^n \left(\xi_i - \overline{\xi}\right)^2}{n-1}}$ – the standard demand deviation, k – coefficient, ξ_i – the actual value of demand in the i-th period, n – number of observations.

The size of the order is adjusted taking into account the available inventories as follows

$$\mathrm{x}^* = \max\left\{\xi^{\max} - \frac{c}{p}\left(\xi^{\max} - \xi^{\min}\right) - y_0, 0\right\}.$$

Algorithm 2. The first step of the algorithm 2 is to construct a table of the empirical distribution of sales, based on available actual information on the volume of sales. The next step is to determine x^*, such that $\Phi(\mathrm{x}^*) = \frac{p-c}{p}$. We can build a table, in which sales data are sorted in ascending order and calculate the cumulative relative frequency. After this x^* is determined. X^* is the value, for which the accumulated value of relative frequencies exceeds the ratio $\frac{p-c}{p}$ for the first time. Further, the size of the order is adjusted taking into account the available inventories as follows $\mathrm{x} = \max\{\mathrm{x}^* - y, 0\}$.

Testing of the algorithms was carried out for the company “Soyuzigrushka”. The study was conducted on the basis of sales data, pricing, procurement, transportation and sale of goods that belong to products with high demand variation. The variation coefficient v for these products ranged from 0.58 to 1.76 and was calculated as:

$$v = \frac{s(\xi)}{\bar{\xi}}.$$

The experiment was conducted with the use of the past data. The results of the algorithms were compared with a profit π^*, when the actual demand was accurately known and the company would receive the maximum possible profit.

The proposed algorithms have been implemented by the author in a programming environment Delphi 7.0. During the experiment for all products for each algorithm 8 time steps have been passed.

For the algorithm 1 a parameter K was changed in the calculations. The highest profit was obtained for the values K = 5-6. Let us consider the algorithm on an example of good "Leopard".

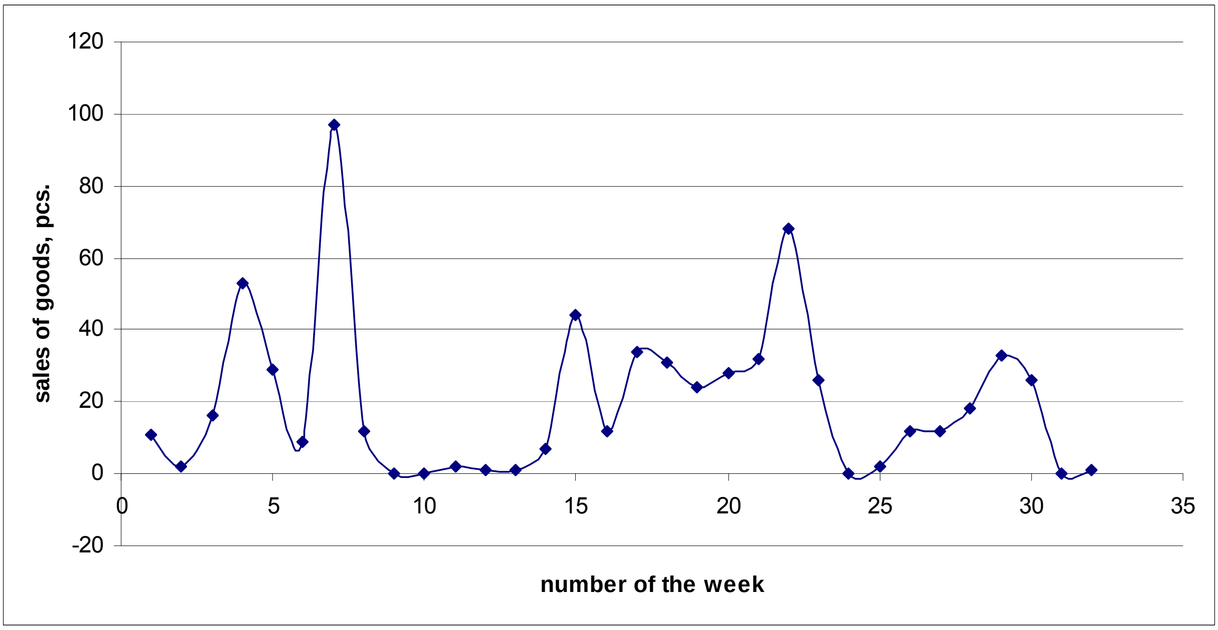

Figure 1 - Weekly Sales of goods "Leopard"

We can see from Figure 1, that the demand has no clearly defined cyclical component, although we can observe small fluctuations. The results of the algorithm 1 for the product "Leopard" for the eight time periods are presented in Table 1.

The total profit over the past eight periods of the algorithm 1 with K=5 was 15 765 rubles. If the demand was fairly well known, the total profit π^* would have been equal to 18 683 rubles. Thus, the total profit of the algorithm 1 was 84,38% of the maximum possible for this product.

Table 1 - The calculation of profit for the product "Leopard" for Algorithm 1 with K = 5

	The time period							
	1	2	3	4	5	6	7	8
Inventories at the beginning of the period, pcs.	99	84	47	0	7	3	41	23
The size of the order, pcs.	0	0	0	46	39	43	5	23
The actual sales, pcs.	15	37	47	39	43	5	23	38
Inventories at the end of the period, pcs.	84	47	0	7	3	41	23	8
Profit (loss) for the period, rub.	1 621	3 999	5 080	1 011	1 908	-2 481	2 135	2 491
Cumulative profit for the period, rub.	1 621	5 621	10 701	11 712	13 620	11 139	13 274	15 765
Profit π^*, rub.								18 683

Similar calculations were made for 22 products relating to the goods with a high variation in demand. The total profit for all products for 8 periods obtained for each algorithm is shown in Figure 2.

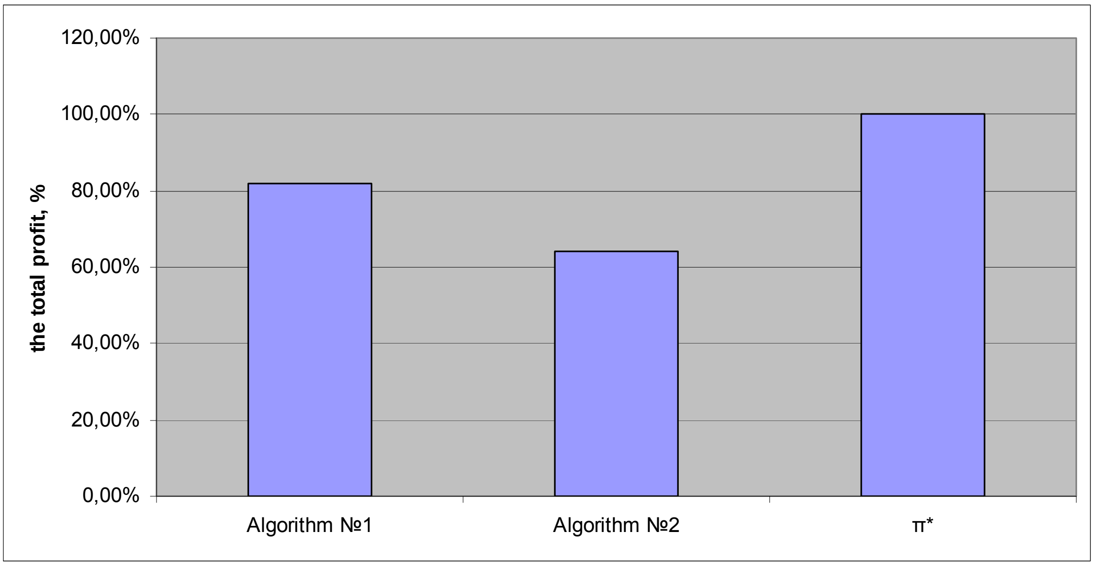

Figure 2 - The total profit for all goods for 8 periods obtained by algorithms with respect to profit π^*, %

The figure 2 shows, that the algorithm 2 would allow to obtain a smaller total profit compared with the algorithm 1, in which boundaries of demand changes are calculated.

The question arises: does it make sense to use the algorithm 2, if it's application leads to a decrease in total profit compared with the algorithm 1?

We note, that at present enterprises in addition to the absolute indicators, the relative indicators are also important, for example, the profitability of working capital, which reflects the efficiency of the use of working capital and which is calculated as the ratio of profit to working capital [9].

The optimal inventory management, taking into account the time value of money, leads to the release of funds required as working capital for the re-order and leads to an increase in capital turnover, which is reflected in the corresponding increase in the profitability of the investment [10]. Illustration of this effect is presented in Table 2.

Table 2 - Profitability of the working capital

Algorithms	Investments in working capital, rub.	Profit, rub.	Profitability of the working capital
Algorithm 1	241 953	192 427	0,795
Algorithm 2	118 941	150 811	1,268

As can be seen from Table 2, the loss of 21.63% of the profit is a kind of payment for the growth of profitability (59.5%) and withdrawal of a part of the capital from the turnover. We note, that after each period of placing the order, the amount of released funds will increase, which will lead to an increase in the annual rate of profitability of the working capital. Free up capital can be directed on the expansion of assortment, or invested in alternative investment projects, which should cover the lost profit.

The results of computational experiments showed, that in the case, when the variation of demand is very high, that is, the demand is almost unpredictable, algorithms, taking into account the distribution of demand, allow increasing the profitability of the working capital.

4. CONCLUSIONS

The results of experiments showed that the algorithm, taking into account the distribution of demand, allows increasing the efficiency of inventory management system, namely, to increase the ratio of capital turnover and reduce the level of “frozen” funds in stocks, compared with the algorithm, in which the boundaries of demand changes are calculated. The algorithm can be useful in determining the size of orders in the conditions of limited working capital.

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MAIN FEATURES OF TRAFFIC FLOWS ON INLAND WATERWAYS OF THE REPUBLIC OF CROATIA

ABSTRACT

Geographic location of the Republic of Croatia is suitable for the development of rail and inland transport, within intermodal transport chain, with aim to be a part of unique European transport network. Croatia transport strategy should be based on attracting traffic flows from the Middle East and the Mediterranean through the port of Rijeka and Croatian territory. Reconfiguration of traffic flow, based on scientific grounds, should aim to emphasize the railway and inland traffic and the construction of logistics and distribution centers at major intersections traffic flow

Key words: *inland navigation, intermodal transport, the reorganization of traffic flows*

1. INTRODUCTION

Extremely advantageous geographical position of the Republic of Croatia is under-exploited and intensified in order of development of river and canal traffic with the purpose of strengthening of intermodal transport and linking into European transport integration. Insufficiently clear strategic determination of Croatia to strengthen the unified traffic system, without favoring certain sectors of transport and routes that do not contribute to strengthening European transport network and its routes are the elements on which to build future development the traffic plan. Linking the Mediterranean and the Pannonia continental parts of Croatian territory guidelines are on which future development of traffic structure should be based.

Reorganization of traffic flows from the Middle East and the Mediterranean through Croatian territory is an opportunity not to be missed, and on which Croatia has to develop its transport strategy.

2. GEOGRAPHICAL POSITION OF CROATIA

The Republic of Croatia to its geographical position belongs to the central part of Europe, also to the Mediterranean group of European countries, Pannonian and Dinaric, Mediterranean-oriented as well as the Danube country (Figure 1). Advantageous geographical position and relief of Croatian are suitable for the development of transport infrastructure facilities with optimal usage of natural waterways (sea and inland waterways). The space between Dinarides and Velebit and the Alps on the other side is the most suitable for the development of the Pannonian-Danube link to Rijeka and Kvarner as an exit to the sea.

Figure 1 - The geographical position of the Croatian-traffic
Source: The river, road and rail routes in Eastern Croatian

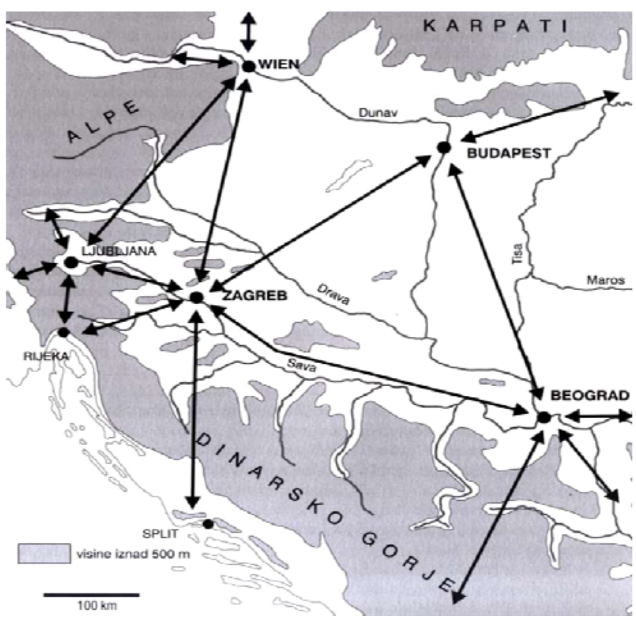


Figure 2 - The transport position of the Croatia
Source: The river, road and rail routes in Eastern Croatian

Through Croatian territory pass roads from Central Europe to Southeast Europe and the Middle East as well as from the countries of Danube region up to Adriatic ports and vice versa (Figure 2).

Figure 3 shows the maritime corridors that are naturally oriented towards the Mediterranean via the Suez Canal to the Indian Ocean and the Far East and Gibraltar to the ports of the Atlantic Ocean among that Croatia could with high quality of traffic and spatial concept attract and significantly interfere existing traffic and transit structures of European and international transport networks.

The fact that the distance from port of Rijeka to the Suez Canal is only 1254 km, whereas that distance to North Sea ports is triple and the trip takes 10-14 days longer, opens up prospect opportunities to attract transit traffic through Croatia over the port of Rijeka with the possible connection with the European transport flows through the VII Danube Corridor.

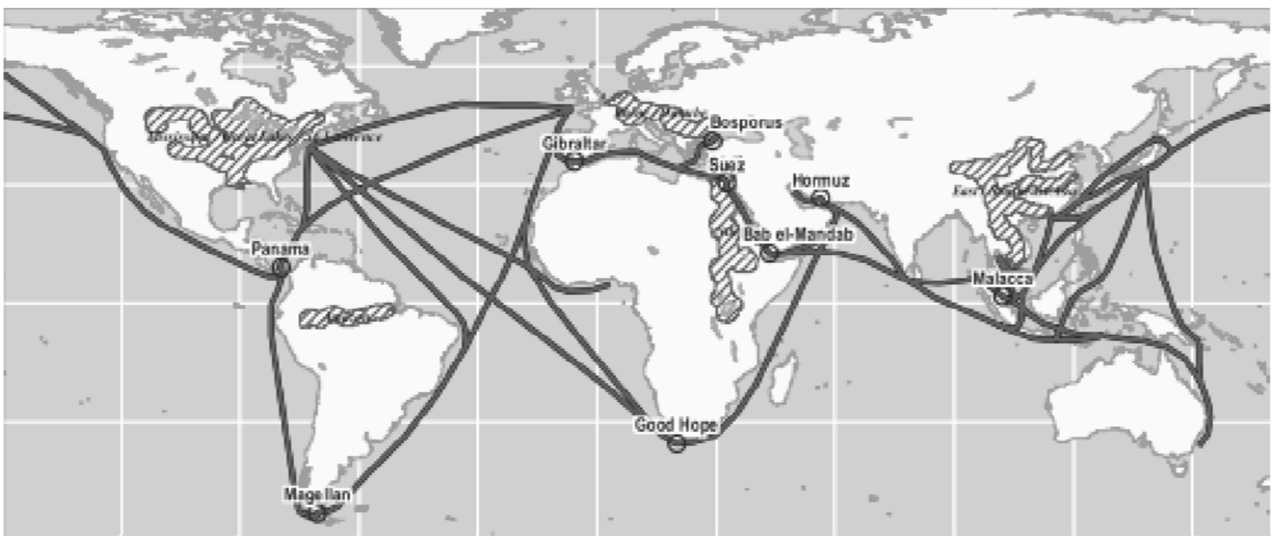


Figure 3 - Croatian and international maritime corridors

Source: http://people.hofstra.edu/geotrans

Through Croatia pass very important Pan-European transport corridors (Figure 4) that are part of European transport networks, which are:

- Vb - road corridor which connects Rijeka, Zagreb, Čakovec and Budapest and rail corridor that connects Rijeka, Zagreb, Koprivnica and Dombovar
- Vc - road corridor connecting Budapest, Osijek, Sarajevo and port of Ploce
- X - road and rail corridor Salzburg, Ljubljana, Zagreb, Belgrade, Nis, Skopje
- Xa - road corridor Graz, Maribor and Zagreb
- VII - Danube waterway corridor

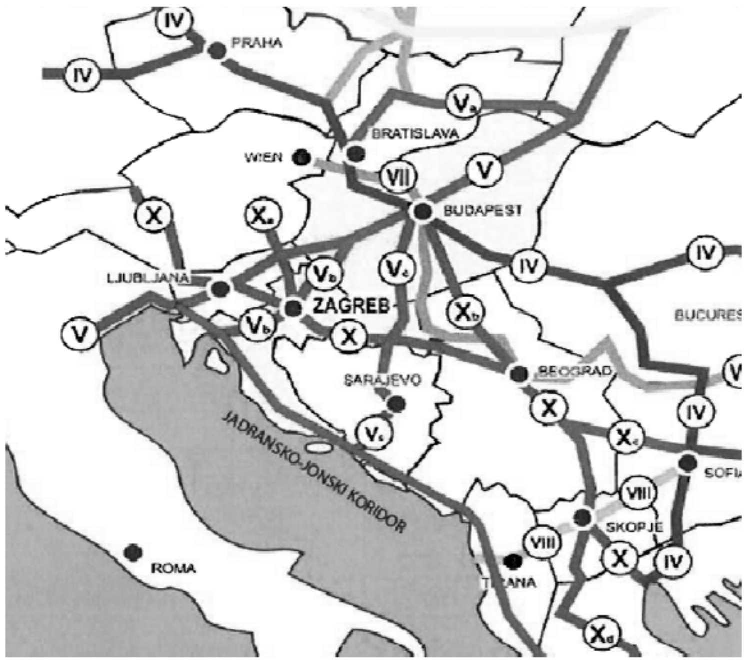


Figure 4 - Pan - European Transport Corridors of the European transport network

Source: Croatian-society and welfare state

3. CROATIAN WATERWAYS IN FORMER TIMES AND TODAY

Inland navigation in Croatia on the Danube, Sava, Drava and Kupa amounted before the war about 3.9 million tons per year (Table 1), with the transport of gravel and sand almost double. Problems of inland shipping were low class of waterway (except the Danube), outdated fleet capacity and high operating costs, and today, after the war damages and with the new regional geopolitical situation it is even worse.

Table 1 - Structure of transport of goods in Croatian transport traffic before and nowadays

	Railway transport thousands of tons	%	Road transport thousands of tons	%	Pipeline thousands of tons	%	Maritime transport thousands of tons	%	Inland transport thousands of tons	%	In total thousands of tons
1985.	44.851	51%	17.073	20%		0%	21.710	25%	3.929	4%	87.563
1990.	35.796	39%	12.764	14%	10.532	12%	29.118	32%	2.713	3%	90.923
1995.	13.318	21%	5.127	8%	4.740	8%	38.121	61%	776	1%	62.082
2000.	10.059	18%	4.872	9%	6.775	12%	32.483	59%	1.045	2%	55.234
2005.	14.333	13%	58.886	52%	9.396	8%	29.975	27%	430	0%	113.020
2007.	15.764	13%	66.814	53%	9.688	8%	32.420	26%	385	0%	125.071

Source: Ministry of Maritime Affairs, Transport and Infrastructure

Domestic traffic cannot achieve a significant increase while the Sava and Danube waterways are isolated for traffic in Croatia. In the part of inland waterways should be more intensively work on the regulation to ensure the navigability of existing waterways and to activities of marking river Sava. To achieve the main goal - to ensure reliable and safe navigation with a minimum gauge of 2.5 meters in 300 days per year is necessary to start two major projects:
- arrangement of the Sava river waterway in category IV (IPA Project)
- arrangement of the Danube waterway (TEN-T[1] projekt)

These two projects are crucial for revival of inland traffic in the area of central Danube and the Sava river navigation revitalization. By removing bottlenecks for navigation, inland traffic would become safer and more reliable transport resource, and thus a competitive compared to other modes of transport. Planning and implementation of all projects of planning and maintenance of waterways is necessary to comply with water management and water management plans. The most important step in the Croatian approaching towards other European countries in inland navigation would be the construction of Danube-Sava canal (E80-10) from Vukovar to Šamac (Figure 5). Canal navigation would shorten the sea route between the Danube and Sava River for more than 400 km, the Slavonian Brod and Sisak would be closer to Europe, Vukovar port would receive greater significance and importance than now and agricultural activities would improve in the area of canal. Without the construction of canals, river Sava with belonging area will remain blind gut of European inland navigation, and Croatia will be left without a significant financial impact.

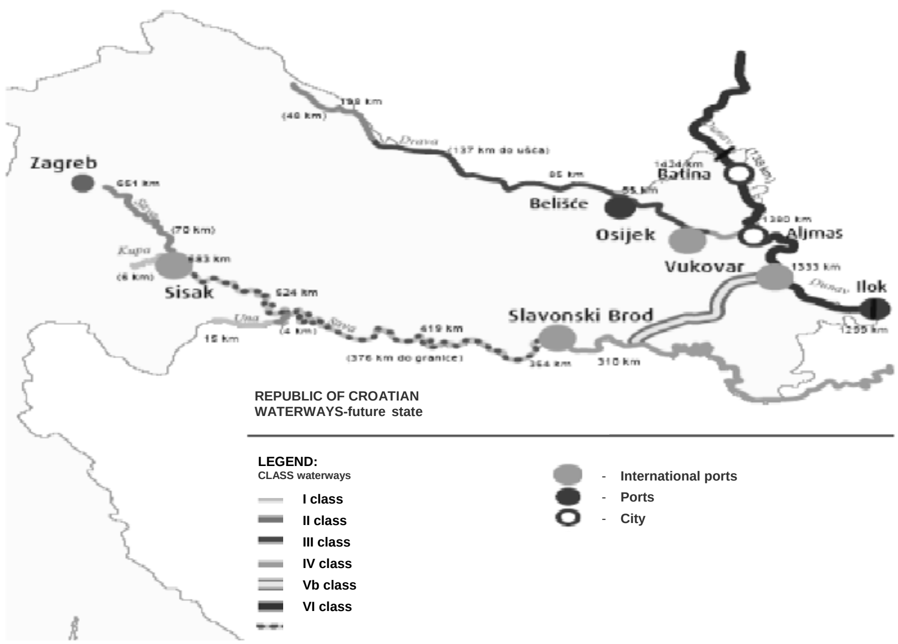


Figure 5 - The Croatian waterways

Source: Ministry of Maritime Affairs, Transport and Infrastructure

In the late 2007th Act of Navigation and Inland ports was adopted, which is fully in line with similar legislation of the European Union and which for the first time legally regulates in Croatia. In 2008th two very important documents were also brought, Strategy for the Development of inland waterway transport in the Republic of Croatia (2008 to 2018). For the success of inland navigation are not only modern fleet, qualified staff and good organization sufficient, but, considering financial weight, optimal waterways (regardless of hydrologic conditions and in accordance with the size of turnover). Optimal waterway also includes a uniform navigable network on national and international level, which allows standardization of the fleet and eliminates the need for transshipment of goods from a vessel to another class vessel as well as connection with the sea.

4. MAJOR PORT TERMINALS AND BOAT DOCKS IN CROATIA

Croatian port system consists of four ports that are located at strategic positions of all Croatian navigable rivers. The biggest among them is the port of Vukovar on the right bank of the River Danube. Vukovar port area is 26 ha and 17 ha of water surface. Ensured depth is 8 meters and has eight berths. Located on the Pan-European Corridor V c is connected by road and rail, and ideally serves as the most eastern hub of Croatian multimodal system. The Physical plans provide the modernization and construction of new port facilities as well as road and rail infrastructure. Modernization and construction of new ports of Vukovar involves further expansion of the port into the area of the future Danube - Sava Canal in a way that the part of the port would be built at the mouth of the canal on the side of Danube and in accordance with the requirements of economic valorization of the port services market. The catchment area of port of Vukovar is very broad, and it includes next to Bosnia and Herzegovina also Hungary, Slovakia, Czech Republic, Austria, Germany, Poland, Serbia, Romania, Bulgaria, Ukraine, Russia and Moldova.

Osijek port area extends to 56 hectares and at approximately 18 ha of water surface. It has six berths and secured depth of 2.4 meters. Port area Slavonian Brod extends to 86 hectares, and approximately 21 hectares of water surface. It has three berths, and secured depth of 2.5 to 2.8 meters. Port Slavonski Brod is located in a favorable geographical-traffic position, at the intersection of road and rail routes that connect the Mediterranean and Eastern Europe, and in the immediate vicinity of traffic junctions of Vc and X corridors.

Therefore, this port has the potential to develop into an important inter-modal hub. The existing port in Slavonski Brod is specialized for transshipment of oil and oil derivatives. The concept of future development of port in Slavonski Brod envisages the construction of the port with specialized terminals for transshipment of goods of different kinds, from containers to general cargo, with adequate roads and rail connections. The total surface area of the port would amount to 1,286 million m2, and the planned annual transshipment would amount to 1.5 million tons of cargo.

Port Crnac in Sisak extends to 1.7 hectares and 400 meters of handling shore, and it is specialized for handling bulk cargo. The port of Sisak spreads on the area of 6.9 hectares with 250 meters of manipulative coastline. Closeness to Zagreb, the largest economic center and transportation hub in Croatia and to Karlovac, also significant industrial center and traffic junction, provide an additional potential to port of Sisak. Oil terminal Crnac on the River Sava is connected via pipelines to oil refinery. Terminal capacity is approximately 1.5 million tons per year, and up to terminal is not built the railroad but only a road. Development of the Sisak port is connected with the construction of the highway Zagreb - Sisak, which would link well industrial and commercial area of Zagreb.[2]

Table 2 - The trans-shipment facilities of the ports

	2000.	2001.	2002.	2003.	2004.	2005.
Osijek	264.000	184.000	197.000	256.414	355.856	478.000
Sisak	169.000	210.000	205.000	201.000	198.000	174.000
Slavonski Brod	169.000	210.000	205.000	201.000	198.000	174.000
Vukovar	44.000	75.000	110.000	153.245	301.304	803.250
In total: (tons)	**646.000**	**679.000**	**717.000**	**811.659**	**1.053.160**	**1.628.250**

Source: Inland ports

The realization of medium-term plan for development of inland waterways and ports for the period 2009 to 2016 is particularly important for the development of inland transport on Croatian territory, and for connecting to transport corridors of the European Union and the Danube region. Its implementation would create the preconditions for a better redistribution of transport in favor of river transport, which is one of the goals of the European action plan for inland navigation (NAIADES)[3]. The basic principles on which should operate port system are:

• Public character of ports and port facilities available to all users
• Market liberalization of port services
• Equal treatment of all users and exclusion of discrimination
• Coverage of costs of port by port users
• Ensuring high standards of safety and environmental protection

In order to resolve the identified problems in the Croatian port system on inland waters, it is necessary to perform the following:

- match the needs of investment in port infrastructure and the financial possibilities of the state and accordingly invest in projects that have priority and which show better economic results from cost-benefit analysis
- resolve ownership relations in the port area combining purchase of land, offsetting claims by the state or long-term agreements to lease land
- provide flexibility in the definition of port fees and deadlines for approval to ensure the right to engage in port activities in the field of public ports, where interest in investing in port facilities and equipment show private investors
- Port Authority to include in the work of joint intergovernmental expert teams within the Sava Commission to coordinate the development goals and development plans of the port on the Sava River
- in the port authorities to unify the procedures of control and monitoring of port operators and establish a uniform system of port administration and management processes
- integrate ports into the system of river information services

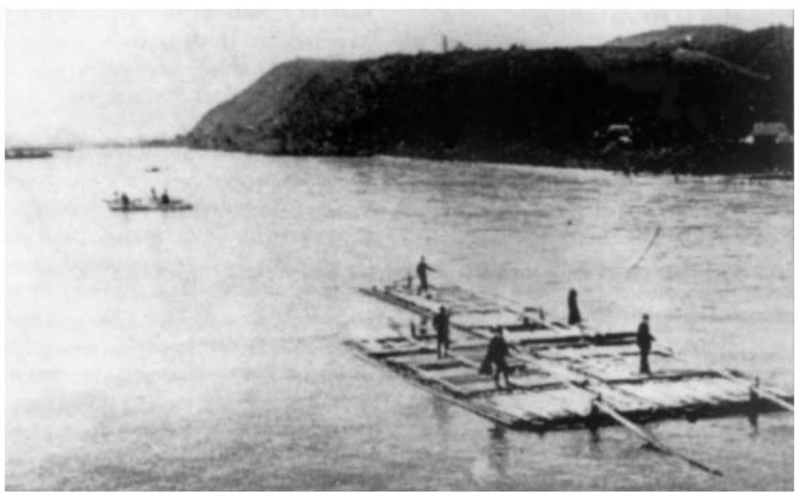
5. MOVEMENT OF MERCHANDISE-TRAFFIC FLOWS ON SAVA WATERWAY

5.1.The historical development of navigation along the Sava

Since Roman times remained the records that the Sava River was then navigable, and that is used in military campaigns to defend the limes on the Danube. The old records say that the Romans done the correction of the riverbed at Podpeca (in Slovenia), where the Sava river was connect by new riverbed with the quarry, from where the stone for the construction of large Roman buildings was driven, suggesting that the Sava from ancient times was navigable and was used for navigation. For the upstream traffic the Sava River was been in the valley of the Sisak navigable even for larger ships. For transport away from Sisak goods were reloaded on smaller ships and transported to Zagreb and further to the Zalog near Ljubljana with the boats which were dragged on ropes by people, and later by horses. In the carriage across Sava from Zagreb to the Zalog (Slovenia) was important delivery and transport of salt. Croatia for centuries supplied with sea salt, and supply was at that time under state monopoly, as well as rock salt which is transported from inside of Hungary. Even from the 14^{th} century, Zagreb was an important traffic hub for trade in salt. There were special shops and warehouses for trading salt then in Zagreb. It is assumed that the salt which King Andrew I donated with Grants from the 1217th Kaptol came from large salt works in Marmaros (in Hungary) by ships, along the Danube and Sava, and arrived via Sisak to Zagreb. At the same time part of the salt came from the seaside on wagon along the road to Zagreb via Karlovac where the part of the salt was reloaded on the boats and was transported through the Kupa and Sava to Sisak and to Zagreb. At the time of favorable water level Sava was navigable up to Rugvica where salt was unloaded from the ships and so called "obalarina" was paid there. Salt was also sell here or reloaded on wagons and vehicles and transported up to the sales or storage in Zagreb. However, during the higher water levels, in spring and autumn, ships with salt came even to Zagreb. Because of the use Sava for navigation and the Croatian Parliament at its session often made decisions about cleaning and renovating the Sava River and its maintenance for navigation to Zagreb.

In addition to salt in the 17th century using waterway grain was also shipped to Zagreb. A record from the 16th century (1541.) says that the Slavonian grain was transported on the Sava to Brezice or Krško, where was took over by so called "tovarnici" and changed for salt. Record from 1790th mentioned that the grain from Banat was transported to Sisak, reloaded on smaller ships and transported via Zagreb to Zalog and further to Trieste. It therefore follows that in the 18th century the river Sava was extremely important for the grain trade, not only to Zagreb, but also to Zalog in Slovenia. Ships for the transport of grain from Zemun to Sisak were supposed to sail about 23 days, and the path from Sisak to the Zalog was much longer. Grain path, as well as salt, went the Tisa and the Danube to Zemun and further on Sava to Sisak, from where most of the crop went to Karlovac and to the seaside, to Senj or Rijeka while smaller part went upstream on Sava across Zagreb to Slovenia. The Sava River was navigable and was being carried out various types of vessel traffic in accordance with the technical possibilities of the time. The ships which sail upstream from Sisak to Zagreb are smaller and are called "tumbasi" made in Kranjska, not covered so the grain is transported in barrels. Ships engaged in this traffic are long up to 46 m wide 4.5 to 5 m and have load capacity of 2000-8000 vagana (85-390 tons).

Navigation of that time complicates and limits the number of obstacles such as poor maintenance of ‘’kopitnica’’ on the bank where towing ships and boats of all kinds is perform, in the riverbed are many bars, layers and stumps but the biggest obstacle are mills where a lot of time is lost during the voyage. A particular problem is shipping at the time of large or small water level, when it usually breaks causing the carriage lasted much longer. Since 1808 it is planned that Sava carry out postal traffic too which was accomplished next year, in 1809th under the name of the "postal diligence" and it was done by boat. This postal links held from Zalog via Zagreb to Sisak and has eight stopovers on the Sava River where the goods for carriage took over and loading or unloading carried out. This postal link is of short duration and at the end of that year it ends because of Napoleonic wars. However, the grain transport continues on the Sava River regardless the French are located on the right bank of the Sava within Croatian territory. From that time, from 1811th, remained the rates for carriage and the passage for every ship or raft which pass through the area of Zagreb regardless if the ship holds here and unloads the goods or continues sailing on the river Sava. In the price list are the costs for the colonial merchandise that comes through Kranjska, since in this way delivery of goods is cheaper than by road from the direction of the seaside. These taxes or fees for the passage of ships or unloading of goods in the 18 century are known as toll, but also as "obalarina", "bregovina" or "splavarina." On river Sava, from Sisak via Zagreb to Zalog (Slovenia), from the 1804th up to 1807th was transported about 85,000 tones of Slavonian and Hungarian wheat, and from the 1817th up to 1826th on the same section of the river Sava, upstream and downstream, annually navigated 117 to 296 vessels and transported 105,000-266,000 vagana of grain. Later, in 1839, even up to 693 ships or vessels passed with 624,000 vagana of transported cargo, while in the 1850 only slightly more than 500 ships and boats, because part of the cargo towards the sea then went off by the road through Karlovac. In the 19th century to Zagreb was transported by boats and other vessels, besides colonial goods also textiles, footwear and finished products because the manufacture of these items increases for civil servants and officials as well as military personnel. Since the mid-19th century steam boats are already being used on the river Sava, which are used as a tug to haul ships with grain, since then the towing vessel on human labor decreased. In 1848 The County of Zagreb prepares a list for the passage and transport of goods across the Sava Bridge in Zagreb, but there is also a price list for the passage of ships, ‘’koraba’’ and ‘’tumbas’’ below Sava Bridge in Zagreb then on Sava sail the ships capacity 46-185 tons (Figure 6). In the past Sava was, in the Zagreb area, navigable and in the 19th and 20th century was used for navigation and transportation of various goods for daily use. After the First World War, the authorities sought to perform, at any cost, navigation along the Sava so in Zagreb in January 1920 the boat with motor power of 24 HP, 8 m long and 2 m wide, named Triglav was purchased which was created as a tugboat to haul trucks between Zagreb, Sisak and Karlovac. At the same time on the Sava River sailed, from ancient times, rafts that were with timber come from Slovenia, passed near Zagreb and continued sail up to Sisak, Jasenovac, Slavonski Brod and Šamac where timber was sold.[4]



Prolaz splavi *Savom pokraj Podsuseda oko 1930. godine (Foto: Muzej grada Zagreba)*

Figure 6 - The former way of moving goods in traffic flows along the Sava

Source: City Museum of Zagreb

5.2. The possibility of future development of goods and traffic flows in inland waterways and canals

For smooth process of development of intermodal transport of goods between sea, land and the inland transportation, besides the construction of modern infrastructure is necessary to provide adequate logistics, with advanced transportation technologies and also development of transport technology of ships for transport of containers, pallets and cargo transport units for Ro-Ro traffic. It is necessary to provide sufficient infrastructure and logistical and technical equipment, which includes support in terms of cargo handling machinery, transport equipment in inland shipping, location for containers, storage space and adequate human resources as well as the infrastructure, building roads, tracks, office buildings and all installations. Long-term Development Plan of waterway transport is necessary to base on assumptions of inland waterways connection with the Adriatic Sea and seek to realize connections between continental, Pannonian part of Croatia with its shoreline, linking on overseas ports and terminals and further connection up to Central Europe by the VII - Danube corridor.

6. POSSIBLE INCLUSION OF CROATIA ON EUROPEAN NAVIGATION SYSTEM OF RIVERS AND CANALS

Inland transport should be integrated into the intermodal transport network in order to strengthen its role in the market. For the integration of Croatian inland transport in the European intermodal transport network, via the VII-Danube Corridor it is important to raise the reliability and efficiency of inland navigation by ensuring the quality of transport infrastructure. In the waterways part the main goal is to provide minimum the international class IV, which means the navigability of vessels with minimum gauge of 2.5 meters 300 days a year. In the part of port infrastructure it is necessary to launch a new development cycle. This refers to equipment with basic port infrastructure as well as the sufficient capacity for transshipment of specialized types of cargo in accordance with market demands. All international ports must meet the requirements of environmental protection, primarily through the construction of special facilities for receiving waste liquids and oil. The purpose of promotion of inland waterway transport is exploring commercial and industrial entities with capabilities and technological advantages of inland navigation and creating a positive image of the river transport as a cost-effective, competitive and environmentally acceptable mode of transport. Implementing this strategy requires the strengthening of administrative capacity in state authorities and institutions, especially in organization of service for safety of navigation with goal of integration of Croatian inland transport in European navigation and intermodal transport network. Although Croatia has a respectable, naturally developed potential of waterways, it is unrealistic to expect construction and reconstruction of existing transport capacity of river and canal traffic in the near future. Unclear strategic development policy with the aim of development of a single preferred traffic branch do not provide sufficient guarantees for the possible impending development of inland transport, as one of the most important sectors of the transport system. Inland traffic currently makes 0.2% of the total transport of goods in the Republic of Croatia. The total length of navigable waterways in Croatia is 805.20 km, of which 287.40 km meets all international class buoyancy. Transport strategy in the Republic of Croatia should be focus on the utilization of geo-strategic potential for the development of inland transport. The revival of inland traffic as acceptable form of transport with advantage of more favorable for the environment, it should set a priority goal in bringing the development of intermodal transport. Intermodal transport development is inconceivable without the strengthening and modernization of inland navigation elements. The goal is to develop an optimal intermodal integration of different transport modules to ensure an efficient and cost-effective transportation system through the use of services that are focused directly on the users of transport services, initiating competition between transport operators. Although funding for the development of non-road forms of transport are provided from the pre-accession funds, vague strategic plan for the Croatian transport system, based and loaded with poor traffic management system gives no real basis for Croatian involvement in this very important development project. Although inland traffic by economy, maritime safety, and least harmful impact falls into the category of most cost-effective modes of transportation, political barriers are limiting elements in the development of this very important branch of traffic.

7. CONCLUSION

It is an undeniable fact that the efficient and safe transport infrastructure allows the increase of productivity and the economy, facilitates and encourages the mobility of people and goods and by reducing isolation creates conditions for balanced regional development. Croatia's transport infrastructure, particularly with regard to its shape and geographical location is extremely necessary. It is necessary to divert traffic from road to more energy efficient and environmentally more favorable modes of transport. Long-term Development Plan of navigable transport is necessary to base on assumptions of inland waterways connection with the Adriatic Sea and to seek to realize connections between inland waterways of Pannonian part of Croatia and its shoreline, tying on overseas ports and terminals.

Development of the Croatian inland port system depends on the overall economic and transport policy and the degree of integration of inland transport in the transport planning process and plans for the construction of transport infrastructure. It is very important that the international ports are connect with the railway and road corridors, whose construction is completed or is in progress and also to locate planed logistics centers with adequate technical and logistical structure on junctions of transport corridors.

Construction of waterways and their connection with the European network of waterways, the development of intermodal transport and political will are essential prerequisites for the overall strengthening of the sustainable development of the Croatia as well as for the realization of the strategic guidelines for the development of inland navigation and overall economic development.

ENDNOTES

[1] TEN-T-Trans-European Transport Network
[2] Source: Mid-term plan for development of Croatian inland waterways and inland ports from 2009 to 2016, Ministry of Maritime Affairs, Transport and Infrastructure, Zagreb, 2008
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DETERMINING TRAFFIC AND TECHNICAL CHARACTERISTICS OF NEW LOCOMOTIVES ON THE RAILWAY LINES IN THE REPUBLIC OF CROATIA

ABSTRACT

The paper gives an overview of the existing condition of railway traffic on the critical sections of the Zagreb – Rijeka railway line. The transport demand and forecast of future traffic have been used to analyze the productivity of the operation of the rolling stock of traction vehicles and to give proposals for the replacement of the existing locomotives in several phases i.e. variants. Taking into consideration the change of the electric traction system on the Rijeka railway line the required number of vehicles for the operation is determined, vehicles for modernization proposed as well as technical characteristics of new electric locomotives that have to be purchased.

Key words: *transport demand, electric traction system, locomotive traction characteristics, transport capacity*

1. INTRODUCTION

The paper attempts to answer the questions related to exploitation and possible modernization and the development of electric traction vehicles in the function of the current and forecast transport demand on Railway Corridor Vb. Modernization and purchase of new electric traction vehicles for the rail transport requirements in this part of Europe are related to the transport market and products that will be realized on it both in case of the existing operators and after the liberalization process of the future operators, as well.

In operational sense, what is common also to a part of countries from the environment which participate along with the Croatian Railways system in providing transport services on the observed railway corridors, is the relatively diverse and obsolete rolling stock, which is expensive to maintain and which is characterized by large immobilization and insufficient availability. The rolling stock of traction vehicles of the Croatian Railways system consists of 18 series of electric and diesel traction vehicles. Although in the recent years a minor number of new vehicles has been purchased and a certain number of the existing ones has been modernized, the average age of the rolling stock continues to exceed 30 years. The technology of maintenance and the obsoleteness of the rolling stock are the main reasons for large immobilization of traction vehicles that daily, on the average, for diesel and electric locomotives amounts from 25 to 30%, and for diesel trains and railcars from 20 to 25%. In spite of high annual costs of regular maintenance (excluding vehicle modernization), insufficient availability of traction vehicles causes everyday shortage of vehicles to meet the timetable requirements which leads to irregularity in traffic, increase of operation costs and losing the users' confidence in transport services.

Therefore, the following study was performed for the needs of the Rijeka traffic route:

1. based on the pre-determined transport demand the structure of the rolling stock of traction vehicles in the system of Croatian Railways on the Rijeka railway line will be analyzed;
2. the operation indicators of electric locomotives on the Rijeka railway line will be analyzed;
3. a proposal of the method of substituting the existing rolling stock of the traction vehicles of series 1061, will be given, both under the existing conditions, and in relation to the traffic forecast on the Rijeka railway line.

2. TRANSPORT CAPACITY OF RIJEKA-ZAGREB RAILWAY LINE

The operation analysis of a railway line is performed according to real data within a certain time period which are compared with the theoretical data obtained by the calculation of the throughput capacity of a certain section or the entire railway line. The biggest possible capacity depends on the longest section of a certain line or section of line with the longest train running times which are caused by the line characteristics, either regarding the position layout of the railway line, technical characteristics of longitudinal and transversal profile of the railway line. Indeed, the highest throughput capacity of the railway line depends on the least favourable section on the line or route. On Rijeka – Zagreb railway line there are several line sections for which the capacity will be determined. It is a single track railway line, which operates two electric systems (25kV on the section Zagreb – Moravice and 3kV on relation Moravice – Rijeka). Between two technical stations, the origin station Rijeka and station Moravice, which is at the same time the border station of the traction section, there are eleven stations (Table 1*)*. It may be noted that, regardless of the fact that the longest distance is between stations Skrad and Brod Moravice, the least favourable sections are between stations Fužine – Lokve and Lokve – Delnice, since due to the transversal profile of the line the travel time of all the trains is 11 minutes.

Table 1 – Section of Rijeka – Moravice railway line

Section	**Km distance**	**Travel time**		
		express	**passenger**	**freight**
Rijeka – Sušak Pećine	2.9			
Sušak Pećine - Škrljevo	9.1	10	11	10
Škrljevo – Meja	7.9			
Meja – Plase	7.4			
Plase – Drivenik	9.1	8	11	9
Drivenik – Fužine	7.2			
Fužine – Lokve	8.7	11	11	11
Lokve – Delnice	8.5	11	11	11
Delnice - Zalesina	5.9			
Zalesina – Skrad	6.9			
Skrad – Brod Moravice	9.2	8	10	9
Brod Moravice - Moravice	7.2			

2.1. Section of Rijeka – Moravice railway line

According to 2007/08 timetable, on the section of railway line between the station Rijeka and the station Moravice, the Delnice – Lokve section is the most disadvantageous one. Forty-nine trains operate along this line, and the line is equipped with interstation dependence devices. Comparing the theoretical maximum capacity which amounts to 63 trains daily and 49 trains that operate on the respective section, the line usability is 78%.

For consecutive train, which has a preceding train in category 10`, the minimal headway is 10.29 minutes, whereas for the trains with the preceding train in category 11`, the minimal headway is 11.6 minutes. The total railway line occupancy for consecutive trains is 72.03+135.84 = 207.87 minutes. According to the calculation and times obtained for sequence of trains running in opposite directions, the total time of line occupancy amounts to 329.52 minutes.

When the total time of trains running in directions *aa* and *bb* are added to the total time periods of trains running in directions *ab* and *ba*, and their sum is divided by the number of trains, the average minimal train headway is obtained which amounts to:

$$t_{sm} = \frac{\Sigma t_{sm}}{n_v} = \frac{329{,}52 + 207{,}87}{46} = 11{,}68[\min]$$

Regarding the traffic quality forecast, the reserve time t_r is also added, for the 24-hour graph:

$$t_r = 0{,}67 \cdot 11{,}68 = 7{,}83\,\min$$

Therefore, the maximal number of trains during the day on the limiting section amounts to:

$$N = \frac{1440}{t_{sm} + t_r} = \frac{1440 - 345}{11{,}68 + 7{,}83 + 0{,}25} = \frac{1095}{19{,}76} = 55{,}41 \approx 55\, {}^{vlakova}\!/_{dan}$$

From the total time, in calculating the maximal time during the day expressed in hours, the time with no traffic is subtracted, and this includes also the 60 minutes for regular daily maintenance for single track lines. According to the obtained result the degree of utilisation of the railway line is calculated:

$$Q = \frac{N_s}{N_t} \cdot 100 = \frac{49}{69} \cdot 100 = 71\%$$

For 2007/08 timetable the usage of the Rijeka – Zagreb line, on the part of the line Rijeka – Moravice, on Delnice – Lokve section, amounts to 71%, and since this section is the most critical one, it stipulates also the throughput capacity, i.e. the capacity of the line on the Rijeka – Moravice part of the railway line.

According to the actually realized operation[1], which is directly related to the operation of the Port of Rijeka, the data on the number of trains and train-kilometres show that every train travels on the average a distance of 63.82 km, and trips for railway needs are of average distance of 21.89 km. The complexity of the Rijeka hub stipulates that on some sections trains operate only on one part of the railway line, which is the case between the Bakar – Lokve stations, where due to the longitudinal section of the line, which amounts to 28‰, trains of lower mass are formed and coupled at the Lokve station (on the Bakar - Lokve section Q_{max}=950t, on Lokve – Moravice section Q_{max}=2,000t). According to the data of train traffic analysis for the time period from 1 January 2008 to 31 May 2008 there were 1,248 extra trains operating, which is on the average eight trains. These trains are added to the total number of trains, so that the degree of utilization of the line is:

$$Q = \frac{57}{69} \cdot 100 = 82{,}6\%$$

2.2 Sequence of consecutive trains for direction aa

For train sequence in direction *aa,* for consecutive trains the speed on the respective section has to be determined, which depends on the travel times, and is determined according to model:

$$v = \frac{l}{t_l} \cdot 60$$

According to calculation for train sequence in direction *aa* the following result has been obtained according to the table:

Table 2 – Total occupancy of railway line for aa headway

		CONSECUTIVE					
		7			10		
		stop A	through A	AB "B"	stop A	through A	AB "B"
PRECEDING	7		20.16		22.45		
	10		21.21		14.38	14.38	
						Σ = 92.58	

2.3 Sequence of consecutive trains for direction bb

The determined train speeds for direction aa are also valid for direction bb, and the difference is in the length of the block section due to the difference in kilometre position of the block signals of opposite directions. According to the calculation for train sequence in direction *bb,* the result is given in Table 3.

Table 3 – Railway line occupancy

		CONSECUTIVE					
		7			10		
		stop E	through E	AB "D"	stop E	through E	AB "D"
PRECEDING	7		21.16		17.88		
	10		44.58		6.88		
						Σ =90.5	

The total train headway of directions *aa* and *bb* is 183.8 minutes.

2.4 Sequence of trains running in opposite directions ab and ba

At stations at which there is sequence of trains running in opposite directions, apart from the running times also the station intervals of non-simultaneous train arrival to the station and the station crossing intervals are relevant, which depends on the consecutive train, i.e. whether it passes through the station or stops at the station. The dispatch time of the crossing train and the communication time are expressed according to the measurements in the field and depend on the station security and the number of station operational staff.

Therefore, the time necessary for the sequence of trains running in opposite directions amounts to:

- for trains with running time 7 minutes, the headway is 9.03 minutes,
- for trains with running time 10 minutes, the headway is 12.44 minutes.

Table 41 – Total time of line occupancy for trains running in opposite directions

		CONSECUTIVE								
		A				**PRECEDING**	**B**			
		7	**7**	**10**	**10**		**-7**	**-7**	**-10**	**-10**
		Stop A	**Through A**	**Stop A**	**Through A**		**Stop A**	**Through A**	**Stop A**	**Through A**
A	**7**							27.09	27.09	
	10							49.76	74.64	
B	**-7**	18.06	27.09	36.12						
	-10		37.32	49.76						
									∑= 346.93	

When headways of trains running in opposite directions and those running in the same direction are added the total time of line occupancy is obtained, which amounts to: 530.73 minutes.

Therefore, the minimal train headway is:

$$t_{sm} = \frac{\sum t_{sm}}{n_v} = \frac{530{,}73}{63} = 8{,}42[\min]$$

The reserve time is calculated, due to the line occupancy, which is over 70% for the peak hour:

$$t_r = 0{,}33 \cdot t_{sm} = 0{,}33 \cdot 8{,}42 = 2{,}78[\min]$$

Additional time is calculated on the basis of the number of block sections, and there are five of them:

$$t_d = 0{,}25 \cdot a = 0{,}25 \cdot 5 = 1{,}25[\min]$$

Maximal throughput capacity of the line is:

$$N = \frac{1440 - T_p}{t_{sm} + t_r + t_d} = \frac{1440 - 395}{8{,}42 + 2{,}78 + 1{,}25} = 83{,}94 \approx 84 vlaka$$

Line utilization is:

$$Q = \frac{N_s}{N_t} \cdot 100 = \frac{63}{84} \cdot 100 = 75\%$$

When the average of extra trains (eight trains) is added to the routes that are plotted in the graph, then the actual utilization is:

$$Q = \frac{63 + 8}{84} \cdot 100 = 84{,}5\%$$

3. ELECTRIC TRACTION OF THE TRAINS ON RIJEKA (BAKAR) – LOKVE SECTION

On railway lines electrified by 3kV DC system in the Republic of Croatia the basic locomotive for train traction in the period since 1963 has been the locomotive of series 1061 of the following technical characteristics:

- hourly power 3,150kW
- maximum speed 120km/h
- traction force – hourly regime 264kN
- locomotive mass 108t

After gaining independence the Croatian Railways, due to the insufficient number of properly functioning electric locomotives of series 1061, used also the Polish locomotives PKP of series ET41, which were in fact 8-axle locomotives of 4,000kW power, conceptually designed as 2xB′oB′o locomotives. Apart from the mentioned locomotives, also the Diesel locomotives of series 2063 were used for the traction. Regular load of the locomotives of series ET41 on the Rijeka (Bakar) – Lokve relation amounted to 900t for the speed of 40km/h, but this was difficult to achieve in practice due to the inefficient anti-slippage protection. The leasing contract of two multi-system locomotives ES64F4 (HŽ code 1241) has confirmed in practice that the future of traction on this line lies in 4-axle locomotives of 5.5-6 MW power, which can be coupled into tandems. Regular load of locomotives of series 1241 on Rijeka (Bakar) – Lokve relation amounted to 1,500t for the speed of 50km/h.

3.1 Traction of locomotives of series 1061

For years the usual practice of hauling “heavy” trains on the most difficult Rijeka (Bakar) – Lokve section was to use two locomotives of series 1061 (train engine and banking locomotive). After 1995 the traction of such trains was performed with two locomotives at the front of the train. In each locomotive there is an engine driver and assistant so that this method of haulage engages four persons, significantly affecting the cost of train traction. According to original technical description the locomotive of series 1061 should independently haul a train of a mass of 570t. Practice has shown that such locomotive load is not realistic. In compliance with the current standards for making the timetable the highest mass of train hauled by one locomotive of series 1061 on this relation has been limited to 500t, and for the train hauled by two locomotives at the front to 950t since the locomotives are controlled individually. According to traction characteristics of the locomotive of series 1061 the traction of such trains on the mentioned section operates at a speed of about 50km/h.

The difficulties that are characteristic for the traction by locomotives of series 1061 result from poor adhesion conditions that are frequent on this section, which due to inefficient protection against slippage often leads to standstill in driving. It has been proven in practice that the B'oB'oB'o concept is unfavourable due to insufficient adhesion utilization of the central bogie.

According to the number of malfunctions in relation to the travelled kilometres the locomotives of series 1061 have been for years the least reliable traction vehicles of HŽ. The traction with two locomotives represents a special technological problem. In case of such traction there is no synchronous control of locomotives, nor is there a possibility for communication of engine drivers so as to reach agreements in situations in which there are difficulties in train traction.

3.2 Existing rolling stock of locomotives for 25kV 50Hz

Regarding the forthcoming completion of the change of the electric traction supply system the traction sections of the locomotive will be extended for the AC system 25kV 50Hz to the most demanding electrified section in the network. The rolling stock of HŽ Train Traction today includes a total of 85 electric locomotives for 25kV 50Hz out of which 70 locomotives of series 1141 and 15 locomotives of series 1142.

The rolling stock of locomotives of series 1141 consists of:

- 20 locomotives for 120km/h with on-load tap changer without electro-dynamic brake,
- 7 locomotives for 120km/h with electro-dynamic brake,
- 17 locomotives for 140km/h with on-load tap changer,
- 1 locomotive thyristorised with analogue control,
- 10 locomotives thyristorised for 120km/h,
- 15 locomotives thyristorised for 140km/h.

After the change of the traction system on Moravice – Rijeka – Šapjane section a certain number of new electric locomotives for freight traction will be necessary. Until then the existing locomotives of series 1141 will have to be used, out of which the preference should be given to modernized locomotives with thyristor regulation for the speed of 120km/h.

Technical characteristics of locomotives 1141 300 (Figure 1):

• continuous power	3,860kW
• maximum speed	120km/h
• maximum traction force	278kN
• traction force – hourly regime	189kN
• locomotive mass	80t
• mass per axle	20t

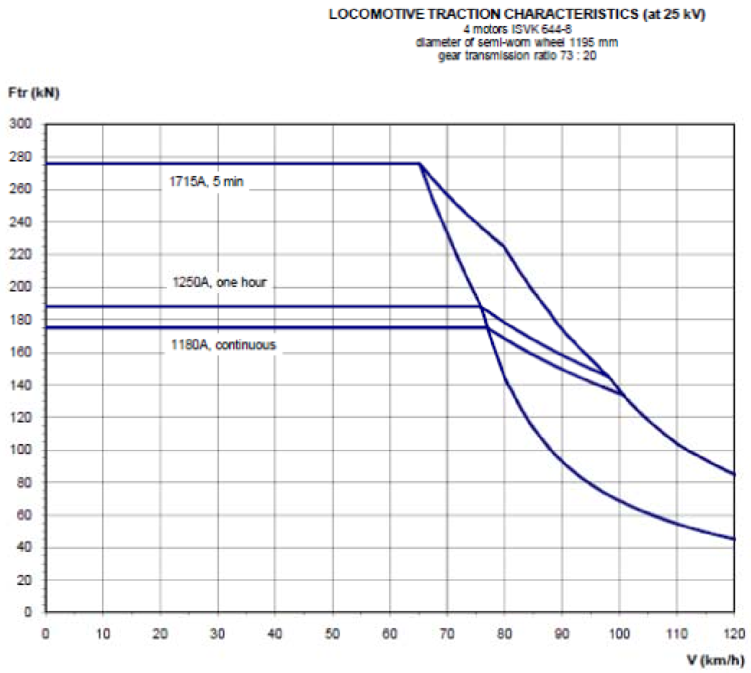

Figure 1 – Traction characteristics of locomotive 1141-300

3.3 Traction options on Rijeka (Bakar) – Lokve relation by locomotives of series 1141-300

a) Traction with two locomotives in tandem

- locomotive mass 160t (2 x 80t)
- train mass 1,000t
- total train mass 1,160t
- characteristic line resistance 29daN/t
- required traction force of starting at incline is 336kN
- minimal coefficient of adhesion required for starting is 0,21
- required traction power at a speed of 50km/h is 4.67MW (2.33 MW/loc)

b) Traction with three locomotives (tandem and banking locomotive)

- locomotive mass 240t (3 x 80t)
- train mass 1,500t
- total train mass 1,740t
- characteristic line resistance 29 daN/t
- required traction force the locomotive wheel flange for starting on incline is 504.6kN

c) Traction with three locomotives for direction Lokve – Rijeka (a single locomotive at the front and tandem at the end of the train)

- locomotive mass 240t (3 x 80t)
- train mass 1,770t
- characteristic line resistance 19 daN/t (Lokve-Drivenik), 0 daN/t (Drivenik-Rijeka)
- maximal braking force of electro-dynamic brakes on the locomotive wheel flange is 300kN which makes it possible to maintain constant speed of 60km/h of a train of total mass of ca. 1,000t without the use of air braking.

d) Traction with four locomotives for direction Lokve - Rijeka (tandem at the front and tandem at the end of the train)

- locomotive mass 320t (4 x 80t)
- train mass 2,768t
- characteristic line resistance 19 daN/t (Lokve-Drivenik), 0 daN/t (Divenik-Rijeka)
- maximal braking force of electro-dynamic brakes on the locomotive wheel flange is 350kN which makes it possible to maintain constant speed of 60km/h of a train of total mass of ca. 1,200t without the use of air braking.

Due to the route profile and other infrastructure limitations on the studied section there is a larger number of trains travelling in the Rijeka – Lokve direction and therefore the return of excess locomotives from Lokve to Rijeka, i.e. Bakar should be solved first. Consequently, the traction model should be selected which will realize the minimum total traction costs.

4. DETERMINING THE REQUIRED NUMBER OF LOCOMOTIVES

The traction section from Moravice to Rijeka is divided into two sections on the direction from Rijeka to Moravice, that is:

- Rijeka – Lokve with line inclines of 20-28‰ and train mass of 1000t,
- Lokve – Moravice with line inclines up to 10‰ and train mass up to 1719t.

The time that a locomotive spends at the home railway station is 5 hours, the planned servicing time is 5 hours, turnaround time is 6 hours, whereas 12% of locomotives are in regular maintenance. If one takes into consideration that on the planned section the trains operate on the average on 63.8km, this means that all trains do not operate on the entire section from Rijeka to Moravice, so that for the calculation of the required number of locomotives the number of regular trains on the mentioned section will be taken. The number of regular freight trains is:

- on relation Moravice – Rijeka: 6 trains,
- on relation Rijeka – Moravice: 7 trains.

$$\Theta = \frac{2l}{V_k} + t_{mat} + t_{ob} = \frac{2 \cdot 90}{17,59} + 5 + 6 = 21,23[h]$$

The coefficient of the required number of locomotives is:

$$K = \frac{\Theta_s}{24} = \frac{\Theta + t_s}{24} = \frac{26,23}{24} = 1,1$$

Number of locomotives on the train is:

$$M_v = K \cdot N = 1,1 \cdot 13 = 14,2 \approx 15[lokomotiva]$$

Number of required locomotives, regarding current maintenance is:

$$M_p = \frac{M_v \cdot p}{100 - p} = \frac{15 \cdot 12}{100 - 12} = 2,04$$

$$M = M_v + M_p = 15 + 2 = 17[lokomotiva]$$

Daily operation of locomotive is:

$$S = \frac{2 \cdot l}{K} = \frac{2 \cdot 90}{1,1} = 163,64\left[{}^{km}\!/_{dan}\right]$$

Daily utilisation of locomotive in hours is:

$$T_l = \frac{S}{V_k} = \frac{163,64}{17,59} = 9,3\left[{}^{h}\!/_{dan}\right]$$

The traction section from Moravice to Rijeka with train masses, due to the cross section of the line, of 1,000t, by locomotives of series 1061, i.e. according to phases by using locomotives of series 1141 and 1142 and the gross train masses of 1,000t [2] or gross train masses of 1,500t[3].

The time a locomotive spends at the home station is 5 hours, planned servicing time is 5 hours, and the turnaround time is 4.3 hours, whereas 35% of locomotives 1061 are in regular maintenance[4], i.e. 18% of locomotives 1141/1142[5]. If one takes into consideration that on the planned section the trains operate at 90km, it means that for the calculation of the required number of locomotives the number of regular trains on the mentioned section will be taken. The number of regular freight trains is:

- on relation Moravice – Rijeka: 9 trains,
- on relation Rijeka – Moravice: 8 trains.

$$\Theta = \frac{2l}{V_k} + t_{mat} + t_{ob}$$

$$\Theta = \frac{180}{41,95} + 5 + 4,3 = 13,6$$

$$\Theta_s = 18,6$$

The coefficient of the required number of locomotives is:

$$K = \frac{\Theta_s}{24} = \frac{\Theta + t_s}{24}$$

$$K = \frac{18{,}6 + 5}{24} = 0{,}78$$

Number of locomotives on the train is:

$$M_v = K \cdot N$$

$$M_v = 0{,}78 \cdot 9 = 6{,}98 \approx 7[lokomotiva]$$

Number of required locomotives, regarding current maintenance amounts to:

$$M_p = \frac{M_v \cdot p}{100 - p}$$

$$M = M_v + M_p$$

$$M_v = \frac{7 \cdot 35}{100 - 35} = 3{,}77 \approx 4[lokomotive]$$

$$M = 7 + 4 = 11[lokomotiva]$$

The productivity of locomotives according to valid Traffic-technical instructions amounts to:

$$S = \frac{2l}{\Theta}\left[{}^{km}/_{dan}\right] = \frac{180}{13{,}6} = 13{,}24$$

$$P = Q \cdot S = 1000 \cdot 13{,}24 = 13.235{,}3\left[{}^{Brtkm}/_{dan}\right]$$

This yields that 11 locomotives daily in the transport of 9 pairs of trains at 100% utilization of gross mass of the hauled trains can transport 18,000t in both directions. By extending the traction section to the Ogulin station, the commercial speed amounts to $V_k=33.43km/h$. For a turnaround of the locomotive on this section the total number of locomotives is necessary *M=11[locomotives]*. At the railway station Ogulin there needn't be any change of locomotives but rather only the change of engine drivers, and the change of the locomotives should occur only if this has to be done because of the domicile depots and current maintenance.

The vehicle productivity in this case is:

$$P=14.5\%$$

After having changed the traction system the following are formed:

1. direct trains:
   - on relation Zagreb - Rijeka: $N_{AD} = \frac{266}{25} = 10.64 \approx 11 vlakova$
2. section trains:
   - on relation Zagreb - Ogulin: $N_{AB} = \frac{42}{25} = 1{,}7 \approx 2 vlaka$
   - on relation Ogulin - Moravice: $N_{BC} = \frac{4}{21} = 0{,}19 \approx 1 vlak$
   - on relation Moravice - Rijeka: $N_{CD} = \frac{30}{17} = 1{,}76 \approx 2 vlaka$

A total of eleven direct and five section trains are composed, whereas the number of included wagons is:

- in direct trains: $N_v = 11 \cdot 25 = 275 vagona$

- in section trains: $N_v = 5 \cdot 19 = 95 vagona$

On the entire relation from Zagreb to Rijeka 370 wagons are dispatched on the average daily. The total reduction in the wagon holding hours is 42%, which along with the increase of the productivity of traction vehicles by 14.5% and increase (1^{st} and 2^{nd} phases) in the number of hauled trains represents a substantial increase in the utilization of the railway transport without investing into the infrastructure, i.e. substructure of the line[6].

5. COMPARISON OF HIGHEST LOADS OF LOCOMOTIVES 1141-300 AND NEW 4-AXLE ASYNCHRONOUS LOCOMOTIVES

In the next two years new electric locomotives should be purchased for the supply system 25kV 50Hz with asynchronous engines of power up to 6MW for bogies B'oB'o which, with no major technical limitations, can be designed as double-system ones (Table 5). Further upgrading of such a platform into a three-system locomotive would depend on the actual market needs of national carriers for multi-system locomotives. The platform for the construction of electric locomotives should be the basis also for the purchase of new diesel electric locomotives since the mechanical part (bogies, case) may be identical for both types of locomotives (Figure 2).

Table 5 – Basic technical characteristics of new electric locomotives:

Supply system	25 kV 50 Hz
Maximal speed	160 km /h
Continuous power	5.0MW or more
Axle pressure	max 22.5t
Security devices	PZB90/ETCS
RD device	analogue/digital for ERTMS

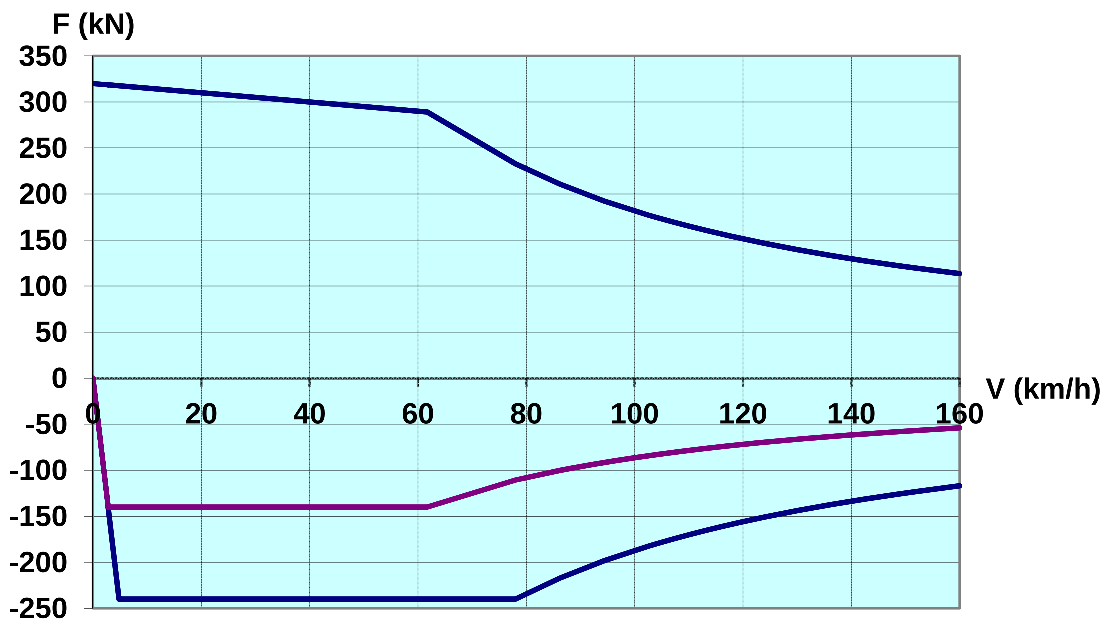

Figure 2 – Simulation of the traction diagram for the new asynchronous locomotive

I. Freight trains

characteristic incline i_m = 30 ‰
v = 60 km/h
specific resistance of freight wagons at level

$$w_{hv} = 2 + k \cdot \frac{v^2}{100} = 2 + 0{,}057 \cdot \frac{60^2}{100} = 4{,}05\ daN/t$$

a) Locomotive 1141-300

F_{tr60} = 176kN (continuous traction force at 60 km/h)
m_L = 80t
W_{hL60} = 2.8kN (normal resistance for locomotive)

$$Q_1 = \frac{F - \left(W_{hL} + m_L \cdot \frac{i_m}{100}\right)}{w_{hv} + i_m} \cdot 100 = \frac{176 - \left(2{,}8 + 80 \cdot \frac{30}{100}\right)}{4{,}05 + 30} \cdot 100$$

$$Q_1 = 438\ t$$

F_{h60} = 188kN (hourly traction force at 60km/h)
Q_2 = 480t (freight train mass at 60km/h, hourly regime)

b) Asynchronous 4-axle locomotive

F_{tr60} = 290kN
W_{hL60} = 3kN (assumption)
m_L = 88 t

$$Q_3 = \frac{F - \left(W_{hL} + m_L \cdot \frac{i_m}{100}\right)}{w_{hv} + i_m} \cdot 100 = \frac{290 - \left(3 + 88 \cdot \frac{30}{100}\right)}{4{,}05 + 30} \cdot 100$$

$$Q_3 = 765\ t$$

F_{h60} = 305kN (hourly traction force at 60km/h)
Q_4 = 830t (freight train mass at 60km/h, hourly regime)

II. Passenger trains (v = 80 km/h)

characteristic incline i_m = 30 ‰
specific resistance of passenger wagons at level

$$w_{hv} = 2 + k \cdot \frac{v^2}{100} = 2 + 0{,}032 \cdot \frac{80^2}{100} = 4{,}05\ daN/t$$

a) Locomotive 1141 – 300

F_{tr80} = 170kN (continuous traction force at 80 km/h)
m_L = 80t
W_{hL80} = 3.7kN (normal resistance for locomotive)

$$Q_5 = \frac{F - \left(W_{hL} + m_L \cdot \frac{i_m}{100}\right)}{w_{hv} + i_m} \cdot 100 = \frac{170 - \left(3{,}7 + 80 \cdot \frac{30}{100}\right)}{4{,}05 + 30} \cdot 100$$

$$Q_5 = 418\ t$$

F_{h80} = 180kN (hourly traction force at 80km/h)
Q_6 = 450t (mass of passenger trains at 80km/h, hourly regime)

- taking into consideration mass of one passenger wagon of 50t, it is possible to haul a composition of 8 passenger wagons in continuous regime, i.e. 9 passenger wagons in hourly regime

b) Asynchronous 4-axle locomotive
F_{tr80} = 230 kN
W_{hL80} = 4 kN (estimate)
m_L = 88 t

$$Q_7 = \frac{F - \left(W_{hL} + m_L \cdot \frac{i_m}{100}\right)}{w_{hv} + i_m} \cdot 100 = \frac{230 - \left(4 + 88 \cdot \frac{30}{100}\right)}{4{,}05 + 30} \cdot 100$$
$$Q_7 = 586\ t$$

F_{h80} = 245kN (hourly traction force at 80km/h)
Q_8 = 630t (mass of passenger trains at 80km/h, hourly regime)

- taking into consideration mass of one passenger wagon of 50t, it is possible to haul a composition of 11 passenger wagons in permanent regime, i.e. 12 passenger wagons in hourly regime

III. Passenger trains (v = 100km/h)

characteristic incline i_m = 30‰
specific resistance of passenger wagons at level

$$w_{hv} = 2 + k \cdot \frac{v^2}{100} = 2 + 0{,}032 \cdot \frac{100^2}{100} = 5{,}2\ daN/t$$

a) Locomotive 1141 – 300

F_{tr100} = 138kN (continuous traction force at 100km/h)
m_L = 80t
W_{hL80} = 4.9kN (normal resistance for locomotive)

$$Q_9 = \frac{F - \left(W_{hL} + m_L \cdot \frac{i_m}{100}\right)}{w_{hv} + i_m} \cdot 100 = \frac{138 - \left(4{,}9 + 80 \cdot \frac{30}{100}\right)}{5{,}2 + 30} \cdot 100$$
$$Q_9 = 310\ t$$

F_{h100} = 138kN (hourly traction force at 100km/h)
Q_{10} = 310t (mass of passenger trains at 100km/h, hourly regime)

- taking into consideration mass of one passenger wagon of 50t, it is possible to haul a composition of 6 passenger wagons in continuous and hourly regime since traction forces are equal in continuous and hourly regime for the speed of 100km/h

b) Asynchronous 4-axle locomotive
F_{tr100} = 180kN
W_{hL80} = 5.3kN (estimate)

m_L = 88t

$$Q_{11} = \frac{F - \left(W_{hL} + m_L \cdot \frac{i_m}{100}\right)}{w_{hv} + i_m} \cdot 100 = \frac{180 - \left(5{,}3 + 88 \cdot \frac{30}{100}\right)}{5{,}2 + 30} \cdot 100$$

$$Q_{11} = 421\,t$$

F_{h100} = 190kN (hourly traction force at 100km/h)

Q_{12} = 450t (mass of passenger trains at 100km/h, hourly regime)

- taking into consideration mass of one passenger wagon of 50t, it is possible to haul a composition of 8 passenger wagons in continuous regime, i.e. 9 passenger wagons in hourly regime.

Table 6 – Train masses in tons for different types of locomotives and running speeds

locomotive	Freight transport (v =60km/h)		Passenger transport (v = 80km/h)		Passenger transport (v = 100km/h)	
	hourly regime	cont.	hourly regime	cont.	hourly regime	cont.
1141 - 300	480	438	450	418	310	310
Asynchronous locomotive	830	765	630	586	456	421

6. CONCLUSION

In the first phase after the change of the electric traction system from 3kV DC to 25kV AC supply there is a need for 11 electric locomotives of series 1141/1142 for freight transport, although according to calculations due to the reduced current maintenance 9 locomotives are required. According to the throughput capacity of the line on the most disadvantageous section Lokve – Fužine the utilization is 71%, which gives the possibility of using the extra locomotives that could according to the valid Traffic-technical Instructions carry 11 pairs of freight trains, and at 100% of utilization of gross weight of the hauled trains 22,000t in both directions can be hauled, which is an increase of 22%.

By increasing the number of locomotives, with 15 available ones, the number of pairs of freight trains would also increase, which could be hauled, and it amounts to 16 pairs of trains and the increase of the total gross mass of trains hauled in both directions Q_{uk}= 32.000t. This is an increase in relation to the current situation of 78%. Besides, the mass of trains would also be increased from 1000t to 1500t.

By purchasing new 15 electric locomotives (mono-system or multi-system ones), of minimal power of 5MW, the gross mass of hauled trains in both directions would be increased, with maximum availability of new locomotives.

ENDNOTES

[1] performance of trains of Rijeka operative for the period from 1 Jan. – 30 May 2008
[2] in the first and second phase
[3] in the third phase
[4] current condition
[5] planned condition

[6] all the calculations refer to the freight transport, whereas in regional transport EMU compositions are used, according to the project "Feasibility study of investment into new transport capacities – railcars".

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ODREĐIVANJE PROMETNIH I TEHNIČKIH ZNAČAJKI NOVIH LOKOMOTIVA NA PRUGAMA U REPUBLICI HRVATSKOJ

Sažetak

U radu se daje pregled postojećeg stanja željezničkog prometa na kritičnim dionicama pruge Zagreb-Rijeka. Na temelju prijevozne potražnje i prognoze budućeg prometa analizira se produktivnost rada voznog parka vučnih vozila i daju prijedlozi za zamjenu postojećih lokomotiva u nekoliko faza odnosno varijanti. Vodeći računa o promjeni sustava elektrovuče na riječkoj pruzi određuje se potreban broj vozila za odvijanje prometa, predlažu vozila za modernizaciju kao i tehničke značajke novih električnih lokomotiva koje je potrebno nabaviti.

***Ključne riječi**: prijevozna potražnja, sustav elektrovuče, vučne značajke lokomotiva, prijevozni kapacitet*

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EU FUNDS AND INTERMODAL TRANSPORT

ABSTRACT

All EU funds and programmes are based on supporting sustainable development, reduction of fume emissions and bottleneck reduction. Intermodal transport enables exactly these actions which are the reason why EU supports the programmes for enhancement of intermodal transport. EU thus issued guidelines for the development of momentarily underdeveloped intermodal transport in Croatia. Additionally, the Republic of Croatia now has at its disposal various funds and programmes which can be used for co-financing of the intermodal transport development. Furthermore, Croatia has the opportunity to use pre-accession funds (IPA is the most prominent), various programmes of the Union as well as bilateral and regional IPA components.

***Key words**: EU funds, intermodal transport, Operative programme Transport, pre-accession funds, Marco Polo II programme, Union Programmes*

1. INTRODUCTION

This paper introduces all major EU programmes and funds which can be used for co-financing development and enhancement of intermodal transport in Croatia by drafting quality projects. As a model of financing, Croatia developed Operative programme for Transport which is also co-financed from pre-accession funds. Pre-accession funds in the transport area that were available for Croatia are ISPA and later on IPA funds which are used to partly modernize railway and inland waterways as fundamental modes of intermodal transport. Since 2009, Marco Polo II fund which finances programmes for the development of intermodal transport through its five activities is also available for Croatia. None of the projects in Croatia is yet financed from this fund although one project (WETRI) is approved but has not yet started with its realization. Beside these already mentioned funds that support development of intermodal transport, another four EU funds are available for Croatia: FP7, CIP IEE, CIP EKO-innovations within the programme CIP-EIP which is focused on innovations and entrepreneurship and TEN-T programme. FP7 finances big research projects and in Croatia it finances 14 projects related to transport. CIP IEE finances innovations that are focused on energetically efficient transport modes while CIP EKO finances projects directed at development of innovative products and services. TEN-T is an EU programme focused on investments in infrastructure of various transport branches with the goal of intermodal transport development. The aim of this paper is to indicate the problem of insufficient utilization of EU funds in the sector of intermodal transport and to motivate project drafting which will result in development and enhancement of intermodal transport in Croatia.

2. PRE-ACCESSION FUNDS

EU funds may be divided into 3 types depending on the users of financing. These are: pre-accession funds where IPA stands out as the most prominent, structural and cohesion funds and EU programmes which are not open only for member states and candidates but also to third countries.

Investments in the transport sector during the pre-accession period are financed through the ISPA and IPA IIIa programmes as well as through bilateral and regional IPA components (IPA HR- BiH, IPA HR-SR, IPA HR-CG, IPA Adriatic, IPA MED, IPA SEE). As priority investment areas, inland waterways and railway are recognized as underdeveloped and disproportionately represented modes of transport especially in relation to road transport. Other areas are: investments in infrastructure, securing sustainability of a system, informatization and communication network. Keyframe for usage of EU funds in the area of transport is the Operative programme Transport.

Within the ISPA programme, following projects are completed: Preparation of the project list for the Instrument for Pre-Accession Assistance in the transport sector and Rehabilitation of railway Vinkovci-Tovarnik-state border.

Component IPA IIIa supports infrastructure projects in the transport sector and it represents the continuation of the ISPA programme. Usage of the resources within IIIa component is based on perennial programme document-Operative programme for Transport 2007-2011. Its goal was choosing the projects which best suit the goals of Operative programme whilst making profit from learning through systems and practice of managing IPA since IPA uses the processes of programming and managing projects that are similar to programming and project management in structural funds.

Operative programme Transport aims at developing transport infrastructure in order to enable uniform transport network development in Croatia and for its easier integration in the Pan-European transport routes. It also aims at developing regional and local infrastructure in the road sector, local and sea ports, airports and modernization of public urban traffic system as well as urban transport.

Operative programme „Transport“ 2012-2013 will create a framework for the selection of projects and its co-financing from EU funds and it will additionally open the possibility for project realization, further improvement of transport development in the Republic of Croatia and its connection to European neighbours with a special accent on those routes which correspond with politic and economic orientation of Croatia.

Operative programme will be co-financed from the Cohesion Fund and European Regional Development Fund (ERDF). Interventions in the programme framework will be divided into 3 priority axes:

- Priority axis 1: Integration and modernization of transport infrastructure in the Republic of Croatia connected to TEN-T corridors
- Priority axis 2: Development and modernization of regional transport infrastructure
- Priority axis 3: Technical help

3. UNION PROGRAMMES

Within the EU Programmes, projects in Croatia may be co-financed from FP7 programme which is also the biggest programme of the Union with a budget of more than 50 billion Euro for a seven-year period from 2007. - 2013. FP7 is **a** financial instrument used by EU to finance research and development in Europe and other parts of the world. The aim of this programme is to help with realization of ambitiously set EU goals formulated in the Lisbon Agenda. This especially concerns the goal according to which by 2010, EU should become the most competitive and the most dynamic world economy based on knowledge. Strategy is based on three pillars of knowledge which make the so called, triangle of knowledge: research, innovations and education. FP7 offers a support to research and development but it doesn`t mean that exclusively researches are financed. FP7 consists of 4 sub-programmes of support for various types of activities related to research and development, for example activities of support or research coordination, strengthening or research capacities as well as building and maintenance of networks. The programme supports pioneer research and mobility of researchers. As the largest programme of the Union, FP7 has a complicated structure and a given collection of the rules for participation. Rules and conditions depend on the type of project and activities that applicants apply and are clearly defined in documents that serve as guidelines for the applicants.

As the programme directed at accomplishing the widest policy goals for research and technological development in the EU, FP7 is divided into 4 categories that are called specific programmes: cooperation, ideas, people and capacities.

In Croatia, Marco Polo II programme is also active and its goal is reducing the traffic load on the roads and reducing its negative effect on the environment by shifting transport from roads to the maritime navigation, railway and inland waterways. Programme duration is from 2007-2013 with a total budget of 450 million € for 27 member states. Countries that are not members of EU may participate in this programme by signing a Memorandum of Understanding with the European Commission and they also need to pay the insurance expenses. Programme supports projects on international transport sections which means that projects may be applied by consortiums that consist of at least two or more subjects founded in minimally two member states or one member state and one third country.

The programme supports 5 types of activities:

1. Modal shift actions
2. Catalyst actions
3. Motorways of the sea
4. Traffic avoidance action
5. Common learning actions

CIP IEE (Intelligent Energy Europe) programme contributes to achievement of European energy and environmental policy goals by promoting the usage of renewable sources of energy, energetic efficacy and energetically efficient modes of transport by financing activities that contribute to reducing market barriers, behaviour changes and that contribute to development of favorable business environment for the growth of energetic efficacy and market of renewable sources of energy.

CIP EKO (Eko Initiative) primarily concerns the organizations that have developed an ecological product, service or a process which has not yet been placed on the market because of the remaining risk. This initiative is directed at overcoming these barriers so that these products and processes could become a success for the future European eko-innovations. In order for the financing to be approved, projects need to have innovative character and ~~a~~ considerable positive effects on the environment, they also need to be open for wide usage, have to show added European value and international dimension and they have to be well thought through from the technical perspective and from the perspective of the project management.

TEN-T programme is one of the oldest EU programmes. In the current budgetary period that lasts until 2012, 8 billion Euro is approved. TEN-T programme is intended for the infrastructure investments in intermodal transport. At this moment, the Republic of Croatia has not yet signed the Memorandum of Understanding with the programme and thus cannot directly use the fund. However, according to the „10 Percent Rule“ it is possible to be a regional partner in the project and so to ensure investments in Croatia with maximally 10% of the project costs. Programme is divided into 4 branches: infrastructure investments, initial investments for the opening of a transport service (infrastructure), studies and investments in the wide range of activities (deepening the operative shore, informatization, RIS, VTS systems etc.) According to the branch, financial support for the project varies from 20-50 percent of total project costs.

4. BILATERAL IPA COMPONENTS

Beside IIIa component, Cross-Border Programmes based on the cooperation of Croatia and neighbouring countries are also available for Croatia.

IPA HR-BiH is a Cross-Border Programme between Croatia and Bosnia and Herzegovina that will be implemented during the period 2007-2013. This strategic document is based on the joint planning of both Croatian and Bosnian side. Programme supports the component II (cross-border cooperation) of the EU „Instrument of Pre-Accession Assistance“(IPA). This programme is trying to revitalize former cross-border relations and activities through solving some common social, economic and ecological issues. Goals of the programme are supporting foundation of cross-border network and partnership as well as development of joint cross-border activities in order to revitalize economy, protect environment and to increase social cohesion of the programme area. Also, goals are: building capability of local, regional and national institutions for EU programme management and preparing these for managing future cross-border programmes within the framework of structural EU funds.

IPA HR-SR is a Cross-Border Cooperation (CBC) Programme which represents an important part of a regional EU policy that intends to reduce the economic and social inequalities between EU regions. The goal of cross-border cooperation is to alleviate negative effects of the borders on social and economic picture of cross-border areas. For the period 2007-2013, European Union anticipated Instrument of Pre-Accession Assistance (IPA) for financing the programme between the EU member states, candidates and potential candidates for the EU membership. Overall goal of the programme is to foster cross-border cooperation for diversification and improvement of regional economy in a socially and ecologically sustainable manner while improving the cross-border, good neighbourly relations.

IPA HR-CG is a Cross-Border Programme which aims at improving the quality of life in the cross-border area between the Republic of Croatia and the Republic of Montenegro. Total contribution of EU funds from the IPA programme for the period 2007-2009 for both countries that participate in the Programme is 2,7 million Euro. Cross-border projects chosen on the basis of quality, creation of beneficial ecological, social and economic conditions in the programme area by supporting cooperation in commonly selected sectors and by improving neighbourly relations, will be financed. Horizontal topics that can be found in all priorities and measures are: development of cross-border capacity, equal opportunities, gender equity and policy that supports gender equality, sustainable development and environmental protection.

5. REGIONAL IPA COMPONENTS

Croatia also has at its disposal regional programmes that support cooperation between the countries of the region: IPA Adriatic (in the Adriatic area), Transnational Programme MEDITERAN which includes the whole Mediterranean area and Transnational Cooperation Programme for South East Europe.

IPA Adriatic is a programme of cross-border cooperation that is developed as a result of joint projects that refer to member states and it is the part of the cooperation process in the Adriatic area. Programme pulls the strength and initiatives from the wide experience from former programmes which were based on concrete results of studies and analysis financed in the past. There are several factors that make the cooperation in the Adriatic area extremely important, especially from the political and economic point of view.

The goal of Transnational Programme MEDITERAN (IPA MED) is to make the whole Mediterranean area measurable with international competition in order to ensure the growth of employment for the next generations and to support territorial connection as well as to actively participate in environmental protection within the logic of sustainable development. These issues cannot be efficiently solved not on a regional nor on a national level; they require considerable efforts in the sense of interstate coordination and consultations. Four priority axes of the MEDITERAN programme can be identified: strengthening of innovative characters, environmental protection and sustainable territorial development promotion, increasing mobility and territorial accessibility, promotion of polycentric and integrated region development in the Mediterranean.

South East Europe Transnational Cooperation Programme (IPA SEE) for the period 2007-2013 is the part of the new Objective 3, European territorial cooperation with an aim to strengthen and promote territorial development and integration in the area of cooperation within the programme period. Transnational cooperation is focused on the limited number of priority areas corresponding with Lisbon Agenda and Gothenburg Protocol: innovations, environment, accessibility, sustainable urban development. Activities related to innovations directly contribute to a balanced economic growth in the area of transnational cooperation. Activities related to environment and accessibility will have a clear transnational dimension. Activities for strengthening sustainable urbane and polycentric region can be implemented on several levels: transnational, national and regional, all with a clear transnational effect. Priorities of the programme are the following: alleviation of innovations and entrepreneurship, environmental protection and improvement, accessibility improvement, development of transnational synergy for a sustainable development of the area.

6. CONCLUSION

As a transit country which aims at environmental protection and bottleneck solution, Croatia should focus its attention on development of intermodal transport which could partly be financed from EU funds. Projects that are financed from pre-accession funds are mostly focused on modernization of railway infrastructure and infrastructure of inland waterways. Because of poor development of intermodal transport, Croatia has a large potential for financing projects from the EU funds and programmes. First of all, it is necessary to start implementing the Strategy for development of intermodal transport and network of intermodal terminals in the Republic of Croatia which should be implemented through projects financed from the EU funds and programmes. Ideas for development of intermodal transport are presented in the Strategy but there is a lack of educated staff. As a result of changes in the European logistic system, necessity for innovative strategies and concepts will appear which will enable modeling of a new type of logistic chains while the development and education must keep pace with the development of intermodal transport system.

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BENCHMARKING IMPLEMENTATION IN BUS TRANSPORTATION QUALITY ANALYSIS

ABSTRACT

Contemporary trends in the busines of bus transportation companies put the quality of transport services in the center of management activities. Managment tools that allow bussiness quality analysis have compelling role here. One of those tools is benchmarking. Unfortunately, benchmarking is not often used in the service of public bus transportation, so the purpose of this work is the exponiention of benchmarking capabilities in transportation branch.

Therefore this work describes the meaning and the process of benchmarking as well as model of benchmarking project in a bus transport company. The entire technological process in the company is described from technical, technological, organizational, legal and economic aspects, as well as possible key process indicators for each of those aspects.

Observations and conclusions set forth in this work should serve traffic technologists and managers as an additional argument for a wider acceptance of benchmarking in transportation service in road traffic. Accepting the best business practices of others, and implementation of quality solutions in one’s own work is one of efficient ways of improving the quality of transport services which is provided on transport market, as well as business profits increase.

Key words: *benchmarking, bus transportation, quality, key indicators of quality process*

1. INTRODUCTION

The quality of public bus transportation is imperative in which passengers, transport operators and wider social community concerned with transport has tendency to occur.. Managers who are in charge of transport companies must find new methods and ways of improving the quality of services their companies provide. The wide range of well acknowledged and universal ways of bussines analysis is to be applicated in bus transportation companies as well. Benchmarking is only one of them. Therefore, the concept of benchmarking in general has been explored in this work : past experience in its implementation, as well as model description of benchmarking aplication in big transport companies that operate in the county, the inter-county and the international bus line transportation have all been explored.

2. CONCEPT AND DEVELOPMENT OF BENCHMARKING

The term 'benchmarking' is difficult to define without ambiguity.A wide range of definitions available in the professional and scientific literature can serve as the foundation for defining the concept of benchmarking in the public bus transportation line of activity. Benchmarking can be defined as a way of observing elements and solutions that made other organizations (companies) successful. Its goal **is** to recognize, to study, to adapt and to adopt the best achievements in the economy, as well as to implement them in one's own company. It is a comparison with the best in the business, or learning from organizations that have established the best business practices. Benchmarking is also defined as a managerial tool that allows analysis and comparison based on the facts, and ultimately results in real improvement of business processes within the organization.

Origin of the term benchmarking is primarily linked with the label (the so-called benchmark) that indicates distance from the starting point from which the distance is measured. In essence, for each organization it is important to have clear goals set, and benchmarking is a reliable indicator to managers about position of their organization in relation to those goals. In the context of transport activities, benchmarking is a process in which technical, technological, organizational, economic and legal business segment of analyzed transportation company will be compared with other companies, trying to identify their own weaknesses and finding opportunities of improving its own business, in the process of learning from the better (best) ones.

Benchmarking development began in 1982. in the United States - when the IT giant Xerox spots dropping back behind competition, not knowing why. They researched in which areas they backdrop, and compared statistics on the cost of production with those of their major competitors. The way in which key indicators that were compared were determined and the way in which collected data and the results were presented, was unknown until then, and was called benchmarking.

Benchmarking was soon to be formally established by the decree of U.S. President Reagan by which National Agency for quality was established. The goal was the improvement of general awareness of the importance of quality in general and developing of need for companies to compete with the best.

Important thing about benchmarking is not only the excellence of products or services but also the excellence of the process. The emphasis is on analyzing the ways in which the competitors perform their work, and not only what their work is. Nowadays under the condition of globalization on the transportation market, on the national, as well as on the level of European Union countries, benchmarking is no longer the process that transportation company managers shudder at. There are more and more occasions when potential, and even the actual competitors sit down to the same table and exchange their experiences and information, with the aim to increase the quality and productivity. The size of transportation companies, the market in which they operate, their locations or form of ownership does not represent the limiting factor.

In Croatia, according to the available research on the application of management tools from 2010. the benchmarking is located on the third place with the frequency of use (benchmarking uses 69 % polled companies, and more represented is only the strategic planning which has used 81 % of the companies and declarations about the mission and visions which uses 70 % of the companies). Unfortunately, in bus transportation companies that deal with the public bus transport, benchmarking is very rarely used. Therefore the purpose of this work is to suggest the model of benchmarking application in transportation activities with the aim of testing the same model in real conditions of transportation production in the passenger transport on the example of big companies. It is very important to say that costs of benchmarking application in companies that use it are very small, at the same time having fast and significant effect. Some economic organizations and societies in Croatia (e.g. Croatian Employers' Association – HUP, Manager's society – CROMA, Croatian Chamber Of Economy - HGK etc.) organize benchmarking training sessions which will enable managers acquiring of basic knowledges and cognitions about the use, possibilities and potential benefits of benchmarking as the managerial tool. Project of promoting of mass use of benchmarking is often advertised with slogan «compare, improve, earn». Use of benchmarking may be the part of ISO quality standards implementations in the company operation, but also the independent process within company, that accompanies its growth and development.

3. TYPES AND EFFECTS OF BENCHMARKING

Types of benchmarking used as the managerial tool can be classified in two criteria: by the methodology of execution and by the field of use

By the methodology, benchmarking can be:

a) systematical benchmarking

b) informal (ad-hoc) benchmarking

Systematical benchmarking is carried out as a project, with the use of certain organization by beforehand known and accepted methodology.

Informal or ad-hoc benchmarking is carried out often and sometimes unconsciously, especially in smaller organizatios, and includes more detailed research of simple working procedures, reading magazines that deal with business processes themes that are similar to those in their own organizations (companies), conversations with competitors about common problems, analysis of competition on great fairs and analysis of complaints and remarks of users that could help compare work of the company with the competiton.

By the fields of use, bencharking can be:

a) internal

b) external

Internal benchmarking is based on internal transfer of the best practice and on mutually contest between employees of the same company. Internal benchmarking is carried out with the goal of getting insight in existing business operations, strong sides and weakness of certain departments inside the company, as well as ways in which every department carries out planning of their activities. The main purpose of interal benchmarking is to determine standarads (norms) of business activities inside the company.

External benchmarking represents learning from other companies. It is defined as competitive, functional and generic benchmarking.

External competitive benchmarking represents the comparison of one's own company with direct competition. The goal is to get specific and important data on competition business activities, in their services and business results.

External functional benchmarking represents comparison of one's own company with other companies that are not their direct competition. Services and business processes are being compared with the best domestic and european (worldwide) companies to determine the best domestic and european (worldwide) practice.

External generic benchmarking extends fields of benchmarking use beyond boundaries of the fields of the activity that an organization belongs to. By comparing different fields of activity, similarities are being determined among many business processes and functions that are not depended on what analyzed organizations do.

Expected effects of benchmarking application in modern companies can be shown in table of comparing characteristics of company business before and after application of the benchmarking project.

Table 1 - Comparison of company business characteristics before and after application of the benchmarking project

BEFORE BENCHMARKING	AFTER BENCHMARKING
- not being inventive	- use of every good idea
- only one possible solution	-more options of problem solution
- focus on internal	- focus on external
- goals from the past	- goal is to accomplish best bussines a.
- poor understanding of the market	- good understanding of the market
- internal priorities	- priority is consumer and his wishes and interests
- we are good	- we can and should be better
- management based on experience	- management based on facts

Source: www.trend.hr - web site of Info press

4. MODEL OF BENCHMARKING IMPLEMENTATION ON BUS TRANSPORTATION COMPANY

4.1. Methodology of benchmarking implementation

Methodology of benchmarking implementation is composed of six stages:

a) starting the benchmarking project
b) choice of the benchmarking partner
c) mutually gathering and transfer of information (transfer of knowledge)
d) comparison and understanding of gathered information
e) analysis of gathered information
f) implementation of necessary measures

Stated methodology can be implemented in benchmarking process that is taking place in bus transportation company as well.

Simplified process of implementation of benchmarking is shown in Figure 1.

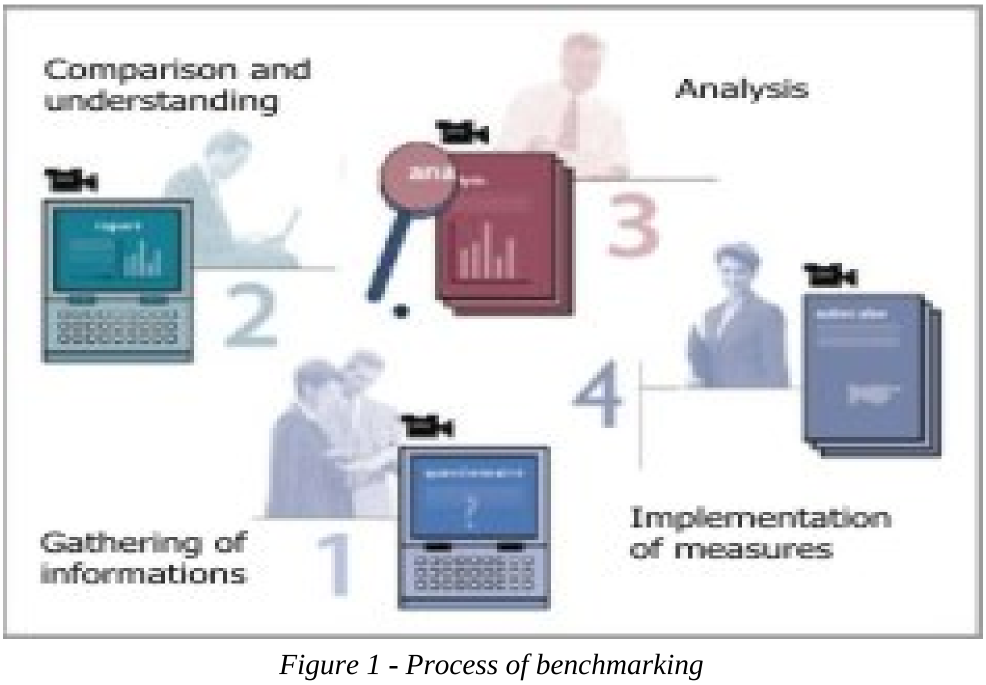

Figure 1 - Process of benchmarking

Source: www.g2r.hr - web site of consulting firm "Gate to reform"

4.1.1. Starting the benchmarking project

First step in starting the benchmarking project is making of the Resolution of starting the benchmarking project by company management. Resulution is to be made in written form and publicly a**n**nounced on notice boards inside the company, so that all employees could get acquainted with it. Resolution should clearly define processes that will be the subject of benchmarking analysis. After making of the resolution, benchmarking team of three to ten members is appointed that will achieve the whole project. Members of the team are appointed to team by following criteria:

- they must have detailed knowledge of business projects and functions in company that is the subject of the benchmaking process
- management must have full confidence in them
- they must have ability and competence of communications, with future benchmarking partners, as well as with colleagues employees within the company
- they must be prone to team work
- they must be higly motivated in participating in benchmarking project

The team members are taking internal and external education programs on benchmarking that are given by specialised consulting institutions whose course leaders spread knowledge and skills of benchmarking realisation with them. Education consists of seminars, conferences, work meetings, consultations and solving practical examples (case studies).

4.1.2. Choice of the benchmarking partner

One of the most complicated, but also the most important stages in benchmarking implementation is identification and choice of benchmarking partner. In the field of public bus transportation, appreciation of the following criteria for the choice of benchmarking partner is recommended :

a) choosing a company that has similar characteristics as the company in which the benchmarking project is being implemented (transportation market structure, size of car fleet, number of bus lines and departures, number of employed drivers etc.)

b) choosing a company that is not in a direct competition with analysed company

c) choosing a company that has history of good management relations with the analysed company

d) choosing a technically, technologically and economically stable company that can be set as an example of "good practice" in transportation business.

e) choosing a company whose management can accept the fact that benchmarking is not "industrial espionage" but "learning", management that will be ready for "merging powers" during the project with goal of mutual improvement in quality of business, management that will be able to solve conflict situations during the project and act openly, morally and be cooperative with management of the benchmarking partner.

4.1.3. Mutually gathering and transfer of information (transfer of knowledge)

Transfer of knowledge is considered to be the process of mutual **ex**change of information that are relevant for understanding and analysis of business processes that are the subject of benchmarking analysis between partners - companies. It usually is a longlasting and sistematic procedure that includes thematical meeting in which there will be presentation and discussion on the data which partner - company is being handled for analysis. Also, members of benchmarking team make visits to company - partner and gather relevant data of its work and functioning themselves.

4.1.4. Comparison and understanding of gathered information

Gathered informations need to be reduced to mutually comparable and measureable entities based on clear and upfront defined criteria. Gathered data are often reduced to theoretical and practical well accepted entities typical for transportation business, for example passenger kilometers, coefficient of technical regularity, coefficient of engagement, coefficient of daily engagement, line network lenght in kilometers, cash deposit amount by days in kunas, portion in achieved income depending on the type of passanger tickets (one-way, round-trip, subscription) etc.

4.1.5. Analysis of gathered information

The goal of analysis of gathered information is to determine differences in execution of business functions and processes that are the subject of the benchmarking project in one's own company, and in partner - company, to recognize how certain differences affect business results and change of mutually comparable natural or financial indicators, and to recognize the reasons that brought to spotted differences. Analysis is caried out very detailed in the way that in the end the benchmarking team identifies key indicators of characteristics of the business system (KBI) that will be the subject of changes based on obtained results of data analysis.

4.1.6. Implementation of necessary measures

The benchmarking project ends with creation of the benchmarking study or report in which project team conclusively gives proposition of measures that needs to be implemented to promote and improve functioning of analysed business processes. Measures do not include "copying" of exisiting solution that partner - company applies, but project team has to consider specificity of their own organizations and limitatons which these organizations impose.

Management then reviews proposed measures and makes resolution of their implementation, appoints persons that will supervise the changes and sets time frames in which implementations should end. Things that should be especially taken care of are costs of the changes and evaluation of expected benefits that the changes will bring.

4.2. Business processes that can be the subject of the benchmarking analysis in a bus transportation company

Business processes that can be analyzed in the benchmarking project in a bus transportation company can be divided by aspects of view, and therefore we differ technical, technological, organizational, economical and legal aspect.

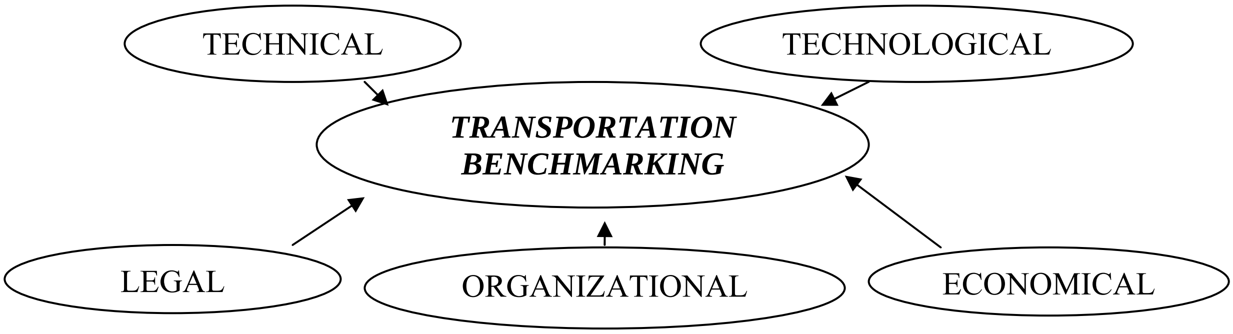

Figure 2 - Aspects of the benchmarking analysis in a bus transportation company

4.2.1. Technical aspect of benchmarking analysis

From the technical aspect we can analyze:

a) number of transportation units (buses) in execution and in reserve, as well as percentage in total number of transportation units that every of those groups have.

b) criteria of units distribution among work assignments depending on their technical and technological characteristics

c) criteria of determining parking places of units in case company has more than one garage

d) process of units maintenance in all technological phases (malfunction reports, workshop reference, admittance of units in workshop, ways of maintenance, control of finished work, delivery of units back to traffic, admittance of complaints and their handling)

e) process of preparing vehicle for exploitation in specific technological conditions (winter and summer exploitation as well as exploitation in periodical and alternate transport)

4.2.2. Technological aspect of the benchmarking analysis

From technological aspect we can analyze:

a) process of making timetables (criteria and ways of determining number of departures, traffic regulations and transport speed of moving vehicles during timetable realization)

b) process of making work assignments or decrees (determination of the time and the place of the rotations, measures and ways of zero and empty mileage reduction, measures and ways of rationalyzing essential number of drivers and units, forms and ways of making working assignments depending on the level of transportation demand)

c) process of making operative work schedule of drivers and units (criteria for obliging drivers with units, criteria for determining driver and unit for occasional transport, technology of making work schedule considering ways and days of execution, ways of assigning backup drivers, dealing with exceptional situations in traffic, communicating between traffic offices, management and drivers)

d) process of obligation, filling out and analysis of the **was !!!!!!** and accuracy of filling out transport documentation (travelling assignment notice, expense reports, tachograph data, work reports, safekeeping of documents)

e) process of charging traveling tickets and analysis of bus passengers flow (station network, technology of entering and exiting of passangers, solutions for charging tickets for passenger and luggage, delivery of collected cash, way and deadlines for making driver's cash reports, analysis of gathered data on financial business results)

4.2.3. Organizational aspect of benchmarking analysis

From organizational aspect we can analyze:

a) organizational scheme of the company (centralised or decentralised organization, structure of business functions and processes, internal connections within company, communication channels between members of management and administration)

b) distribution of authorities and responsibilites (lines of managing, centers of responsibility, communication chains between employees and superiors, delegation of authorities and reponsibilities on lower organizational levels)

c) organizational segmentation of traffic market (local, county, inter-county and international transportation or their combination regarding criteria of region coverage, teritorial segmentation of the market on business units, market segmantation regarding forms of transportation that is executing on line transportation and occasional transportation)

d) internal and external factors of the organization (stability of the organization, relation and communication with competent establishments and institutions, influence of social and political environment on organization, organization change analysis)

e) controlling inside the organzation (constitution of control function, jurisdiction of the control, methods of control, reporting executed controls to management, applied corrective and preventive meassures)

4.2.4. Legal aspect of benchmarking analysis

From legal aspect we can analyze:

a) internal regulations within transportation company (regulation on unit's staff, regulation on vehicle maintenance, regulation on transportation service, general transportation conditions, tariff regulation)

b) employment contract (contents of the contract, special regulations, employer and employee protection, categorization and grading of drivers and staff)

c) regulations on salary and awarding of employees (monitoring and grading of work, stimulative and discouraging measures, special rewards)

d) constitution and organization of employee education (internal and external training, plans and programs of education, selection of staff that performs education)

e) documentation of quality system (working instructions and procedures, goals of quality, regulations of quality management)

4.2.5. Economical aspect of benchmarking analysis

From economical aspect we can analyze:

a) tariff system (prices of transportation, tariff table, zone and relation system of freights, exclusions in execution of tariff tables)

b) process of line profitability (passanger flow analysis, analyzing and formatting of bussines incomes and expenses)

c) investment and financing policy (profit distribution, investment decisions, credits and leasing)

d) process of business expenses analysis (monitoring expenses rate by bus, formatting of expenses, determining rentability treshold of bus exploitation)

e) realization process of financial business function (computer business system analysis, method of keeping accounting documentation, income and business expense entering)

Specified areas of analysis from every segment of bus company business is chosen on relevance criteria and by possibility of getting a clear insight in partner - company business, with goal of easier comparsion and differences analysis between partner - company and analyzed company.

5. BENCHMARKING STUDY OR REPORT

Benchmarking project ends with creation of a benchmarking study (report). Study is made by independent consult company, with active participation of benchmarking team members. Essence of a benchmarking study is to state key process success indicators that can be easily measured and with which benchmarking partners are analyzed as well as progress of your own company. Benchmarking study making can be shown in the next flow chart.

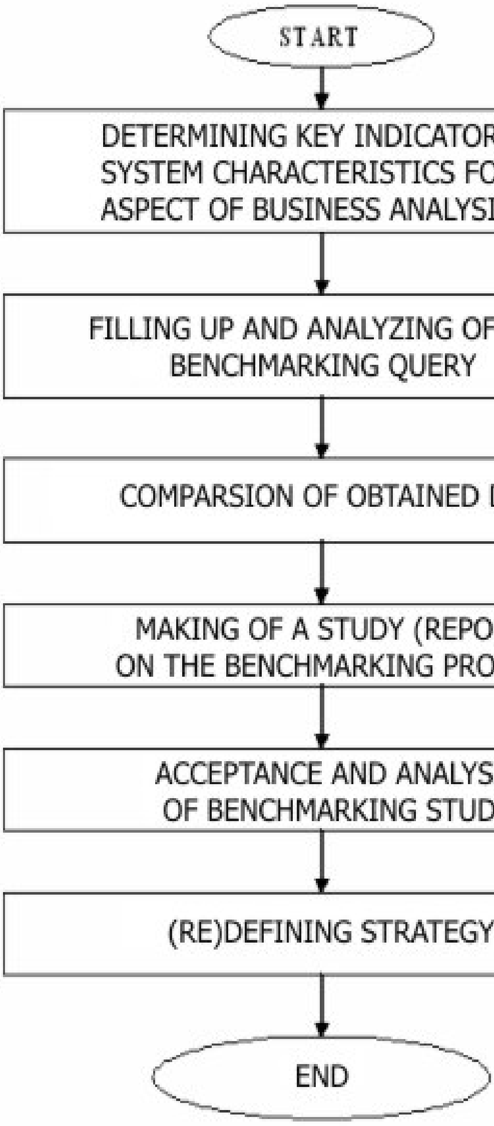

Figure 3 - Flow chart for making benchmarking study for public bus transportation company

Key indicators of system characteristics are proposed by traffic technologists based on their judgment and wishes about data they want to obtain and analyze. Indicators don't necessarily need to be mathematically measurable entities, but also textually described appearances and occurences in business system of transportation company. From every aspect of benchmarking analysis of transportation company (technical, technological, organizational, legal and economical) queries are being made with as much questions as possible (at least 50 from every part) which need to be answered precisely by both: analyzed company and in partner - company.

After the analysis of the obtained data, study (report) is being made, to which filled out queries are enclosed. Company management that carries out benchmarking project brings a decision on accepting benckmarking study (report). Based on study conclusions, strategy of further development is definied, with the goal of improvement and refinement of one’s own business results, done with benchmarking partner.

6. CONCLUSION

Methodology of benchmarking implementation in public bus transportation field of business described in this work is just one of possible models of implementation of this very popular and generally accepted managerial tool in transport profession.

Benefits of benchmarking can be numerous:

- meeting the reality - it is shown that we exaggerate in self-praise and self-sufficiency while real state of our organization is mostly worse than we think it is
- changes focusing is based on real facts
- defining of measurable business goals
- higer level of successfulness of internal initiative and projects of one's own human potentials
- work productivity improvement
- business competency improvement

This work will be useful to the management of bus transportation company "PRESEČKI GRUPA" d.o.o. to do the following in the future:

a) to define key indicators of the system characteristics for every of specified aspect of monitoring technological process of bus transportation

b) to make and fill up benchmarking queries in asocciation with chosen benchmarking partner and an independent consultant company

c) that based on filled up queries determines possibilites of improvement of their own business by the model of benchmarking partner they choose.

The presented model will be tested at least partially and in most important points in that way..

Authors of this work had an ambition to animate and motivate managements of bus transportation companies and consultant companies that work on benchmarking professionally on its wider implementation in road transport. It is also expected to encourage creativity of transpot technologists in defining key indicators of the system characteristics, that can be implemented in wider circle of transport companies dealing with bus transportation, as well as in transportation of goods in domestic and international road transport.

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POSSIBLE SOLUTIONS OF CONNECTING ZAGREB AIRPORT WITH THE CITY OF ZAGREB BY RAIL

ABSTRACT

Airport access can be realized by one or more transport modes. Depending on the number of passengers, accompanying persons, meeters, visitors and employees, apart from road transport, rail transport can also be realized. Zagreb Airport, the biggest airport in the Republic of Croatia is connected with Zagreb only by road D30 which is at the same time the only road connection between the city of Velika Gorica and the city of Zagreb. Road D30 represents one of the busiest roads in the Republic of Croatia. This paper presents the possible solutions of rail connections that would connect the city of Zagreb with the airport and the city of Velika Gorica. In this way not only the problem of connecting the city of Zagreb with the airport would be solved but also the connection with the city of Velika Gorica.

1. INTRODUCTION

Airport needs to be efficiently connected with the area it serves. Usually, the primary connection are roads that allow access to the airport by public transport and passenger cars, and in case of a larger number of passengers also by rail or some other modes of transport [1]. Apart from public transport the airport employees use also personal transport, depending on the parking possibilities provided for the employees. Some of them also use "carpooling".

Physical and urban development around the airport, such as Zagreb Airport, and the growing number of vehicles on the access roads towards the airport, increase the traffic congestion, reduce the reliability of connection with the airport and increase the degradation of the landscape. The precondition for further development of the airport in case of certain level of traffic, apart from the already existing road transport is the introduction of a rail connection.

In Europe, in case of the traffic level of some millions of passengers annually, rail connections are introduced for best possible service of the catchment area. The examples of different solutions of accessing the airport by using rail transport include:

- metro (Madrid, Stuttgart…)
- high-speed rail network (Frankfurt, Charles de Gaulle, Kopenhagen, Beč…)
- light urban rail (Washington/Baltimore, Bremen, San Francisco…)
- dedicated high-speed rail (Heathrow, Oslo, Stockholm, Hong Kong, Kuala Lumpur…)

2. CONNECTION PROBLEMS OF THE CITY OF ZAGREB AND THE AIRPORT

Zagreb Airport is connected with the catchment zone exclusively by a road connection, via state road D30 whose primary role is the connection of the City of Zagreb and Velika Gorica (Figure 1).

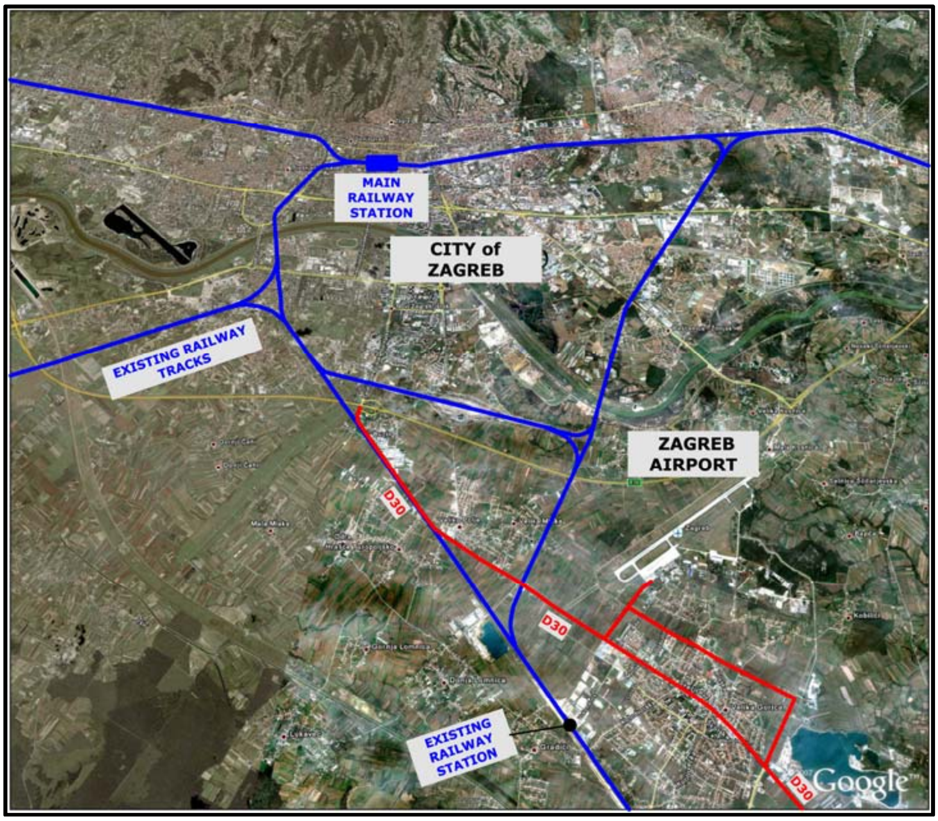

Figure 1 - Zagreb Airport location

This state road is one of the most heavily burdened roads in Croatia. According to the statistics of the Croatian Roads [2] the section between Zagreb and Velika Gorica is ranked third regarding traffic load according to AADT (Average Annual Daily Traffic) in 2010 (Table 1). Traffic congestions are especially pronounced during morning and afternoon peak periods (in the morning towards Zagreb and in the afternoon from Zagreb).

Table 1 - Seven most burdened highways in Croatia in 2010 according to AADT

ROAD NUMBER	POSITION OF TRAFFIC COUNT	AADT
D8	Stobreč	51,030
D8	Solin	42,904
D30	Velika Mlaka	39,413
A1	Lučko - south	30,357
A1	Zdenčina - south	30,311
A1	Jastrebarsko - south	28,238
A3	Ivanja Reka - east	26,544

Source: Hrvatske ceste d.o.o.

The railway line passes in immediate vicinity along the airport but there is no connection with it. From the very centre of the city of Zagreb (Main Railway Station) to Zagreb Airport the road distance is 14.5km and can be travelled on the average in 20 minutes in the off-peak hours. For the need of this paper the studies have been done on site in the duration of one week. Every day a vehicle travelled along the route from the centre of the city to Zagreb Airport and back during the morning and afternoon peak hours, i.e. in the morning between 07:30 – 08:30 and in the afternoon from 16:00 – 18:00. Apart from the peak hours, the measurements were performed every day in randomly selected time intervals that do not overlap with the peak intervals. During the peak hours the average travelling time took 38 minutes, or about 25km/h.

Pleso Transport, which provides line transport, operates shuttle buses regularly between Zagreb (bus station) and Zagreb Airport, offering a timetable adapted to the airlines schedule. There are daily 24-30 bus departures in both directions [3]. The departures take place every half hour, and if necessary even at shorter intervals. Apart from the mentioned regular departures transport is also organized upon demand and using special bus lines for regular flights of Croatia Airlines. Apart from the transport of passengers, accompanying persons, meeters and visitors, the employees of Zagreb Airport, Croatia Airlines, customs, police, air controllers, and others are carried as well.

Passengers can reach the airport also by taxi, passenger cars and rent-a-cars. Regarding taxis, only Radio Taxi Zagreb vehicles are allowed to wait at the reserved taxi stands located in front of the airport passenger terminal, since due to the complex competitive relations other taxi carriers have no right to use the stands in front of the passenger building. Therefore, other taxi carriers (Cameo Taxi, Oryx Taxi and Eco Taxi), as a rule, only take passengers to the airport, and possibly, if agreed in advance with the passengers take the passengers from the airport as well.

3. ANALYSIS OF PASSENGER TRANSPORT BETWEEN ZAGREB AND AIRPORT

Passengers between Zagreb and airport and vice-versa in a general sense are the arriving and departing passengers, accompanying persons, meeters, visitors, employees of the airport and of other activities at the airport and others.

Zagreb Airport realized in 2011 a turnaround of 2.3 million passengers [4] or on the average about 6,000 passengers per day. There was a turnaround of 15% transfer passengers so that there would be a bit fewer than 5,000 daily arriving and departing passengers or about 2,500 departing passengers and as many arriving ones.

The split mode of passenger transport to and from the airport is supposed to be as follows:

- 40% passenger cars,
- 40% bus,
- 20% taxi.

According to the data from Europe [1] it may be concluded that due to the high price of parking and the lack of parking places for the employees, about 30% of passengers, primarily those who use public transport or their own cars, would change to rail transport. This is about 1,500 departing and arriving passengers. A transport of about 500 accompanying persons, meeters and visitors is assumed, and they travel in both directions accounting for about 1,000 persons. It is also assumed that daily in each direction about 250 airport employees would change to rail transport, or a total of 500 employees.

In total this is about 3,000 potential users of rail transport daily in both directions, which is obviously an insufficient number to justify the investments into the rail infrastructure.

The current numbers of passengers at Zagreb Airport as well as in the near future, do not indicate economic justification for the construction of a rail connection. This is confirmed also by the statistics from the majority of the world and European airports which have shown that rail transport accounts for a relatively small share in the total transport of passengers; in the USA up to 10%, whereas in Europe this number ranges up to one third of passengers [1].

Zagreb Airport is located in the immediate vicinity of Velika Gorica. Several tens of thousands of passengers travel daily on Velika Gorica – Zagreb relation and back. The connection of the transport demands of Velika Gorica and Zagreb Airport towards Zagreb and back may justify the investments into the rail infrastructure.

4. ANALYSIS OF PASSENGER TRANSPORT BETWEEN VELIKA GORICA AND ZAGREB

The main traffic connection between Zagreb and Velika Gorica is the already mentioned state road D30 which is used daily by 39,413 vehicles. Considering that the average occupancy of vehicles travelling to Zagreb in 2010 was 1.35 passengers [5], one obtains a number of 53,207 passengers who commute daily along the state road D30 on the section between Zagreb and Velika Gorica.

Two ZET bus lines operate along state road D30, a regular and an express one. The regular line has 17 stops between the terminal in Velika Gorica and the Main Railway Station in Zagreb, and operates on the average every 10 minutes during the day. The express line has 4 stops between Velika Gorica and Zagreb, and it operates on workdays and on the average every 15 minutes, but only during morning hours (from 04:40 – 08:40h) and in the afternoon (from 12:00 – 16:40h). Both lines carry on workdays on the average about 22,000 passengers [6]. A detailed presentation of the carried passengers can be seen in Table 2.

Table 2 – Number of carried passengers between Zagreb and Velika Gorica (date of traffic count (2011-10-16)

BUS LINE 268 (ZG – VG)			
	Direction: ZG –VG	Direction: VG –ZG	TOTAL
Number of passengers	9,780	7,737	17,517
Number of departures	124	125	249
BUS LINE 330 (ZG – VG) Express connection			
	Direction: ZG –VG	Direction: VG –ZG	TOTAL
Number of passengers	2,423	1,961	4,384
Number of departures	64	51	115

Source: Zagrebački električni tramvaj d.o.o. (Zagreb Electric Tram Ltd.)

On the express line the percentage of passengers of the city of Velika Gorica amounts to 97.35%, whereas this amount on the regular line is 64.3%, which means that out of the total daily number of the carried passengers on both lines (21,901 passengers) the passengers of Velika Gorica account for 70.1% (15,528 passengers).

The citizens of Velika Gorica have also the possibility of using rail transport towards Zagreb. The section between Zagreb and Velika Gorica is the section of the Zagreb-Sisak-Novska railway line in the length of 15km. In each direction there are daily 16 trains, and the average travelling time is 20 minutes [7]. On this section the clock-face timetable is in force with trains departing every hour which is not satisfactory since this is a too long time interval for suburban rail transport. Neither is the location of the railway station in Velika Gorica satisfactory, since it is located at the periphery of the city, and there is no public connection to the centre of the city. The average daily number of passengers in each direction is about 4,300 passengers [8].

It may be assumed that about 1/3 of passengers would shift on workdays from personal transport to rail, which would be about 18,000 passengers, and about 2/3 of passengers, or about 10,000 passengers from Velika Gorica would change from public bus transport to rail transport on workdays. The total expected number of passengers from Velika Gorica to Zagreb and vice versa would be about 28,000 passengers on workdays. This is some ten times more than the traffic demand on the relation between the airport and Zagreb.

The total traffic demand in road traffic between the airport and Velika Gorica towards the city of Zagreb is about 31,000 passengers daily, or about some ten million passengers annually, which indicates a possible justification of the rail connection. Considering the exploitation of the rail system 18 hours a day, the hourly load would be almost 1,000 passengers per hour in every direction which justifies the frequency of departures of 20 minutes on the average, and even less during peak loads if necessary.

5. POSSIBLE SOLUTIONS OF RAIL CONNECTIONS OF ZAGREB WITH AIRPORT AND VELIKA GORICA

There are several different types of rail connections: metro, high-velocity rail, regional and national and light rail. The decision on connecting the metropolitan area and the airport by means of rail transport depends on several factors, particularly:

- on the annual number of airport passengers, number of meeters, accompanying persons and visitors;
- possibilities of connection to the already existing traffic infrastructure;
- on traffic demand;
- number of employees;
- available number of parking places;
- parking price, etc.

The transport demand of about 31,000 passengers daily in both directions, or some ten million annually indicate the need to construct a double-track line, especially if referring to the use of the existing Zagreb – Velika Gorica line, which is burdened also by other passenger and cargo trains.

5.1 Solution of extending the existing railway line Zagreb –Velika Gorica

The planned intervention would require the construction of an underground railway line from the railway station in Velika Gorica with two stops: centre of Velika Gorica (bus terminal) and the end stop below the new airport terminal. Because of the densely populated area around the existing railway line, the underground section of the new line would start in the immediate vicinity of the existing railway station in Velika Gorica. The advantages of this solution lie in the already existing rail infrastructure that should be extended with one more track to Velika Gorica, and the fact that the airport terminal is the start-terminal point of this line so that the passengers from the airport board empty coaches.

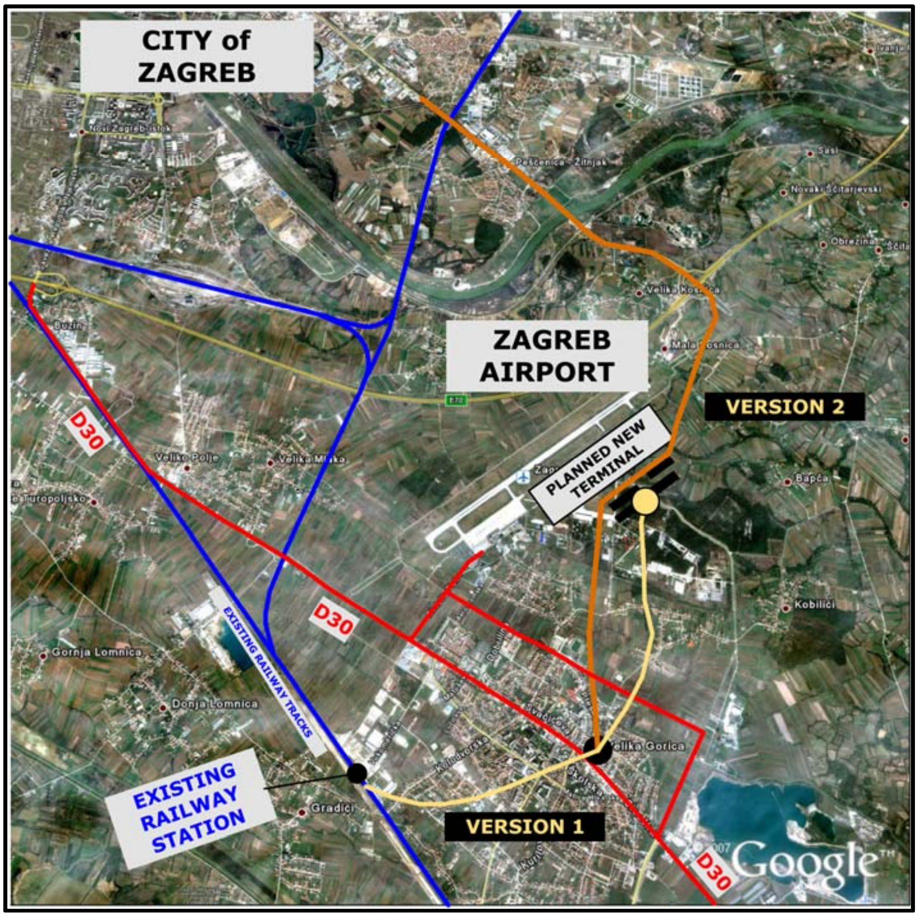

Figure 2 – Routes of the proposed solutions of railway lines

5.2 Solution via Domovinski most

The alternative solution would be the connection of Velika Gorica and Zagreb Airport by rail connection via Domovinski most (bridge). The drawbacks of this solution are the bridge dimensions planned for rail vehicles, but not of the classical train type but rather light urban rail or tram. This would mean a completely new system for the investor, both regarding infrastructure and regarding transport means, its maintenance, etc. In case of this connection the airport would not be the start-terminal station which is unfavourable for the air passengers who would board the already full trains since 90% of traffic demand is accounted for by the citizens of Velika Gorica who commute to Zagreb.

6. CONCLUSION

The analysis of the passenger transport indicates a potential of about 3,000 passengers in rail transport daily on Zagreb – Zagreb Airport relation. This traffic level is probably insufficient to justify the necessary investments into a rail connection of the airport and the city of Zagreb. Not even the expected increase in passengers in the following years is going to exceed the threshold of profitability of construction of a new or extension of the current rail system.

Taking into consideration the number of the citizens of Velika Gorica and the number of passengers commuting daily to Zagreb already indicates that the investment into additional rail infrastructure that could take over a part of road traffic demand at the level of about 31,000 passengers daily in both directions, would be probably cost-efficient. Considering the congestion of the only road that connects Velika Gorica and airport with the city, it is to be expected that about 1/3 of individual passengers and about 2/3 of public ones will use the alternative connection with the city, the rail connection.

Out of the two potential alternatives, the extension of the current railway line from the railway station Velika Gorica via city centre to the new passenger terminal, and the construction of a new route along the extended Radnička cesta (road) via Domovinski most (bridge), the preliminary analysis shows that the extension of the existing railway line, i.e. the former solution, is economically more acceptable.

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ANALYSIS OF THE TAXI SERVICE IN THE CITY OF ZAGREB

ABSTRACT

In the paper is presented data about the history of the taxi, and the procedure for obtaining taxi license in the City of Zagreb. Also, current taxi carriers in the City of Zagreb, and their basic characteristics were analyzed. Finally, a comparison of certain taxi carriers in order to test the quality of their services is done. Results of the research shows that taxi Cammeo is 20 percent cheaper than it's largest competitor Radio Taxi Zagreb. Idea of cheaper and more accessible taxi transport in Zagreb has just begun.

Key Words: *taxi service, City of Zagreb, taxi carriers, quality of service, prices of services*

1. INTRODUCTION

Taxi transport has an important role as alternative transportation in many cities. Although it is often defined as a module of semi public transportation, taxi service is in fact the first form of public transportation in small towns when the distance between the origin and destination has become too large to be traveled on non-motorized way. However, the demand for taxi services is very heterogeneous and varies in developed countries and developing countries. In developed countries, taxi tends to be used as a substitute for passenger vehicles by users who use this service for practical reasons or because they do not want to own their own car. In countries that are developing taxi service is often used as a supplement to inadequate public transport system based on buses or trains [1].

The aim of paper is to analyze the situation in the taxi market in the City of Zagreb, and to check the quality of service for some taxi carriers. For this purpose analysis of the four largest carriers taxi is made: Radio Taxi Zagreb, Cammeo Group, Oryx Group and Eco Taxi Group.

The first taxi car in Zagreb appears on the Ban Jelacic square 11 June 1901. After the premiere of the Buick automobile, cabman Tadija Bartolović ordered the car from the factory Nesseldorf in Baden near Vienna and introduced the first car taxis in Zagreb. His car had a 6 hp engine, was 950 pounds heavy, and there was a 4600 crown. In test drives, except members of the committee, attended the city mayor A. Mosinski. The car was forced to ride in the upper town to see if he can climb the hill. As a trial run failed, Bartolović opened position of the first coach car on Ban Jelacic Square. The fare was the same as the coach. Of course, people immediately flocked to the first car a taxi to the city transported out of curiosity [2].

2. THE PROCESS OF OBTAINING A TAXI LICENSE IN THE ZAGREB

Taxi transportation license is act which approves performing taxi transport and is issued by the city governing body in charge of traffic in accordance with the provisions of the law governing road transport services. License for taxi transportation in Zagreb issued by the Department for public road transport and the City Department of Planning, City building, construction, utilities and traffic.

If the carrier does not meet the requirement of professional competence, or if no employee who is eligible, he must take an examination of professional competence that is organized and conducted by the Croatian Chamber of Economy and the Croatian Chamber of Trades and Crafts. To obtain a taxi license operator must submit a "Request for a taxi license." After the taxi drivers got licenses necessary to perform taxi transport it is also necessary to obtain permission. Permission is act for each vehicle issued by the city governing body in charge of traffic, based on which to conduct taxi transportation in the area is the City of Zagreb. The permit is issued by the Department for public and road transport on request.

Addition to the requirements of taxi drivers to be accompanied by documentation which shows that fulfills the following conditions:

1. Established or resident in the City of Zagreb
2. Has owned or leased vehicle that meets the requirements prescribed by special regulations governing public transport and road transport on own account
3. It has passed the exam, and has employed a driver who gained the knowledge of basic information on cultural, economic, tourist, transport and other important buildings and landmarks of the City of Zagreb

The applicant is also required to submit with the application and price taxi transportation services that will apply after the issuance of permits [3].

3. ANALYSIS OF ZAGREB TAXI CARRIERS

3.1. Radio Taxi Zagreb

Radio Taxi Zagreb is an association of taxi drivers in Zagreb. It is a professional business organization of craftsmen engaged in taxi transport of passengers in public transport in Zagreb, which promotes, coordinates and represents the common interests of the affiliated members. The Association is affiliated in Zagreb Chamber of Trades and Crafts and it currently has 1030 taxi drivers [2].

Association of car taxi carriers in Zagreb was founded in year of 1924. Call center opened 1977 become operational with 160 vehicles involved in the radio network. After more than thirty years of call center, 2005 opened a new, fully computerized and is one of the most advanced radio-taxi centers in Europe, in which are today included all 1030 vehicles. The new center provide exceptional speed and their acceptance of a call divert to the nearest taxi.

By 2011 the only authorized concessionaire was Radio Taxi Zagreb - an association of taxi drivers in Zagreb. Driving with a taxi was very expensive and those who could afford it were rare. Radio Taxi Zagreb had charged for decades, of course, with the approval of the relevant municipal institutions, an astronomical figure for a few kilometers of city driving. It is certain that the taxi drivers used to the maximum the current situation, which was secured by the city government: there was not the competition because it was discouraged by that same government, taxi drivers formed prices without any real control.

Arrival of competition, especially Cammeo, caused great discontent among drivers Radio Taxi Zagreb, and because of conflicts within organizations some members began to leave. Then the speculation began about the change in the administration and it was achieved. The new president, besides introducing new prices announced and the fight against excessive fees payment service of its members, the introduction of receipt printers and various technical changes to modernize the center and the Radio Call-center, and a new code of conduct, dress and business taxi driver. This initiative was announced to the market's cheapest taxis in Zagreb. It took more than half a year to the Association of Taxi Drivers, after unsuccessful strikes, blockades and threats, someone reacted the right way - by lowering prices.

Despite the price reductions of as much as 40 percent, the abolition of special tariffs for the holidays, night driving, additional baggage charges and the introduction of billing passengers, taxi drivers certainly did not solve all the problems, and can"t be sure that they get rid of competition, which by their negligence and indifference allowed to harden. Today, the number of competitors radio taxi rose to more than one and in fact raises the question whether the taxi driver are a bit late to attract passengers in their vehicles and restore confidence in their services. To this should be added and for years kept a negative image of taxi drivers in the public as expensive, not friendly and lazy people. But the question is how many taxi driver would stay in Zagreb taxi market the way it is now, after years many of them did not even need to renew the fleet, sure to be occasional traveler to once a day "put a drop" [4].

In fact, the case of Zagreb taxi drivers is a classic example of how the free market, when demand dictated exclusively sell and offer price, the emergence of competition must respond immediately, without hesitation, and calculations, because all the other results in the loss of a job.. And finally, that someone in the taxi association ten years ago, thinking about the future, when it was clear that the market will be liberalized and that their monopoly has a shelf life, and then began to invest in the business from which they live, this situation would not have occurred [4].

Radio Taxi Zagreb has a new tariff, and the wholesale price cuts forced by the competition. Start Radio Taxi Zagreb will amount to 9,90 HRK 4,90 to HRK kilometer ride. The drastically lower cost Radio Taxi Zagreb decided after the arrival of a taxi cab Cammeo and Oryx. The new price list is effective from 1 December 2011. Radio Taxi Zagreb lowering prices by as much as 40 percent to become the cheapest taxis in Zagreb. However, there is only one problem - they can guarantee a lower price just in case you are ordering a taxi through the call center [2].

Table 1 - Old Radio prices of Taxi service

SERVICES	DAILY RIDE	NIGHT DRIVING
Start	16,00 HRK	19,20 HRK
kilometer ride	6,00 HRK	7,20 HRK
hour waiting	43,00 HRK	51,60 HRK
luggage	2,50 HRK	2,50 HRK

Table 2 - New pricelist of Radio Taxi Service

SERVICES	PRICE
Start	9,90 HRK
kilometer ride	4,90 HRK
hour waiting	40,00 HRK

Nighttime driving is lifted, and a special collection of holidays. Accordingly, this bargain is valid from 00-24h, 365 days a year. Citizens can order them through the numbers 060-800-800 and 060-800-801, cheaper, and the number 1777 and the Internet, or simply enter the first vehicle stops. Zagreb Radio Taxi uses a 105 TAXI stop on the narrow and wider metropolitan area including Velika Gorica, Zaprešić and Sesvete [2].

3.2 Analysis of Cammeo Group

After many years of monopoly of the Association of Radio Taxi Zagreb, since of 22 April 2011 citizens may choose with which taxi carrier they want to drive . Radio Taxi cab drivers is competition newcomers company Cammeo Zagreb, which is the lower prices of their taxi services already won in Rijeka and Osijek. In this way a taxi in the city of Zagreb will be the richer for new vehicles and should improve to a greater degree of public service, auto transportation. Cammeo Zagreb offers 76 vehicles Škoda Octavia 1.9 TDI, of which 60% of sedan, wagon and 40% for larger cargo space. All vehicles are equipped with the latest satellite navigation system that allows drivers to easily navigate to any part of the city, while giving dispatchers the ability of rapid and reliable monitoring and provision of vehicles. There are several ways of ordering taxis in Zagreb: the first reference to phone number 1212 in Zagreb, get the operator, and every time will be able to leave order on the answering machine or sending a text message, e-mail or through smart applications with iPhone. Starting price is 15 kuna which includes the first two kilometers of driving. Each next after that will cost 5 kuna. No more night tariffs, but this one takes 24 hours. Another novelty is the possibility of payment card. Besides the comfort of the passengers also offers wireless internet, and if necessary, and child seats. If the traveler will be satisfied with a driver, a service can advertise during the ride and not pay it. Unlike the Radio Taxi Association, their competition and long-term monopoly of the metropolis, Cammeo will not have their own taxi stand. Only they will be invoked by the dispatcher at the number 1212 or stopping on the road, if the vehicle is empty. Contrary to the announcements, Cammeo not "collect" the citizens on the road and allow them to ride when the vehicle is already a party. Cammeo taxi drivers will be recognized by a specific way of dressing. Specifically, at the week drivers will be dressed in black suits, and on weekends will have vests [5].

Despite the attempts of other taxi associations to become more competitive than taxi Cammeo, they remain the cheapest. With the start of 15 kuna, which includes the first two kilometers of driving, which in practice the starting tariff lowered to 5 Kuna, what is the amount that users pay for each additional kilometer run, and remains the leading position of the best taxi service in Zagreb [5].

Table 3 - Prices of services of Cammeo

SERVICES	PRICE
Start-includes first 2 km	15,00 HRK
kilometer ride	5,00 HRK
hour waiting	40,00 HRK

To be able to meet the huge demand, and also create a profitable way to expand into new markets, Taxi Cammeo introduced a new franchise business - Taxi Cab. Taxi drivers who sign a contract with them on co-operation will be able to use the services of Cammeo"s call center, gas station and car wash, and will visually resemble Cammeo taxis with the exception of the large "Taxi Cab" stickers. The whole thing works so Cammeo taxi drivers pay a fixed monthly rent, while all other profits go directly into their pocket. This franchise their services will soon be offered in other Croatian cities. It is important to note that the taxi cab ride at the same price as taxi Cammeo. The agreement with Cammeo for "Taxi Cab" has been signed by only five taxi craftsmen, including the Radio Taxi Zagreb. The agreement between the formerly opposing sides taxi was finally reached. Specifically, signed a cooperation agreement according to which individual drivers are able to use the radio taxi dispatching center and the streets will come out called "Taxi Cab". As is already said, the taxi cab franchise business, through which local craftsmen will have the opportunity to recover their business, improve profits, but to be branded as a taxi Cammeo. So they decided to move because it is impossible to meet the needs of the Zagreb market with only 76 cars, and they need to ensure smooth operation of "reinforcement". Do not be surprised if we came to call their taxi cab vehicle [6].

3.3 Analysis of Oryx Group

After Radio Taxi and Taxi Cammeo in Zagreb began operating Oryx taxi. Oryx Taxi is an integral part of Oryx Group, which is to conquer the market of Zagreb began a taxi service with a total of 120 brand new vehicles of the Volkswagen and Audi, with the largest share of the total of 100 vehicles has a model of the Volkswagen Passat. To make the vehicle at all times be available to users, employing a total of 300 new employees. In addition to brand new fleet, Oryx Taxi boasts many innovations of which the most outstanding brand new models of payment that would use a taxi service should bring a wider audience than the former. In addition to cash and credit cards, driving service can pay for unique Oryx Taxi vouchers and cards, which as a major advantage for its customers carry convenience, availability and additional savings on our already affordable prices. In addition, the service, except the standard way by phone 1888, can be ordered online through the website and for the first time in Croatia through its own Oryx Taxi applications for smart phones, which is completely free for users. A certain number of vehicles is equipped with special equipment like child seats and compartments for big pets. For the first time and people in wheelchairs will be able to use a taxi in Zagreb for four vehicles equipped with special hydraulic ramps. To comfort and safety of the passengers were at the highest possible level, all drivers have undergone training and pass safe driving, and driving cost-effective training in specific communication training [7].

Oryx is currently the most expensive of all the taxi service taxi service in Zagreb. So you will start to allocate 14 HRK for each kilometer 4.8 HRK If you decide to use a special compartment for pets that will cost you an additional 10 kuna regardless of the length of the ride. Other services such as baggage transfer, use of child seats or transporting persons in wheelchairs can not be charged extra. It is also important to emphasize that these prices do not increase at night, Sundays and holidays [7].

Table 4 - Prices of services of Oryx

SERVICES	PRICE
Start	14,00 HRK
Kilometer ride	4,80 HRK
hour waiting	41,00 HRK
transport of animals	10,00 HRK
luggage	0,00 HRK
Addition / child seats	0,00 HRK

3.4 Analysis of Eco Taxi Group

On the Zagreb roads began to drive green cars, white limousines with effective Eco Taxi label. This is a new service by which Zagreb joined the top of European clean and quiet transportation service that is particularly popular on the streets of the United States, Canada and Australia. The fleet currently has 30 vehicles, but the plan is to expand the fleet to 100 Eco-driving. Taxi fleet mostly consists of the Toyota Prius, equipped with a hybrid system that combined electric and petrol engines that emit 50% less CO2 than other cars. Driving a hybrid vehicle at low speeds, Eco Taxi contributes to a healthier lifestyle with less pollution and less smog, and protecting the citizens of Zagreb and of the large and often neglected pollutants, noise.

Console built into the car informes driver all the time of how many fuel was spent and encourage economical driving. In fact, up to 50 km/h is used exclusively by energy from the batteries located under the last bench. And they are full while driving or braking, and fuel consumption in the bustle does not exceed five liters per 100 kilometers. Namely, since the engine while standing and moderate drive draws power from the battery, the sounds of combustion of fuel in the engine are a thing of the past, which surprised and passersby. By the end of the year the plan is to "wear" a complete fleet of Toyota hybrids, which would become the single provider of such services in the world [8].

With many providers of taxi services, Eco Taxi stands out for its superior dispatcher technology that enables high-quality coverage of Zagreb, and attendance at the required location within 3 min to a maximum of 15 minutes. By calling the number 1414 060 or 77 77 dispatcher occurs immediately, please find a vehicle to a maximum of 30 seconds, and the call is charged at the marginal rate of value-added numbers. Staff of Eco-Taxi is providing a service to its passengers sightseeing and excursions accompanied by professional guides and leadership, and conversation in different languages. Drivers are not uniform but were casually dressed. In line with the brand dominates the blue color, the color of Zagreb, and green, which refers to the protection of the environment. Also, the entire fleet will be renewed every two years [8].

Initially, the price was 14 kuna for the start and 5,8 kuna for kilometer. But after three months, Eco Taxi surveys to customer needs has decided to make taxi services more accessible to citizens of Zagreb with a 30% lower prices than the previous. Thus, of 16 January 2011 the new price list takes effect from 8.80 kuna to start and 5.00 per one kilometer. Price is still 40 kuna for waiting per hour. Luggage is not charged, and the ride outside the city of Zagreb, as well as transport of goods (eg refrigerator, TV, etc.) shall be paid according to pre-agreed price. This Eco Taxi become the most ecologically and economically taxi driver in the city of Zagreb. According to some calculations, Eco Taxi with the new prices on the most popular routes to be cheaper 10 kilometers from Zagreb Radio Taxi's and Oryx. From Eco-Taxi is now cheaper just Cammeo, in which as is already mentioned take for the start 15 kuna, but it includes two free kilometers, and each kilometer of driving is 5 kn.

But the Eco Taxi says that does not expect profits overnight because prices Cammeo for this company, will be unattainable. Specifically, their main advantage is the car and the only provider of such services in Croatia. There are taxi drivers used hybrid vehicles, but the whole fleet is comprised of such cars. The project was launched a year ago because the expected liberalization of the market. Their goal was to be different from others and to offer this city amenities and quality. The Eco-Taxi service vehicles can pay all credit and debit cards, and developing a loyalty program that will allow clients Eco Taxi ride even better. Thus, for example, retired people and students to achieve special discounts to make them even closer to taxi services.

Table 5 - Prices of services

SERVICES	PRICE
Start	8,80 HRK
kilometer ride	5,00 HRK
hour waiting	40,00 HRK

4. CHECKING THE QUALITY OF SERVICE

After many years of monopoly of the Association of Radio Taxi Zagreb, citizens can finally choose with which taxi carrier they want to drive. To check the quality of services of two biggest competitor were tested - "natives" from the Association of Radio Taxi and Taxi Cammeo which is still elusive in their prices. Taxis are tested between street 5th Požarinje, Gornji Bukovac to the terminal in Dubrava. Taxi drivers were invited at 3:00 pm from 5th Street Požarinje. Immediately after the call in the call center of Zagreb Radio Taxi, operators contacted and told to get a taxi for 5 min, and so it was. Taxi driver was not wearing a uniform or not wearing clothes that had the characteristics of the company. The driver is not out of the car and offered to open the door, but was neat and polite. At 3:10 pm has already arrived in Dubrava. On the streets, because it was Sunday there were no crowds. Taximeter showed 3,48 km, and the price of 26,93 HRK. The service is paid in cash and the driver was issued account at the request.

During this time, line of Cammeo call center was busy. After some time, contacted the operator and said that a taxi is coming for 8 minutes. Taxi was late for five minutes. At 3:17 pm he arrived at 5 Požarinje. Unlike Taxi Radio driver, taxi driver Cammeo is out of the car, was wearing a uniform (wearing a suit and tie) with the characteristics of firm Cammeo and apologize for having arrived late. At the Dubrava he arrived at 3:22 pm. Taximeter also showed 3,48 km, and the price of 22,38 HRK. The service is paid in cash, and the driver was issued the account.

When we compare the costs of transportation on the characteristic routes (Table 6.) we come to the conclusion that Cammeo is the cheapest taxi operator.

Table 6 - Prices on the characteristic routes in Zagreb

Route (km)	Cammeo (HRK)	Oryx taxi (HRK)	Eko taxi (HRK)	Radio Taxi Zagreb (old) (HRK)	Radio Taxi Zagreb - new price (HRK)
Avenue Mall - Ban Jelacic Square (6,4 km)	37	44,72	40,80	54	41,26
Ban Jelacic Square - Jarun (6,7 km)	38,5	46,16	42,3	67	42,76
Dugave - Lang Square (6,4 km)	37	44,72	40,8	54	41,26
Pool Utrine - Trešnjevka lot (6,0 km)	35	42,8	38,8	52	39,3
Maksimir Stadium - Ban Jelacic Square (3,2 km)	21	29,63	24,8	35	25,58
Dubec Terminal - Terminal Črnomerec (13,2 km)	71	77,76	74,8	95	75,58
Lisinski - Tomislav Square in Samobor (23,9 km)	124,5	128,72	128,3	160	127
Shopping Center Arena - terminal Dubrava (13 km)	70	76,4	73,8	94	73,6
Esplanade Hotel - Airport Pleso (16 km)	85	90,8	88,8	112	88,3

Source: processed by the author [9]

5. CONCLUSION

Price of transportation is one of the determining factors when deciding on the use of taxis. It generally consists of a starting price, cost per distance traveled and the cost of waiting, last one service is rarely used. Until recently, one of the reasons for high prices in Zagreb was the lack of competition, there was only one taxi operator, as in most cities, there are three or more companies engaged in a taxi. With the arrival of the first competition, taxi Cammeo, in April 2011 began the liberalization of taxi markets in Zagreb. After him followed a row of taxis Oryx Group and the Eco taxis. Recently, the carriers lowered prices of their services frequently to be in advantage over competitors.

As we conclude from the conducted research, Cammeo is 20 percent cheaper than it's largest competitor Radio Taxi Zagreb, and the Oryx, which is the most expensive on the market, even up to 30 percent. Immediately behind the cab is positioned Cammeo. Eco taxi in which the maximum difference in price compared to Cammeo not exceed more than 3,8 kn. Although taxi operators compete in a lower price, in order to attract the growing number of travelers, they are not always the decisive factor in how to decide which carrier. This is illustrated in taxis Cammeo that every day thousands of recorded calls of citizens who wish to drive, but due to small number of vehicles that carrier, in the end, however, must decide for the competition. On the other hand, those who are environmentally conscious, they will probably opt for the eco fees regardless of the price and availability of services. We can conclude that the idea of cheaper and more accessible taxi transport at the end has not been realized as planned, and the competition for cheaper taxis, which would among other things, reduce the traffic jams in the city center, has just begun.

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RIVER INFORMATION SERVICES IN THE CROATIAN INLAND WATERWAY TRAFFIC SYSTEM

ABSTRACT

RIS - River Information Services represent a concept of information services covering a wide range which has been developed in the majority of European countries to support the traffic management on the inland waterways. Among other European countries, the Republic of Croatia signed in 2001 the Declaration thus accepting the obligation to develop and implement the River Information Services in the inland waterway system. The CRORIS project (Croatian River Information Services) was started in 2003 and the first RIS Centre in Croatia was opened in Vukovar in 2006.

The Republic of Croatia has completely covered the Danube River waterway and the commercial waterway of the Drava River by AIS signal, and the prototype installation has been developed on the Sava river. The guidelines for the further development and implementation of the River Information Services into the Croatian inland waterway traffic system has taken into consideration the possibilities of supervision and control of the river navigation, as well as the influence of the system on the improvement in the navigation safety and on reducing the probability of accidents in the observed traffic area on inland waterways.

European Commission adopted a proposal for the next Multi-Annual financial framework for the period 2014-2020: "A Budget for Europe 2020" that proposed the creation of a new integrated instrument for investing in EU infrastructure priorities in Transport, Energy and Telecommunications: the "Connecting Europe Facility" (CEF) whose aim is to streamline and facilitate EU support to infrastructures. Further implementation and development of the RIS into the Croatian IWT system should be at least in some parts financed or co – financed by CEF because it is a part of the one of the core multimodal corridors - 10. Strasbourg – Danube Corridor.

Key words: *River Information Services (RIS), inland waterway traffic (IWT), European Union, "Connecting Europe Facility" (CEF)*

1. INTRODUCTION

Traffic on inland waterways has been recognized by the European Union administration bodies as an economical, safe and environmentally friendly transport mode, and at the same time an important link in the European intermodal traffic system. According to the NAIADES Action Plan for the promotion of traffic on inland waterways issued by the European Commission in 2006, in this transport mode the share of external costs amounts to €10 per

1,000 ton-kilometres, compared to €35 of external costs in road transport and €15 of external costs in rail transport with the same number of ton-kilometres [1,2].

The River Information Services (RIS) represent a concept of harmonized information services to support the traffic management and goods transport on inland waterways as well as an interface with other transport modes[1]. Because of the benefits provided by RIS, this concept in different extents has been developed in the majority of European countries, including the Republic of Croatia.

Regarding their equipment level, scope and quality of logistic services and the existence of intermodal interfaces the river ports affect also to a great extent the possibility of integrating transport on inland waterways into the intermodal transport. An assumption for optimal usage of port capacities lies in the level of providing and exchanging information with an important role played precisely by RIS, which makes it possible to avoid many errors and to maximally use the provided possibilities. It is therefore necessary to realize the interoperability of its applications, which is difficult due to the fact that for the moment there are different standards – those accepted by PIANC and by CCNR. The acceptance of a unique concept is still to be realized and the foundations for this exist in the European White Paper for transport, revised guidelines of TEN –T program, and finally in the RIS Directives.

The Republic of Croatia, along with the European states, signed in 2001 the Declaration accepting the obligation to develop and implement the River Information Services in the inland waterways by the year 2005. The CRORIS (Croatian River Information Services) Project was started in 2003 when the Ministry of the Sea, Tourism, Transportation and Development signed an Agreement on the development of the information services system in inland waterways with Centar za razvoj unutarnje plovidbe d.o.o. (CRUP d.o.o. - Centre for Inland Waterway Development).

The IRIS Master Plan[2] Study of the consortium from Austria and the Netherlands completed in 2005 planned, after the establishment of the River Information Services at the level of Europe, a requirement for the exchange of the following data from the RIS Centre of different countries:

1. tactical and strategic information (AIS);
2. information on cargo and travelling (Electronic international reporting);
3. information on vessel certification (Hull data).

Meanwhile, there have been two projects, IRIS Europe I that involved eight Europe countries in the pilot project of RIS implementation (finished in 2008), and IRIS Europe II (from January 2009 to December 2011) dedicated to further RIS development in the area where it is in use. They both have been co-financed by TEN-T (Trans European Networks).

In February 2012 ended the Project RISING whose main goal was to improve the integration of European inland waterway transport into intermodal chains with the help of RIS services.

2. RIS SEGMENTS, KEY TECHNOLOGIES AND SERVICES

Apart from contributing to the inland waterway navigation modernisation, RIS accelerates administrative processes, makes inland waterway navigation safer and more reliable, integrates river transport in intermodal supply chains, and contributes to shifting cargo to environmentally friendly river transport.

The basic concept of RIS are the information about the vessel and the information about the waterway, obtained by the application of advanced information and communication technology, using automatic identification receivers. The vessel is equipped by the so-called AIS (Automatic Identification System) receiver used to collect and emit information on the vessel, whereas the base stations are located on the mainland and they receive information and send them directly to the RIS system. Information on the waterway are contained in the form of Electronic Navigation Charts (ENC) and Notice to Skippers (NtS) thus making the current traffic condition and nautical data available in real time. All the information are saved automatically into the central database, where they are available at any time to the users of administrative (government and local administration bodies) and commercial (participants in the transport process) levels.

- Segment Ship, where ships communicate between each other (change of position and other important data) using the Tracking&Tracing system (e.g. AIS = Automatic Identification System).
- Segment Coast, with stations on the coast sending data towards and from the segment Operator (e.g. via ISDN).
- Segment Operator, where RIS services are managed by the operators; data are saved, processed and available for authorized users.
- External Segment, where RIS users (state officers and commercial users) are connected with the RIS system with the intention of obtaining necessary information.

Those segments provide the platform for all RIS key services and technologies designed for IWT safety, efficiency and effectiveness enhancement. As it is shown in Figure 1, the Key technologies are Inland ECDIS, Electronic Reporting, Vessel Tracking and Tracing (Inland AIS) and Notice to Skippers. Notice to Skippers (NtS) can be sent by authorities to users (vessels, other authorities, RIS centers) containing information on current fairway situation or warning on potential technical barriers to navigation.

RIS references data, Hull data and RIS index are supplemental key elements in the RIS standards that represent the link between various RIS services.

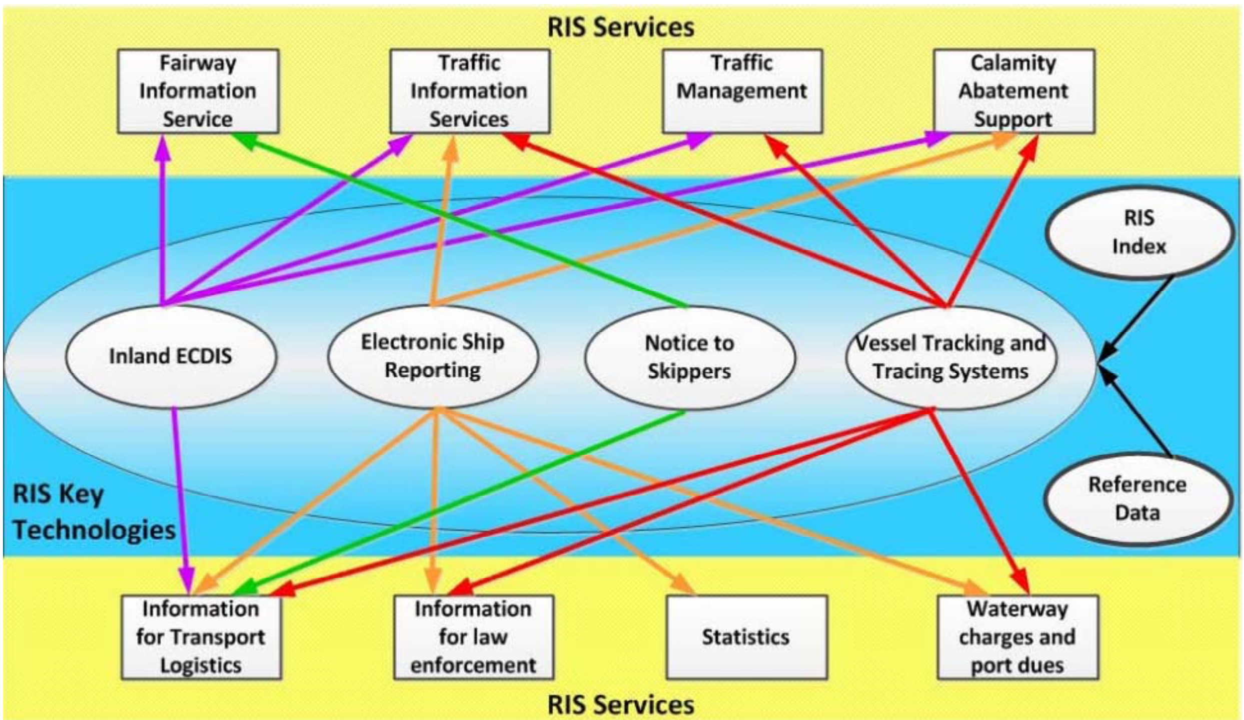


Figure 1 - RIS Key technologies and services

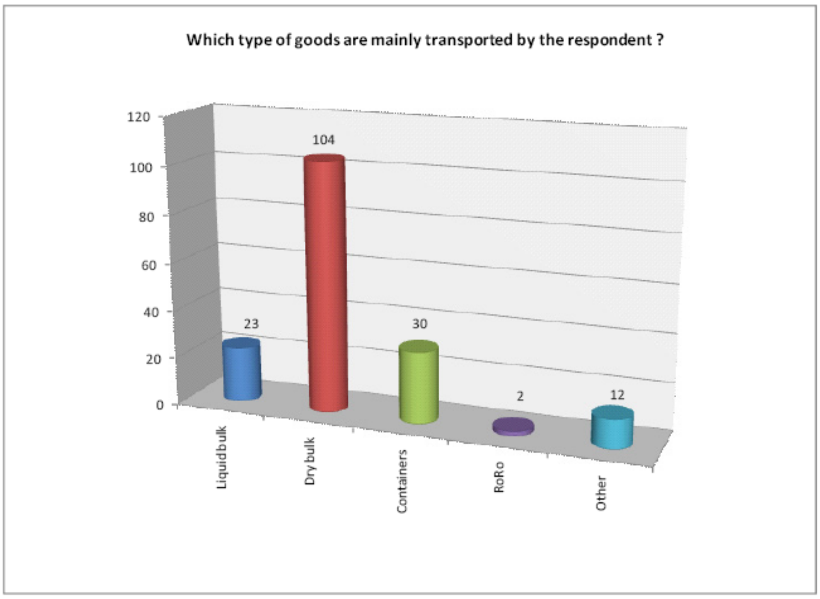
Source: PIANC RIS working group - Willems, C.: PIANC RIS Guidelines 2011, Edition 3, Smart Rivers Conference, September 21, 2011, New Orleans

2.1. AIS – Automatic Identification System

Automatic Identification System (AIS) is one of the first main applications in the frame of the so-called RIS Directive which will have far-fetching consequences and provide advantages for the logistic service providers on the mainland. AIS uses dynamic digital radio-transmission which is used on the ships using time-multiple methods and continuous information about the ship position (static traffic data) and messages in case of danger (radio transmission) within regular intervals (every two seconds). Automatic identification has been applied as a system in tracking cargo when entering the port or leaving the port. Integration with the electronic data exchange system results in reduction of errors, improvement of handling, reduction in delays in the port and in front of the port as well as in increasing the cargo throughput capacity in ports, landing places, and terminals.

Tracking and tracing of vessels is a service that present permanent monitoring of vessels which carry an active AIS transponder that automatically identify, locate and track other vessels that are also equipped with an AIS transponder. This service provide statistical information (name of the vessel, its length and width), dynamical information (location, speed, route and direction of the vessel, navigation status) and travelling information (length and width of the composition, draught of the vessel, dangerous cargo on board, time of arrival, destination, crew number) [9].

The usage of AIS system is currently obligatory only on the Austrian section of the Danube River. The Central Commission for the Navigation on the Rhine (CCNR) has not yet introduced the obligation of using AIS, but they issued a protocol with standards for AIS devices. The results of a research carried out at the beginning of 2010 in Flanders by the Flemish office for inland navigation promotion (PBV) show that out of 13% of ship operators that use AIS, 94% of them believe that it contributes to better traffic management, and all of them claimed that AIS makes the traffic system safer. Among those 87% ship operators without AIS, 74% consider purchasing it, probably because they are completely convinced that it is of greatest benefit to the skippers, and in a great percentage to the bodies of waterway administration. Although among the surveyed ship operators there are mainly those who prevailingly transport dry bulk cargo, AIS systems are mostly used by the ship operators who transport container cargo [4].



Graph 1 - Share of type of cargo among surveyed ship operators
Source: AIS Survey 2010, Promotie Binnenvaart Vlaanderen, Hasselt, 2010

2.2. Electronic Navigation Charts (ENC)

Electronic Navigation Charts – ENC, contain information about the depth of the waterways in narrow and shallow rivers based on the data for standard water level, as well as current level, which serves for optimal usage of ships on waterways. Inland ECDIS is used in two ways, for navigation and information, with or without information on traffic using radar or AIS system for supervision.

The Electronic Information Charts System for inland navigation is also an important element of navigation safety. Inland ECDIS facilitates search and rescue since, for instance, it contains real-time data, as well as information of warning, alarming, weather reports and similar. The system provides essential assistance in search and rescue activities [5].

Figure 2 - Sample of Electronic Navigation Chart in accordance with the Inland ECDIS standard installed on a computer

2.3. Electronic international reporting

Modern requirements of the traffic users on inland waterways have resulted in the need to develop parallel logistic system that would rely on AIS, but at the same time it could function also in the countries that currently do not have available the AIS system. A team of experts, including experts from Croatia, brought in 2006 an information exchange standard called ERI (Electronic Reporting International).

The standard is based on a detailed study of customs, police and logistic procedures and enables sending of digital notification message for each vessel. The message would be sent from the port of origin, and via provider's network in certain countries automatically forwarded to the national provider in the destination country and from there distributed to potential users, police, customs, ports, port authorities, port offices and forwarding agents. The ERI implementation in practice would enable high acceleration of procedures in the transport of goods and people. As part of the project a user's interface has been developed, central database with authorised access, depending on the users' rights, and the system for traffic tracking on international network that would be responsible for automatic forwarding and receiving of messages for individual vessels.

The National RIS Centre (further in the text: NCC) should take over the role of administrator so that it insures staff capacities itself or signs a contract with an authorized company to subcontract these services. Therefore, NCC or the subcontractor would be in charge of entering the new users and for the management of users. Apart from the Regional RIS Centre (RCC), the users would, naturally, be all ship operators located at the given moment on the territory of the Republic of Croatia, as well as the Croatian ship operators on the territory of other countries with which the protocol of international electronic reporting has been established. The users would also be the Ministry of Finances – Customs Authority, Ministry of the Interior – cross-border police, National Protection and Rescue Directorate, port authorities, port operators and forwarding agents.

Each of the mentioned users would have an assigned role or roles, according to which they would have defined rights to use the ERI data. The total sum of individual roles will define the rights of individual users, i.e. available information [3].

2.4. Hull database

The European RIS Directive 2005/44/EG, European Technical Directive No: 2006/87/EC and UNECE Recommendations No. 28 as precondition for the development of the River Information Services mention the existence of a unique identification number of the vessels at the level of entire Europe ("Unique European Vessel Identification Number" - UEVIN or ENI number) as well as the minimal group of hull data. The meeting of mentioned conditions would enable international data exchange at the level of entire Europe, which is the basis of further development of the River Information Services.

The European hull database has the following objectives:

- to insure information on vessels using the ENI number and facilitate vessel search using different criteria such as the ENI number, vessel name, etc.
- to provide verification possibility whether the vessel has been entered into the database, i.e. whether it has been assigned the ENI Number.

Although these databases will be developed at the national level, they have to be compatible for international exchange and as such have to contain a minimal set of data which encompasses the ENI number, vessel name, vessel type (according to UNECE or European Technical Directive), vessel length, vessel width, vessel draught, vessel height, source of data, total capacity (only for cargo vessels), highest displacement, call sign, IMO number if it refers to the vessel from the sea which navigates on the inland waterways, data about the ship operator/owner and producer.

The number of users who will have the possibility of updating and shifting the data provided by others is very limited, and the entry of one’s own data will include identification, including, naturally, the responsibility. The realisation of the mentioned protocol and generally, functioning of such databases at the international level will require eliminating of certain legal barriers, which will certainly represent the most difficult phase in the implementation [3].

3. THE NEW WHITE PAPER AND “A BUDGET FOR EUROPE 2020”

The tendency of the River Information System is the development at the national basis and its integration into the common operative concept on the territory of Europe. The integration into the system requires a cooperation of the EU member countries and it is also necessary to determine the information and communication standards among the parties that participate in inland waterways [3].

On 28 March 2011, the Commission adopted the White Paper "A Roadmap to a Single Transport Area — Towards a competitive and resource-efficient transport system". The White Paper aims at reducting by at least 60% the greeenhouse gas emissions ("GHG") of the transport sector by 2050 with respect to 1990. As far as infrastructure is concerned, the White Paper aims at establishing a fully functional and Union-wide multimodal TEN-T 'core network' by 2030.

The White Paper also aims at optimising the performance of multimodal logistic chains, including by making greater use of more energy-efficient modes. Therefore, it sets the following relevant targets for TEN-T policy: 30% of road freight over 300 km should shift toother modes by 2030, and more than 50% by 2050; the length of the existing high-speed rail network should triple by 2030 and by 2050 the majority of medium-distance passenger transport should go by rail; by 2050, all core network airports should be connected to the rail network; all seaports to the rail freight and, where possible, to the inland waterway system. The way of increasing the efficiency of transport and of infrastructure use is in reliance on information systems and market-based incentives, and deployment of equivalent land and waterborne transport management systems with the help, among others, of ITS[3] and RIS [11].

On 19 October 2011, the European Commission published its proposals for the development of the Trans-European Transport Network (TEN-T) that consist of a new set of TEN-T guidelines, and a proposal to establish a 'Connecting Europe Facility'. In its proposal the EC aims to continue RIS implementation support. The TEN-T guidelines confirm the dual-layer approach with a comprehensive and a core network. The comprehensive network consists of all existing and planned infrastructure meeting the requirements of the guidelines and it is to be in place by 2050 at the latest. The core network overlays the comprehensive network and consists of its strategically most important parts. The core network consists of 10 multi-modal corridors and concentrates on those components of TEN-T with the highest European added value: cross border missing links, key bottlenecks and multi-modal nodes such as sea and inland ports. The ten corridors are expected to absorb the major part of the 31.7 billion Euro that is proposed for the period 2014-2020 (10 billion Euro of which is earmarked through the Cohesion Fund). The core network should be ready by 2030 and will be implemented through the concept of core network corridors.

Six of the ten nominated multimodal corridors have a connection to inland waterways, thus RIS. The ten corridors are expected to absorb the major part of the 31.7 billion Euro that is proposed for the period 2014-2020 (10 billion Euro of which is earmarked through the Cohesion Fund). One of those multimodal corridors is **10. Strasbourg – Danube Corridor**:

- Strasbourg – Stuttgart – München – Wels/Linz; Strasbourg – Mannheim – Frankfurt – Würzburg – Nürnberg – Regensburg – Passau – Wels/Linz – Wien – Budapest – Arad – Brašov – Bucurešti – Constanta – Sulina.

Also, on 29 June 2011, the European Commission adopted a proposal for the next Multi- Annual financial framework for the period 2014-2020: "A Budget for Europe 2020". In its proposal[4], the Commission decided to propose the creation of a new integrated instrument for investing in EU infrastructure priorities in Transport, Energy and Telecommunications: the

"Connecting Europe Facility" (hereafter CEF). The main goal of the CEF is to streamline and facilitate EU support to infrastructures by optimising the portfolio of instruments available, standardising the operational rules for using them, and capitalise on possible synergies across the three sectors.

The Connecting Europe Facility will have a budget of EUR 50 billion[5] for the period 2014- 2020, of which EUR 10 billion are earmarked in the Cohesion Fund for transport infrastructure. While the Facility will be a centrally managed instrument, the greatest possible priority will be given to respect the national allocation under the Cohesion Fund when allocating the EUR 10 billion. These EUR 10 billion will be reserved for Member states eligible for the Cohesion Fund, and co-financing rates from the EU budget will be set at the same level as the Cohesion Fund.

Table 1. The Connecting Europe Facility (CEF)

CEF	**EUR 40 billion**
• Energy	EUR 9.1 billion
• Transport	EUR 21.7 billion
• Telecommunications/Digital	EUR 9.2 billion
Amounts earmarked in Cohesion Fund for transport infrastructures	EUR 10 billion
Total	**EUR 50 billion**

In the transport sector, a Europe-wide 'core network' has been identified using a pan-European planning methodology. This core network with corridors, carrying freight and passenger traffic with high efficiency and low emissions, makes extensive use of existing infrastructure. By completing missing links and alleviating bottlenecks and with the use of more efficient services in multimodal combinations, it will handle the bulk of transport flows in the single market. The cost of EU infrastructure development to match the demand for transport has been estimated at over €1.5 trillion for 2010-2030 for the entire transport networks of the EU Member States. The completion of the trans-European transport networks requires about €500 billion by 2020, of which €250 billion would be needed to complete missing links and remove bottlenecks on the core network[6].

4. CURRENT STATE OF RIVER INFORMATION SERVICES ON THE CROATIAN INLAND WATERWAY TRAFFIC SYSTEM

The first RIS Centre in Croatia was opened in 2006 in Vukovar, and until today 100% of the Croatian section of the Danube and the commercial section of the Drava have been covered by AIS signal. In this part of Croatia, there are five AIS base stations installed in Osijek, Vukovar, Opatovac, Čvorkovac, Batina and the prototype installation has been developed on the Sava river. The other service, Notices to Skippers are in function at Croatian stretch of the Danube, Drava, Kupa and Sava rivers, and are issued by Harbour Master's Offices Slavonski Brod, Sisak, Osijek and Vukovar [9].

The Sava River is the longest waterway in the Republic of Croatia, and on the Croatian territory it has the third navigability class to Jasenovac, second class to Sisak and first class to Zagreb. For the implementation of the Framework Agreement on the Sava River Basin, signed on 3 December 2002 in Kranjska Gora by Croatia, Slovenia, B&H, and Serbia and Montenegro, the International Sava River Basin Commission – ISRBC – was founded (further in the text: the Sava Commission). The Sava Commission entrusted the Pacific Consultants International Company, as the main consultant, with the development of the Feasibility Study and Design Documentation for renewal and development of traffic and navigation on the Sava River waterway (the Study) which was completed in 2008. The main objective of the Study was to recommend a strategy and programs for the development of the Sava River waterway and to ensure adequate economic and organisational frame for the re-establishment of the trade and transport of cargo and passengers on the Sava River. The final conclusions of the Study say that the guaranteed waterway for the navigation downstream from Sisak on the

Belgrade – Sisak section should be in accordance with Class Va of the Sava Commission classification, whereas the Sisak – Brežice sector is adequate for the development of tourism and there the introduction of commercial navigation is of secondary significance. If, considered over a long time, a waterway for the navigation upstream of Sisak were developed, it would be sufficient to establish Class II according to the Sava Commission Classification in order to enable recreational navigation. If the port of Rugvica is constructed and if there is tendency to establish commercial navigation on the Sisak – Rugvica (Zagreb) section, it is necessary to guarantee Class Va so that this section would be efficiently connected with the river section downstream of Sisak [6].

In the Study, the cargo traffic increase assessments on the Sava (according to the past planned Sava waterway upgrade to Navigability Class IV) range within three economic scenarios – high, medium and low increase rates of the carried cargo volumes, so that in 2027 they range between 3,500,000 tonnes (low increase rate scenario) to 18,700,000 tonnes annually (high increase rate scenario), but mainly in the area from the mouth of the Sava River to the future International port of Šabac (which is expected to be opened in 2012). These forecasts are based on the planned total transhipment result of all the port on the Sava, provided in the Šabac sector the heaviest traffic of vessels in both directions is expected and the upstream route will be dominant regarding carried volumes of cargo due to import.

Based on the forecast scenarios the frequency of the passage of vessels per Sava River waterway segments have been calculated with average loaded volumes of cargo in the amount of 800, 1,000 and 1,200 tonnes in one direction, with empty vessels on return, presented in Table 2.

Table 2: Forecast of vessel passage along Sava River waterway segments (empty on return navigation) by the year 2027

Port	**Annual Bi-directional Vessel Movements by Average Capacity and Growth** Scenario								
	800			**1,000**			**1,200**		
	Low	Med	High	Low	Med	High	Low	Med	High
Sisak	3,362	7,999	12,660	3,067	7,154	11,260	3,444	6,590	10,327
Slavonski Brod	5,984	10,942	17,751	4,789	8,757	14,206	4,790	7,300	11,842
Bosanski Brod	7,464	13,403	22,192	6,069	10,918	18,047	6,167	9,261	15,283
Samac	11,378	19,882	31,835	9,243	16,187	25,890	9,384	13,723	21,926
Brdsko	13,397	23,119	36,616	10,872	18,804	29,756	11,026	15,927	25,182
Sremska Mitrovica	14,457	24,814	39,196	11,617	19,954	31,511	11,669	16,714	26,388
Sabac Industrial	14,893	25,535	40,328	11,923	20,445	32,288	11,931	17,052	26,928
Sabac International	17,915	31,005	48,745	14,500	25,140	39,500	14,668	21,230	33,337

Source: Pacific Consultants International: Feasibility Study and Project Documentation for renewal and development of traffic and navigation on the Sava River waterway, Zagreb, 2008

Calculations have shown that during the peak hours on the waterway segments up to the port in Šabac the vessels will move in one direction every 15 minutes (at 800 tonnes of cargo and in the scenario of high increase rate in the volumes of cargo), i.e. every 20 minutes (with 1,000 tonnes of cargo of the same scenario) and 30 minutes (with 1,200 tonnes and the same scenario).

With such frequency of vessel traffic the RIS implementation represents an imperative for the reasons of navigation safety and planning, and high-quality management of cargo tracking. According to the Study, RIS should be established on the entire route between Sisak and Belgrade, when the commercial traffic reaches sufficient cargo volumes, with RIS expected to provide at least four basic and two additional services that need to be ensured:

- Fairway Information System – system of static (e.g. traffic signs) and dynamic information (e.g. water level) about the waterway, which consists of geographic,

hydrologic and administrative data, as well as data on the traffic infrastructure, with ENC and Inland ECDIS[7];
- Tracking and Tracing – system which tracks and traces the ships by means of the AIS network;
- Notice to Skippers – messages for the ship operators;
- VHF direct ship-coast radio connection for two-way message exchange;
- Electronic Ship Reporting – system of electronic reporting of ships for the collection of information on the data related to the trip (additional service);
- Calamity Abatement – mitigating the consequences of accidents – enable competent persons to react promptly in case of accident by provision of data to the rescue teams. With the assistance of ship reporting system, the vessels are registered at the beginning of their travel and the data are updated during the navigation (additional service) [6].

The obligation to use these systems leads towards the planning and organization of river navigation and transport by the system operator on the respective area.

Further implementation and development of the RIS into the Croatian IWT system should be at least in some parts financed or co – financed by CEF, Cohesion other funds that will be in our disposition as member states of European Union, because according to the CEF the financing is ment to be for studies and works on several sections, inland waterway ports and hinterland connections of core multimodal corridors such as 10. Strasbourg – Danube Corridor.

5. CONCLUSION

Apart from the standard vehicle onboard vessels, the usage of computers with mobile Internet connection, and gradual implementation of electronic navigation charts and transponders contribute to the modernisation of inland navigation which is thus becoming safer. A structured and well-set navigation signalisation and built advanced control information-communication systems raise the level of safety, reliability and competitiveness of the inland waterway transport.

The proposed directions of implementation and further implementation of RIS on Croatian inland waterway traffic system has considered the possibilities of supervision and control of river navigation, as well as the impact of the system on the raising of the navigation safety level and reduction of the probability of accidents in river transport. The structure of river traffic supervision and and management in the considered region contributes to higher quality and more detailed tracking of ships with the aim of increasing the navigation safety, particularly regarding the assessments from the Study on increase in the cargo volume, and consequently higher traffic density and number of berthing at river ports. Therefore, the traffic supervision and management system and the system of the recommended navigation area can be primarily considered as recommended or obligatory systems. The basic function of the recommended system consists of collecting and archiving of data and provision of safety and navigation information on ships. On the contrary, the obligation to use these systems leads towards the organization of river navigation by the system operator on the respective area. This makes it possible to plan the ship movements on the supervised area with the aim of better commercial efficiency of the waterway and the respective ports and terminals, as well as avoidance of the occurrence of possible dangerous situations and the Croatian inland waterway traffic system protection from the environmental aspect.

In March 2011, the Commission adopted the White Paper "A Roadmap to a Single Transport Area ― Towards a competitive and resource-efficient transport system" that aims at establishing a fully functional and Union-wide multimodal TEN-T ‘core network’ by 2030.

The core network consists of 10 multi-modal corridors and concentrates on those components of TEN-T with the highest European added value: cross border missing links, key bottlenecks and multi-modal nodes such as sea and inland ports. Six of the ten nominated multimodal corridors have a connection to inland waterways, thus RIS, inluding 10. Strasbourg – Danube Corridor. In June 2011, the European Commission adopted a proposal for the next Multi-Annual financial framework for the period 2014-2020: "A Budget for Europe 2020" that proposed the creation of a new integrated instrument for investing in EU infrastructure priorities in Transport, Energy and Telecommunications: the "Connecting Europe Facility" (CEF). The main goal of the CEF is to streamline and facilitate EU support to infrastructures by optimising the portfolio of instruments available, standardising the operational rules for using them, and capitalise on possible synergies across the three sectors – Energy, Transport and Telecommunications. The Connecting Europe Facility will have a budget of EUR 50 billion for the period 2014- 2020, of which EUR 10 billion are earmarked in the Cohesion Fund for transport infrastructure. According to the CEF the financing is ment to be for studies and works on several sections, inland waterway ports and hinterland connections of core multimodal corridors such as 10. Strasbourg – Danube Corridor so further implementation and development of the RIS into the Croatian IWT system should be in some parts financed or co – financed by CEF and other funds that will be in our disposition as member states of European Union.

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VEHICLES POWERED BY HYDROGEN ON DEMAND, APPLICATION AND RESULTS OF HIGH STANDARD TECHNOLOGIES

ABSTRACT

Separate hydrogen - new combustion energent, is produced by H20 electrolysis in vehicle installation set.

This technology has been known for 100 years, and transition processes, from the known (HE 94%) through the hybrid system for getting and spending power, have been in progress. Cleaner energy, produced by fossil fuel and hydrogen combustion, forms a hybrid vehicle whose engine reduces fuel consumption (~30-80%) in certain interval, l/km, or operation mode.

***UN** initiative - for the **global fuel efficiency** - **consumption reduction l/km** by **50%** in **2050**, is ongoing.*

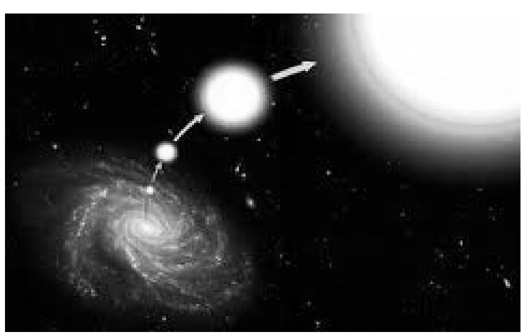
Nowadays registered fuel consumption reduction l/km is reaching more than 110%. High quality and less expensive energy has an extremely high multiplicative effect on all types of transport, as well as on all adaptable mobile and stationary power plants.

Minor consumers and smaller power systems can relatively quickly achieve different effects by using hybrid systems in private and public sector, from starting the production to new products and services.

***Key words:** Hydrogen, Heat Engine (HE), H20 Electrolysis, Fossil Fuel, Engine Efficiency, Cleaner Energent, Savings, Higher Quality Systems, Hydrogen Fuel on Demand.*

1. INTRODUCTION

Energy flows and changes the world constantly. The forces generated from energy move the body, speed it up-slow down or change the motion direction. Energy appears in many forms and is visible only as a light. [1]



Internet

Figure 1 - An imaginary transformation of the x energy space

As energy can not be destroyed nor created out of nothing (Figure 1), consequently, it can only convert - pass from one form to another. Engines are devices that convert various types of energy in motion - kinetic energy.

The human body has certain warmth - energy, and the normal temperature is a measurable value expressed in number from 36° – 37° C. Each dissipation or creation of surplus temperature on the (so-called) energy controlled systems; unbalance the body - a system.

The society recognizes the importance of global human activity. Actions of various intensity are performed in order of preserving the existing values.

An initiative of the United Nations and professional organizations for global efficiency is carried out by reducing the consumption of a fuel liter per kilometer to 50% by 2050. [2]

Personal responsibility calls for human self control, and we also have a duty to identify and eliminate the problem, so we could work on preserving the balance of our planet. Earth's (body) salvation or balancing is a process which has already begun, and is continual.

<u>Getting the energy in the world [3]</u>

▪ 5.3% of the energy derives from nuclear fuel combustion power

▪ 6.8% of the energy derives from directed water power

▪ **87.9%** of the energy derives from the fossil fuel combustion power (30% carbon, 20% gas, 37.9% naphtha (oil))

It is concluded from this review that the energy is converted – produced ≈ 93% by heat engines and ≈ 7% by hydroelectric power plants.

Other ways of obtaining energy are ignored here, as they are in the irrelevant sphere ≈ 0.01. Further, in terms of getting energy it is important to know the target, likely impacts and profits.

The main transport fuel is oil.

Naphtha (oil) and its derivatives run cars, buses, trucks, operating machinery, civilian airplanes, boats, motorcycles.

2. ENGINES

The first engines produced the movement by utilizing the forces of nature. Watermills and windmills used water and wind power, and later in the 20th century there are also machines with external combustion (steam) and internal combustion (petrol and diesel engine). Different types of engines are being developed also; electric, linear, jet, rocket and ion engine. As a main actuating element, the engine has a task to convert various kinds of energy into kinetic energy - motion.

2.1. The degree of engine efficiency (ηt)

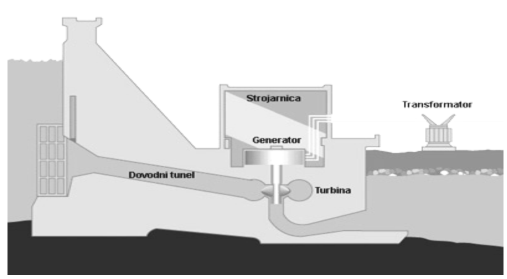


Figure 2 - Sectional drawing of the engine

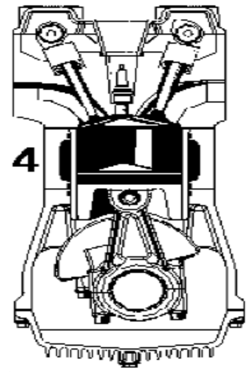


Figure 3 - Schematic representation of hydro power plant

By using different engines (Figure 2) for various purposes and uses, a question of effectiveness degree is opened. [4]

It is known that there is no engine with 100% efficiency, or engine that would turn all the energy of propulsion means into useful work.

Therefore, it is worth noticing the degrees of effectiveness by a type of engine;

- Steam-engine-machine, 7%
- Otto engine, 25% - 35%
- Diesel engine, 30% - 40%
- Thermal power plant (coal-oil), 35%
- Hydro power plant (Figure 3) 80%

Efficiency level (operation) of the **engine** with the internal combustion is connected to *I. main law of thermodynamics*, which can be understood as aformulation of the energy conservation law, whereby the heat is just one form of energy, for which the energy conservation law applies.

$$Q = U2 - U1 + W = \Delta U + W \qquad (1)$$

Δ U - The increment of internal energy (1)

$$Q = Qb - Qt = W \qquad (2)$$

W - the system - engine work (1) (2)

Qb - brought heat - energy (2)

Qt - taken heat - energy (2)

$$\eta t = 1 - Qt / Qb < 1 \qquad (3)$$

Q - heat - energy of the system - engine (1) (2)

ηt - level of engine efficiency (3)

2.1.1.Usability and potential energy

It is known that 60-70% of input energy of any heat engine dissipates, provided that the amount of energy is measured by the laws of thermodynamics. The previous data thus reveals a huge unused energy resource.

To avoid wastage of the potential energy of a heat engine (HE), it can be largely used; especially if we improve the primary fuel combustion in an internal combustion engine,

meaning - intensifying its energy value and usable work of HE that can be increased. The increased performance and increased usable work on the crankshaft depends on:
▪ Heat of exhaust gas, 30-35%

▪ Cooling mode, 33%

▪ Friction and radiation mode, 7%. Generally, there are different groups of alternative fuels. In road transport, as well as in other HE; natural gas, bio-diesel and hydrogen in liquid and gaseous state are imposed as better solutions.

In sequel, degrees of effectiveness will be compared in: internal combustion engine (which uses only **fossil fuel**, petrol or diesel), according to the heat and amount of the exhaust gas and a hybrid engine (with the **hydrogen H** in the gaseous state as a supplement) [5].

Mfx - indicates engine considering **the fuel** ηt **M** f1 - indicates usability of **fossil fuel**-powered engine ηt **M** f2 - indicates usability of **hydrogen**-powered engine (fossil fuel + hydrogen in a gaseous state)

Q.E.D. 1. for Heat Engine

The equation for calculating the degree of the engine usability:

$\eta t = \mathbf{1 - Qt / Qb < 1}$, (3)

The general claim is that the taken temperature is:

Qt **M**f**2** > Qt **M**f**1** , and

if two different sizes QO mutate in equation (3) and calculate the value, the outcome is: ηt **M** f**1** < ηt **M** f**2**, and

it is generally valid: ηt => **1** ,

(*tends*)

so it is finally valid: ηt **M** f**2** **is better - higher**

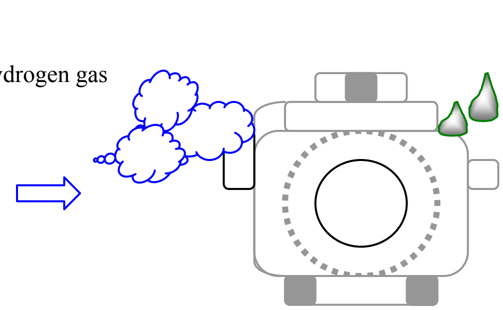


Figure 4 - HE with internal combustion

The results of the application, according to Q.E.D.1 and Q.E.D.2

By utilizing the hydrogen on demand and in order to obtain additional fuel, a system is incorporated in a personal vehicle tested, 1.7 TDS. During the test period, a vehicle was hydrogen-powered consuming diesel and hydrogen (produced in the vehicle).

By measuring the output volume of hydrogen, incorporated electrolyser - a generator in the vehicle, produced additional fuel - hydrogen, ~ **0.8 - 1.0** l/min, exactly according to manufacturer's nominal values.

By measuring the exhaust gas
at 3500 rpm, HC = 5, or 7:19 l/100 km (diesel)
at 3800 rpm, HC = **3**, or **4.86** l/100 km (hybrid)

By measuring the opacity (1)
at 4620 rpm, mean = 0.99 (diesel)
at 4440 rpm, mean = **0.50** (hybrid)

By measuring the opacity (2) even better result was recorded.

At 3670 rpm, mean = 0.31 (hybrid)

As an input parameter (from the manufacturer) a listed limiting value is **2.0**. The quality of the hybrid vehicle exhaust is obvious. Measurement in the test run was done by refueling after driven section (50 km). The added amount is the amount of consumption / km.

From four performed drives on freeways, at a constant speed of ~ 130 km / h, with ~ const. > 3200 rpm, consumption of diesel and hybrid drive.

From two results, one is boundary and unexpected:

10.8 l/100 km (diesel mode)
4.0 l/100 km (hybrid mode)

Two other results are expected in terms of differences:

6.6 l/100 km (hybrid mode) / 130 -140 km/h
4.7 l/100 km (hybrid mode) / 120-130 km/h

By dynamic measurement, at lower rpm. ≈ 2500 (in the case of 6-speed transmission vehicles), the savings would be significantly higher, and consumption of the same test vehicle (1.7 TDS) would be 3.0 - 4.0 l/100 km. This small amount of base fuel (diesel) consumption I noted in two smaller independent drives in lengths of 50 and 70 km.

It is generally worth emphasizing that the other fuel, H2, derived "only" from 1.4 l of distilled water, is sufficient enough to enable the car to cross the ≈1500 km long path.

Since consumption of 3.0 l/100 km corresponds to the production of minor 78 g CO2/km, it is obvious that the same test vehicle already has a good standard of less than 100 grams of CO2, but at a speed of 80 km/h.

Thus, a very good result and **CO2** eco standard is already achieved, "just" **104** grams/km / **130** km/h. The result corresponds to the vehicle - HE even twice weaker than the test vehicle, which also produces CO2.

Here are registered fuel savings in increased engine load from 26% - 68%

Values were obtained according to the current formulas FC (fuel consumption) and from the EU standards, 93/116 / EEC: "If toxic emissions decrease by 10%, fuel consumption will decrease to the amount of 1.6%. " [6]

It is generally true: less exhaust gases = better combustion = less fuel consumption.

It has been shown that HE driven by additional fuel - hydrogen in the gaseous state, has a higher engine efficiency degree than the conventional powered engine - the one with fossil fuel only.

3. POTENTIAL EFFICIENCY OF POWER PLANT AND TRANSPORT

Efficiency is an economic principle of every company that is manifested in striving to accomplish a certain effect with less power (labor, energy) or: smaller input – greater output.
Efficiency calculation:
E = Q / T, or re = T / Q (4)
re - reciprocal efficiency

Q - achieved performance
T - spent elements of production
e> 1 => economical operation
e <1 => uneconomical operations
e = 1 => limit economy
Vgx - indicates engine considering **the fuel**
Tvg 1 - indicates consumption of **fossil fuel**-powered engine (l/km)
Tvg 2 - indicates consumption of **hydrogen**-powered engine (l/km)
Q. E. D. 2. for HE of the Vehicle or Power Plant

According to previous Q.E.D. 1, hybrid engine (code ηt M f2) efficiency is determined and applies to every transport mean which has the same engine installed (vehicle, truck, boat...); and a working machine or HE stationed in the power plant, whose integral consumption part is a fuel Tvf2, as indicated in equation (4).

Analogously, here was also determined more efficient operation of a hybrid machine than the machine powered the fossil fuel.

In general, the cost of a certain system includes many elements. There are parts of calculation methods in sequel by which the thesis of greater efficiency could be confirmed.

- For means of transport, efficiency is also being measured by the l/km spent, among other consumptions
- For working machines (mobile and stationary), efficiency is also being measured by the l/h spent, among other consumptions
- For power plants (mobile and stationary), efficiency is also being measured by l/kWh, among other consumptions

3.1. Notable additional good qualities of H2 – cleaner energy

Evidence (QED 1 and 2) are actually an introduction to several other cognitive qualities of hydrogen in gaseous state.

Specified aggregate state hydrogen meets all the criteria by the definition of fuel. Additional benefit of hydrogen; and some of which are not in the definition of fuel, except for the inexpensive production, is also the fact that it can be produced and spent at the same place (in means of transport - vehicle, truck, boat etc.; working machine or stationary power plant) and needs not to be stored. [7]

Stoichiometric amount of air is the amount of air by which 1kg of fuel burns completely so there is no free oxygen in the combustion products.

When **ג = 1** , from relation of quantities, we can speak of a stoichiometric mixture.

When **ג < 1** , the mixture is high in fuel; and when **ג >1** , the mixture is low in fuel. [8]

Engine powered with hydrogen as additional fuel, with stoichiometric mixture of approx high quality, has:

• quieter operation
• higher lubrication level
• lower air pollution level
• longer economic life - less expensive maintenance
• slightly higher output power
• higher engine efficiency

• slightly higher level of heat
• reduced consumption of fossil fuel km/h
• less expenditure for environmental annuity
• good adjustability of existing systems for further improvement
• relatively rapid technical and technological applicability
• extremely low consumption of water for obtaining hydrogen fuel

A new cleaner energy, produced by combustion of fossil fuels and hydrogen (produced by electrolysis of water at the point of consumption) makes a generator run by hybrid-power. It can reduce the consumption of fossil fuel 30-80% at a certain period of time, by l/km, h, kWh, and the operation mode in general.

3.2. Obtained ergonomic quality

Ergonomics, as an interdisciplinary science, from different positions of science, tries to adjust a machine and working environment to psychological, economic and somatic characteristics of a man. [9]

People see noise as a big problem. It has a negative effect on the auditory, cardiovascular and neurovegetative system, and reduces the working efficiency. It was determined previously that hybrid-powered engine operates more quietly so it can be determined, by ergonomic factor of the same, that it has more favorable effect.

3.2.1. Improving the prices of human labor

The present relation between human labor price and machine work is disastrous for a man.

A comparation of the mean fuel price value 7.6 HRK/l (Croatian currency), an average fuel consumption of some machines l/kph and the mean wages of a worker in Croatia, the one who manage with the machine, provides a value ratio expressed in HRK/hour.

The cost of fuel per hour of labor : The cost of a man labor

DC 10	76760.0 HRK/ h		44.0 HRK/ h
ship	5320.0 HRK/ h		44.0 HRK/ h
locomotive	2280.0 HRK/ h	~	44.0 HRK/ h
bus	304.2 HRK/ h		44.0 HRK/ h

Obviously, a hybrid machine in use has lower costs, and the price of a man labor (driver, captain, pilot, etc.) can increase according to the proportions, while the cost of transport and energy services can be significantly decreased. Thus, the reflection of the lower prices can have a positive impact on the more favorable cost of a man labor.

4. EXPECTED FLOW

• We must accept the fact about energetic power, of its omnipresence and constant necessity-dependence, about heat and its conversion value, about used and unused-thrown energy.
• We must accept the evidence of efficiency and effectiveness of alternative technologies, (we must not remain indifferent by not striving to acknowledge the fact that today's expensive fuel can be improved in the process).

• It should be determined that consumption of fossil fuels significantly reduces by applying the hybrid; the effect of machines increases; and finally, the possibility of substitution with the similar fuel (generally acceptable), is opened.
• The possibility of new manufacture and new products, etc., is opened to individuals and the broader community.

So, by the replacement with natural gas or bio-diesel, an already improved method of utilization of energy would have an important role in the transition of accepting the **omnipresent** and **energetically strong hydrogen**.

All that was put forward is applicable to the individual, transport or non transport company (which produces and distributes energy).

The efficiency of company business considerably affects the level of service, comfort, regularity, frequency, security and reliability.

5. CONCULSION

A number of evidence suggests the quality and effectiveness of technology "hydrogen on demand" (implies production and consumption of hydrogen at the point of consumption, without storing it in the machine-vehicle). Mode and dynamics of application in so-called "larger" and "smaller" operation systems is left for discussion. Inertness of the "larger" systems is not of larger concern, considering that flexibility and rational use is expected in the "smaller" systems which implementation process is less questionable.

Nowadays, the effect of l/km is nearly doubled; and the local energy independence, increased production of bio fuels, better effects in the production and consumption, as well as the environmental effects are not questionable.

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PUBLIC TRANSPORT PRIORITY - PAST ACTIVITIES AND POSSIBLE TECHNICAL SOLUTION CASE STUDY: SAVSKA STREET, CITY OF ZAGREB

ABSTRACT

This paper deals with past activities needed before implementation of Public Transport (PT) priority system. Main tasks before implementation are definition of PT performance indicators, analysis of current condition of traffic control equipment, traffic flow data collection, measuring and calculating PT performance indicators, simulation model building, simulation executing and analyzing results of simulation. These activities and available technical solution for assignment priority to tram at signalized intersections are briefly described.

Key words: *CIVITAS ELAN, Public Transport Priority, data collection, simulation, assignment priority to tram*

1. INTRODUCTION

The City of Zagreb, among other European cities, is participating in the European program CIVITAS ELAN funded by the FP7 program. The objective is to enhance the mobility while reducing congestion, accidents and pollution in the European cities. There are several measures in which Faculty of Traffic and Transport Sciences is involved. One of them is Measure 8.2. "Public transport priority and traveler information". The main objective of this measure is the improvement of mobility for all vehicles, especially for public transport vehicles, at signalized intersections. Demonstration corridor for public transport priority is bi-directional Savska Street, 3.2 km long. The main mode of public transport on Savska street is tram.

Numbers of activities and tasks were done within the Measure 8.2. Public Transport (PT) performance indicators were defined, because there is not unambiguous definition of PT performance indicators. Documents about condition of traffic control equipment on demonstration corridor were prepared. Data collection for measuring and calculating PT performance indicators was conducted. Thereat several methods were used and analyzed. In addition, traffic flow data, traffic volumes data and OD matrices, were collected several times. User controlled video system on telescopic mast was designed. Simulation in PTV VISSIM software for entire corridor and for demonstration segment (where PT priority system implementation is planed) was done. Possible (available) technical solution is presented. Furthermore, numerous activities and administration steps were needed, like permissions for video data collection, coordination of student's activities, coordination of various departments and services, etc. Mostly, this article is based on papers and working papers for CIVITAS ELAN (referenced in literature).

2. PUBLIC TRANSPORT PRIORITY AND PERFORMANCE INDICATORS

2.1. Public transport priority

Increased usage of transport infrastructure leads to traffic congestion with its negative impacts: traffic delays (increased travel times), productivity losses, increase in vehicles gas emission, increased fuel consumption, etc. Above-mentioned problems are specially expressed in urban areas where capabilities of capacity increase are limited or impossible.

Delays of public transport vehicles on urban traffic intersections include cca 50% of all delays induced by all traffic in urban network (including public transport). Priority techniques on signalized intersections include providing green lights to public transport vehicles whenever possible.

Basic principle of PT priority on signalized intersections starts with PT vehicle identification on predefined location. After identification, PT priority request is sent to signal controller or traffic control center. Signal controller or traffic control center processes requests and adapts signal plan if possible. There are three main PT priority approaches: passive approach, active approach and unconditional approach.

PT priority assignment in real situations depends on signal control infrastructure condition (technological age and capability of signal controllers, their coordination, etc.), existence of signal control center and its communication with signal controllers. Also, implementation of PT priority techniques depends on condition of traffic infrastructure overall, traffic flow structure, and other relevant factors. In real situations PT priority is combined with classical (older) techniques, i.e.: usage of passive priority techniques where cycle length and phase splitting are adapted for public transport vehicles, but without vehicle identification. For analysis of PT priority levels and benefits, simulation tools are used for signal plans optimization.

2.2 PT performance indicators

Evaluation of public transport (PT) system performance and evaluation of implementation of PT priority requires a set of performance indicators or merits that may be used for quantitative evaluation of current state of PT system. Performance indicators define the set of data that must be collected or calculated in order to determine the level of delivered performance or to detect a critical spots in PT network where performances deteriorate. If the same data set is collected before and after the implementation of new systems or services (e.g. priority system), difference in values of performance indicators can lead to conclusions about the impact of that system or service on the traffic environment.

Various projects and research studies define PT performance indicators differently. In the available literature on this topic, there is a distinct lack of universal approach in defining PT performance, PT quality of service, PT performance indicators and possible analysis approaches. Authors in [1] define four levels of PT system performances: external, strategic, tactical and operational. In [2], evaluation of PT system performances considers only economic performance indicators, while in [3] authors dedicate more attention to the user perspective of PT performances.

Different sets of performance indicators may be defined depending on which system is the subject of evaluation (e.g. tramway network, bus network etc.). For the needs of CIVITAS ELAN project the set of measurable performance indicators were defined. Specifically, the indicators are quantitative attributes, which represent different time intervals in the tramway itinerary. This approach is depicted in Figure 1, where operation time segmentation is introduced. The segmentation enables detection of critical spots in the PT network where PT performances deteriorate, [4,5].

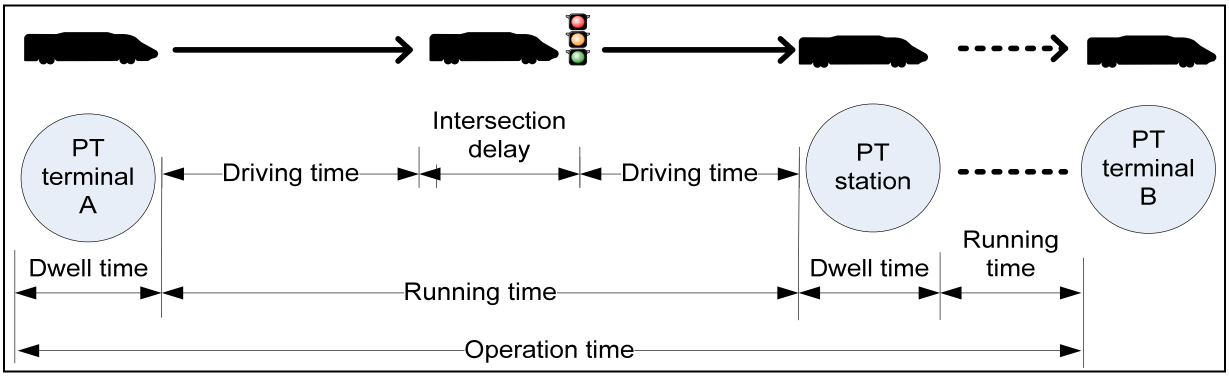

Figure 1 - Operation time segmentation [5]

Set of the public transport performance indicators are:

- Operation time
- Running time
- Intersection delay
- Dwell time
- Driving time
- Speed per segment
- Operation speed.

Operation time represent the time that elapses from the departure of a tramway from the PT terminal to the arrival at the other terminal on the line. *Running time* is the time that elapses from the departure of a tramway from a stop to the arrival of a tramway at the adjacent stop. *Intersection delay* is the time that elapses from the arrival of a tramway at an intersection approach to its passing through the intersection. *Dwell time* is the time, which a tramway spends on PT stops for boarding and alighting of passengers. *Driving time* is the time that a vehicle spends in motion. *Speed per* segment is the tramway speed on the predefined segments of the line and it is calculated based on the length of the segment and time spent on that segment. *Operation speed* is the average journey speed of tramway between an origin and a destination terminal, including any delay arisen in course of the journey [5,6,7].

3. DESCRIPTION OF DEMONSTRATION CORRIDOR AND TRAFFIC CONTROL INFRASTRUCTURE

Demonstration corridor is a 3.2 kilometers long Savska Street, and it connects the historic City centre (on the north) with multidirectional intersection on the southern part of the corridor, see Figure 2. Savska Street is one of the most loaded streets in the City of Zagreb, which is obvious during the morning and afternoon rush hours. Traffic along the corridor is managed in both directions, with personal and public transport vehicles traveling in one level. Exceptions are small parts of the street, which are reserved for tram lines. Even though personal vehicle drivers do not respect them entirely, this causes significant increase in tram travel times and dwell times on stops before intersections. Public transport is managed by Zagreb Electrical Tramway (ZET) with eight tram lines operating on the corridor. In the public transport modes on Savska Street, tramway mode is the dominant one, and bus service is used only in night hours and on special occasions [8].

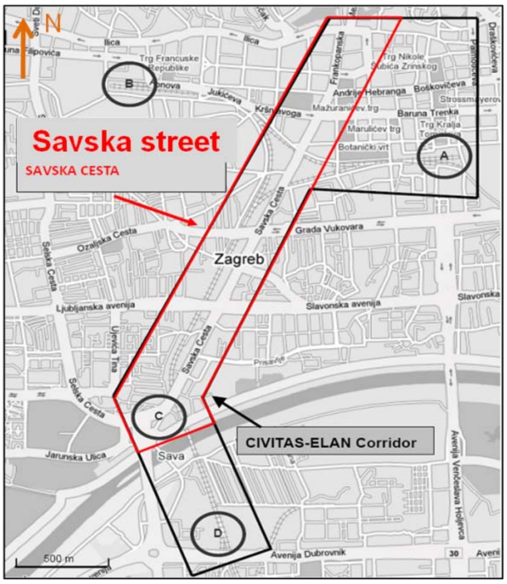

Figure 2 - Demonstration corridor of CIVITAS Elan

Along the corridor there are 12 intersections, all of them equipped with horizontal and vertical traffic signalization and fixed signal control. There are four different types of controllers, mostly aged technology types: Tessa (TESLA), Fanos (FANOS), PSV (TESLA), EC-1 (PEEK). The oldest controller is PSV, implemented in the 1977, and the newest is EC-1 implemented in 1992. Controller coordination does not exist along the whole corridor, but there are five coordinated segments as depicted in Figure 3. There is no communication links between: R4 – R5, PP – R8, R8 – R9 i R9 – R10 [9].

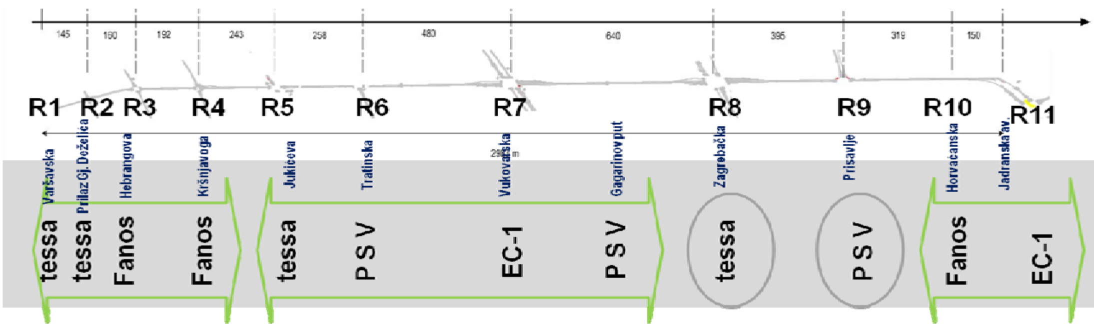

Figure 3 - Signal controllers and coordination on the corridor

4. DATA COLLECTION

4.1. PT performance indicators data collection

Several data collection methods for the performance indicators are used and analyzed: manual time recording, GPS vehicle tracking, PDA (Personal Digital Assistant) computer system and manual video data processing.

Manual time recording. Six students equipped with stopwatches travelled in tramways in the period of one week, manually recorded the time at tramway stops, and signalized intersections. The data was then manually imported into a database. During data processing, the PT indicators were derived.

GPS vehicle tracking. Four GPS receivers were installed in four tramways travelling on the same route. Recording took place in a period of one week, each day from 6 AM to 10 PM. Every device recorded the vehicle's position and actual speed with one-second step. GPS data was extracted from devices and imported in database.

Manual video data processing. A video was extracted from the vehicle surveillance system (for one working day). While observing the recorded video, two students manually entered the data for performance indicators directly into database.

PDA computer system. By using the application installed on a PDA device one student recorded arrival/departure times at PT stops and on intersections, as well as duration of the dwell times. The application recorded and calculated the values of the performance indicators. Data from the relation database on the PDA device was exported to the relation database on the computer for data processing [4].

By analyzing these methods, regarding accuracy, measurement resolution, reliability, measurement simplicity, personnel needed and time consumption, equipment costs and data processing it is concluded that GPS method is the most appropriate. In general, GPS vehicle tracking method gives very accurate results for the vehicle operation time and average operating speed. But, when the speed is around 0 km/h, due to the GPS signal reflection, GPS tracks can be about 30-40 meters in offset. Without map matching it is impossible to determine the actual vehicle position at a specific point in time, which is important for the calculation of different operation time segments. In spite of this problem, which can be solved by post processing, high resolution of measurement due to one-second step data recording allows detailed analysis of tram itinerary.

Measured and calculated performance indicators are presented in [10,11,12,13]. For illustration purpose, in Table 1 only two examples of PT performance indicators are presented: tram speeds in southbound direction and on one segment of corridor, and intersection delay, which could show the need for priority techniques implementation. Example of intersection delay PT performance indicator on intersection Vukovarska Street – Savska Street (Zagrebčanka) is shown in Figure 4 and in Figure 5. Level of Service (LoS) is also shown on the same Figure, dependent on the time of the day

Table 1 - Descriptive statistical parameters for tramway speed

	Tram lines						
	3	**4**	**5**	**9**	**12**	**13**	**14 , 17**
Speed (km/h)	7,46	12,50	18,16	9,25	13,09	10,98	13,30
Standard deviation	9,71	11,48	11,89	7,53	11,68	11,32	12,01
Speed (km/h) (excluding time when tram is stopped)	15,35	17,81	21,08	12,88	17,48	16,88	18,59
Standard deviation	8,55	9,65	10,12	5,67	10,26	9,86	10,16
Maximum measured speed	43,49	46,12	45,47	30,64	50,15	50,15	50,15

Since the measurement was performed on November 2009, for the purpose of evaluation of priority system, new measurement has to be performed before and after the implementation.

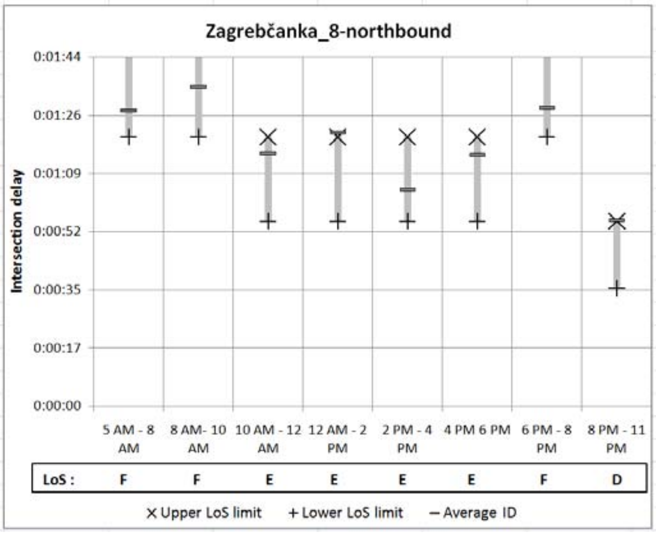

Figure 4 – Daily variations of intersection delay at Zagrebčanka northbound

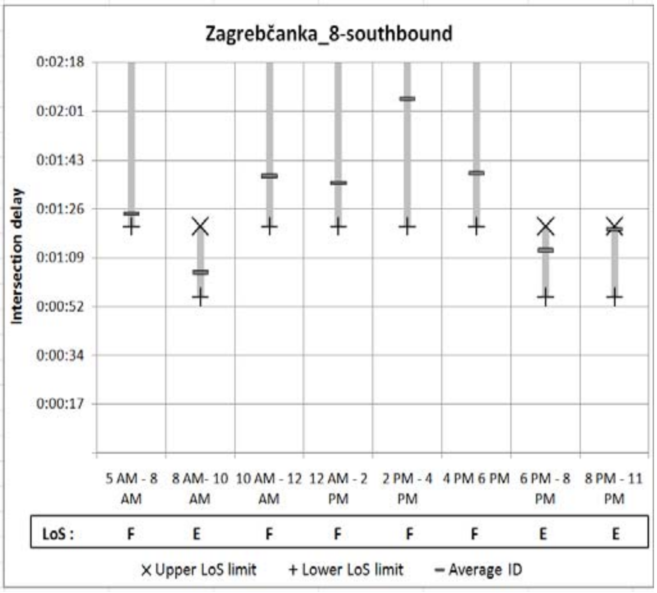

Figure 5 – Daily variations of intersection delay at Zagrebčanka southbound

4.2. Traffic flow data collection

First traffic flow data were collected in April 2010. For data collection along the corridor, around 60 observers/students were involved in vehicle counting process. They counted traffic simultaneously at all corridor intersections in peak hours between 4 and 5 PM. For the purpose of simulation, during vehicle counting, the structure of traffic flow (i.e. private vehicles, public transport vehicles, etc.) was also recorded.

Second traffic flow data were collected in February 2012, but only for one segment of Savska Street (intersections Savska Street – Deželićeva Street, Frankopanska Street – Varšavska Street). Data on this segment is collected again because the demonstration of technical solution is planned only on this segment. Data collection was performed from 7 AM to 9 PM. For data collection, video system was used. The system was mounted on the vehicle as depicted in Figure 6. Components of video system are: telescopic mast with mounting equipment, movable camera housing, actuators' controller, PC, video capture card, cables and HERO 2 camera. The view field of camera is presented in Figure 7. From the recorded video, traffic volumes and O-D matrices were extracted. Unfortunately, the whole process was done by manual counting. Recorded video is valuable for further video image processing experiments. For example, *bird perspective* video recording from Vjesnik building was conducted, and students for Faculty of Electrical Engineering and Computing (FER) developed an algorithm for generating O-D matrices, see Figure 8. Unlikely, this way of traffic recording (*bird perspective*) affiliates numerous problems like: not enough tall buildings, sight of view obstacles, and permissions.

Figure 6 - Video system for data collection

Figure 7 - Mounted camera view field

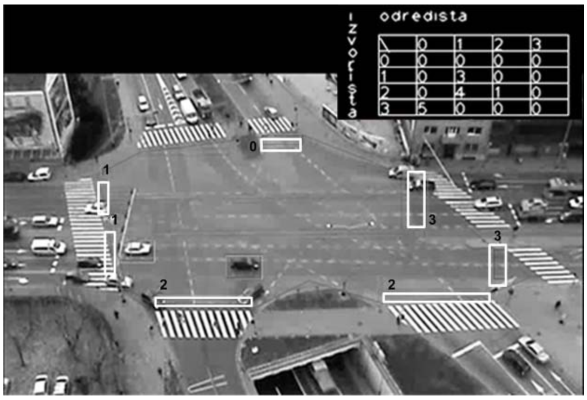

Figure 8 – Camera view field – bird perspective

5. SIMULATION

Simulation model was developed in PTV VISSIM simulation tool, with its additional modules. Simulation development was conducted in several steps. First step was to build entire traffic network of corridor based on geometrical data and traffic infrastructure data (lane width, number of lanes, section length, intersection geometry, signals head position, tram stop position, etc.). After completion of traffic network, signal logic for all intersections and other relevant data were inserted in the model, along with the traffic flow data and distribution based on data collected. Data needed for simulation model was gathered from various sources (field measurement, road service departments: ZG Ceste, Semafor, etc.).

After completion of simulation model, PT priority algorithms were developed. For development and implementation of priority algorithms in simulation model, PT VisVAP module was used. VisVAP is flow chart based software for creation and edition of program logics. Basic priority techniques used in model were early green extension and red truncation based on detection of PT vehicles. Example of graphic preview of simulation sequence on one intersection is shown in Figure 9.

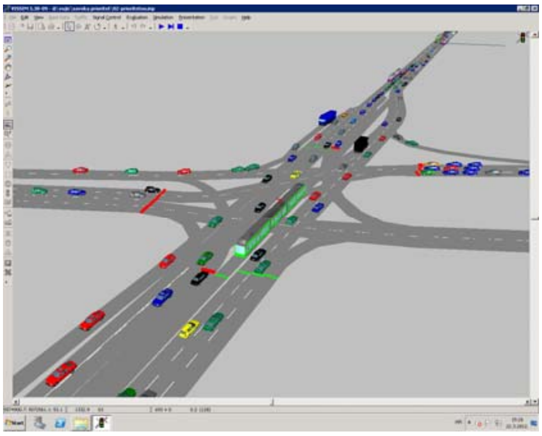

Figure 9 - Graphic preview of simulation sequence

The basic indicator of PT priority benefit is operation time of trams that operate through the whole corridor. Simulation results show that after the implementation of PT priority techniques in the simulation model, operation time was decreased. In Table 2 example of operation times for tramlines number 14 and 17 (both directions) are presented. Simulation results (operation time decrement) show significant improvement of operation time through the whole corridor.

Table 2 - Example of simulation results – operation time [13]

Tram line	**Direction**	**Without PT priority [s]**	**With PT priority [s]**	**Operation time decrement [%]**
17A	Southbound	1222,13	1124,05	**8**
17B	Northbound	1293,12	1213,31	**6,17**
14A	Southbound	1246,67	1136,30	**8,85**
14B	Northbound	1273,77	1176,82	**7,61**

The simulation tool used has a number of adjustable parameters (drivers behavior, PT vehicle speeds, acceleration, deceleration, reduced speed areas, vehicle input distribution, etc.). Adjustment of mentioned simulation parameters is one of the most challenging tasks.

Signal control optimization module (VISSIG) was not available in this project. With that module, optimization of signal control timings would be much easier.

6. PUBLIC TRANSPORT PRIORITY ON DEMONSTRATION SEGMENT

This section describes used priority technique on demonstration segment of the corridor. First part deals with traffic demands and concrete priority solution, and second part of the chapter describes technical solution.

6.1 PT priority traffic analysis

Public transport priority technique is elaborated in detail in project [14], which contains traffic flow analysis and safety analysis, changes in signal controller programs, capacity analysis, and other relevant elements. Demonstration of PT priority is planned on segment of the corridor (northbound only), and three intersections are included: Hebrangova Street – Savska Street, Deželićeva Street-Savska Street, Varšavska Street – Frankopanska Street, as depicted in Figure 10. On the Hebrangova Street – Savska Street existing signal program and signal controller logic is kept. On the Franskopanska Street – Varšavska Street, duration of signal phases and cycles are unchanged, but offset is changed based on the average tram speed. In the daily signal plan on the Frankopanska Street – Deželićeva Street, early green is enabled if PT vehicle is detected. If PT vehicle is not detected, then existing signal plan is kept. Position of detection zone is located 150 meters before the intersection Frankopanska Street – Deželićeva Street, therefore PT vehicle is detected after passing intersection Hebrangova Street – Savska Street, northbound, see Figure 11.

Figure 10 - Demonstration segment of corridor for PT priority implementation

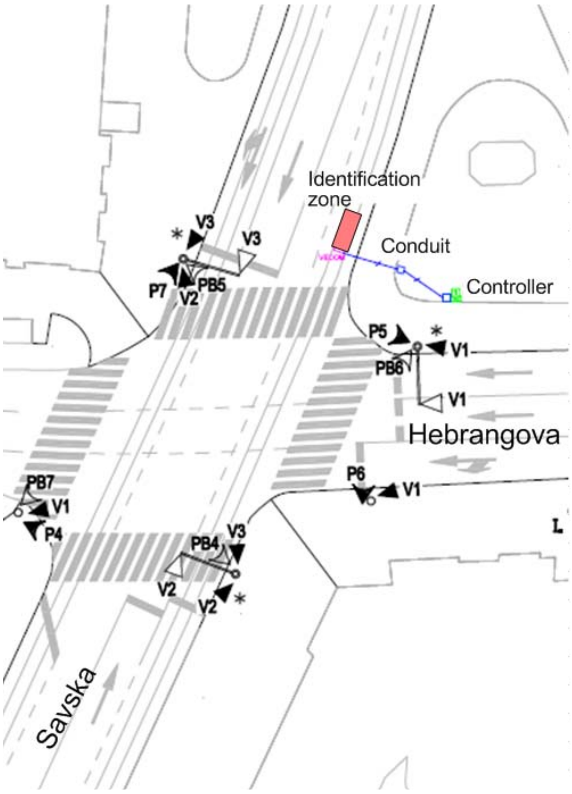

Figure 11 - Detection zone position

According to [14], LoS decrement will occur only on intersection Savska Street – Deželićeva Street (eastbound), although it will not affect in significant traffic congestion and queues. On other approach tracks of Savska Street – Deželićeva Street intersection throughput is slightly increased, while on the Frankopanska-Varšavska intersection remained the same. LoS decrement is expected because giving PT priority affects cross street vehicles.

6.2 Technical solution

Demonstration of priority assignment is intended by installation of VECOM system, described in project documentation [15]. VECOM is an electronic communication system between tram vehicle and fixed equipment positioned close to road, a commercial product of Peek Traffic. Basic components of VECOM system are inductive loop (antenna), loop buffer, roadside electronic equipment (VECOM-Compact), GPRS based communication module (wireless module), VECOM Transponder and vehicle communication unit (VCU).

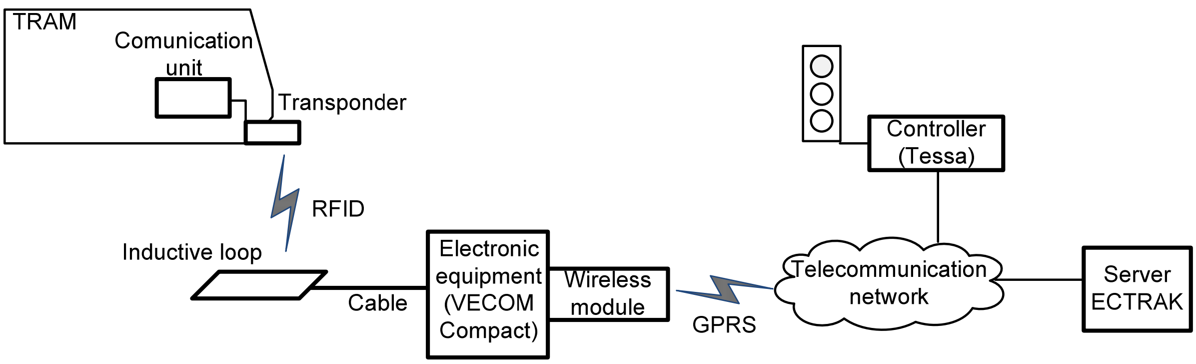

Figure 12 - Diagram of system for priority assignment

Diagram of system for priority assignment is shown in Figure11. Transponder is very robust, and is mounted below the vehicle on the distance of 15 to 30 centimeters from the top of pavement. Transponder and inductive loop serve for radio link establishment between vehicle communication unit and roadside equipment. When tram crosses a loop, VECOM system "connects" to the vehicle system VCU and data messages (vehicle ID, vehicle group ID) are exchanged between them. Signal controllers on Savska Street – Deželićeva Street and Frankopanska Street – Varšavska Street are linked to traffic control center EC-TRAK Zagreb. Because signal controller on Savska Street – Hebrangova Street is not linked to EC-TRAK, GPRS based link will be established (using wireless module). PT priority request is forwarded to EC-TRAK which gives instruction to signal controller on Deželićeva Street for PT vehicle passage through the intersection (in accordance with developed priority logic).

VECOM system has some advantages and disadvantages. Advantages are its robustness, especially in electrically noisy environments, and accurate positioning. Disadvantages are its fixed location and the bandwidth that is limited by the loop size [16]. In addition, serious disadvantage is the need for construction work (pulling up concrete plate between tram rails, digging canal for conduit) which is expensive and demands traffic regulation during construction work.

One more identification system will be tested in real traffic conditions. Cooperation with the MARETON company results in development of PT vehicle identification system based on industrial RFID devices (readers and very robust tags). Readers will be mounted below a tram, and tags on or inside the pavement. Possible advantages are low cost of such identification system, position accuracy and easy mounting or relocating tags. For communication between vehicle and signal controller ZiGBee could be used and between vehicle and traffic control centre GPRS could be used.

7. CONCLUSION

Coordination issues and aged signal controllers cause great difficulties in priority techniques implementation for the whole corridor. Furthermore, budget and time limitations in this moment bound technical solution only on demonstration of priority assignment to one tram vehicle and on one segment. Therefore, real problem is not solved, but several benefits are achieved.

Firstly, some data collection methods were developed and PT performance indicators were defined. Calculating PT performance indicators from GPS data is a promising method. Traffic flow data collection, especially OD matrices, by video system has the potential, but video image processing application should be developed. Secondly, traffic modeling using simulation tools has been adopted. Simulation tools could greatly contribute to planning public transport priority on signalized intersections. Thirdly, contact with city authority and services was improved. Some tasks and activities in the future will be done faster. At last, cooperation with other faculties and companies has been established.

Considering VECOM as technical solution, there are some advantages and disadvantages. In case of enough budget for PT priority on whole corridor, other public transport vehicle identification technology should be taken in consideration, too.

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ANALYSIS OF THE NEW COMPUTERIZED TRANSIT SYSTEM FOR USERS IN CROATIA

ABSTRACT

The Republic of Croatia, joining the European Union, must assume all obligations under European legislation, relating to the Customs Union. The development and introduction of a fully functional NCTS system is one of the basic conditions that the European Commission presents to all new EU members. Full implementation of NCTS system includes the implementation of the NCTS transit procedure without paper documents. Benefits of NCTS are numerous, as for customs and for the economy, especially for the shipping, authorized senders and recipients, as well as carriers and other participants of the transit procedure.

1. INTRODUCTION

Geographical position of Croatia led to the importance of transit to the country's economy. The Republic of Croatia joining the European Union must assume all obligations under European legislation relating to the Customs Union. One of the areas that will significantly change the business process is the process of transit of goods, so-called NCTS (New Computerized Transit System). NCTS transit supports uninterrupted process of transit of goods under customs supervision which are applied by the customs administration of the member states of EU and EFTA countries, and the members of the Convention on common transit procedure and it is the first interoperable trans-European customs system.

2. BASIC FEATURES OF NCTS

The development and introduction of a fully functional NCTS system is one of the basic conditions that the European Commission presents to all new EU members, so that the Republic of Croatia has decided to develop its own national transit applications (NTA - National Transit Application) that supports all the functionality of NCTS.

From the first of July 2009, the NCTS faze 4.0. is produced in the European Union. This version of the system includes procedures for the dispatch, destination and transit customs, and management of guarantees, the process of search and collection, security and data protection. This allows the electronic receiving and sending of messages that are necessary for the initiation and successful completion of the transit procedure.

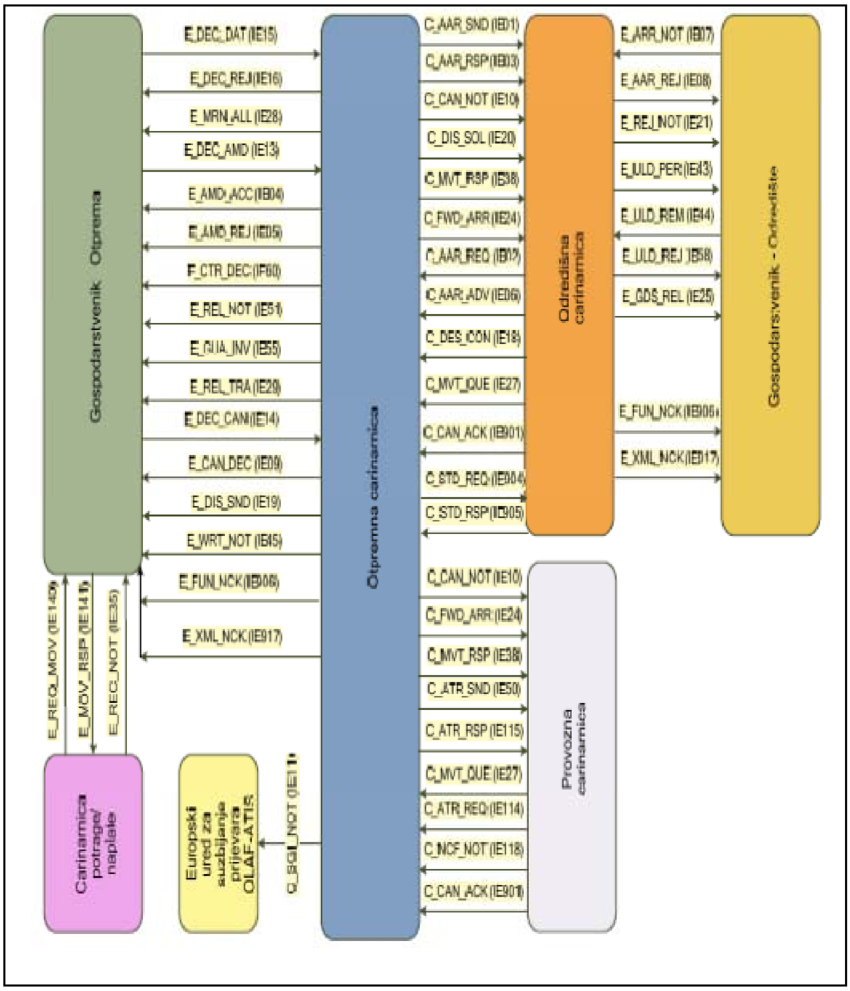

Figure 1 - Schema of IE messages exchanged between the participants of the proceedings

Full implementation of the NCTS system also includes the implementation of the transit procedure without paper documents. The exception is the only document that follows the transit (TAD/TSAD - Transit Accompanying Document/Transit Security Accompanying Document) and serving as the print data declarations and the holder of the transit procedure (MRN - Movement Reference Number). However, the introduction of NCTS, electronic record of data only, becomes legally valid proof, unlike the current system where it was a paper declaration.

Benefits of NCTS are numerous, as for customs and for the economy, especially for shipping, and authorized senders and recipients, as well as carriers, and other participants of the transit procedure. Businessmen communicate with the NCTS system electronically and thus exchange data and information on specific transit procedure, so they are timely informed about the progress of this process. On the other hand, the Croatian Customs Administration exchange data on all transit procedures through electronic messages with other European customs administrations and thus allows continuous and uninterrupted movement of shipments from the point of shipment to destination.

To achieve these advantages business entities have to develop their own IT systems compatible with NCTS as well as with external users to connect with the custom information system in a way that lets them send electronic messages in form and content acceptable in advance.

All e-mails with such prescribed form and content are obligatory and transit applications of external users must be able to generate them and send or accept these messages depending on their direction of transmission. Messages of such structures and content will also be compatible with the NTA application that supports the NCTS system.

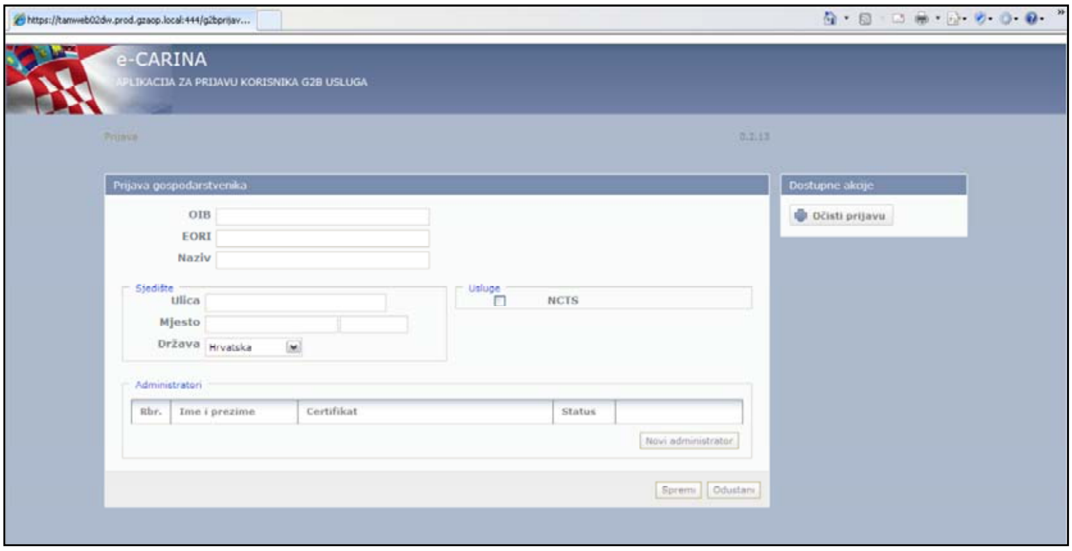

Figure 2 - Application for registration of users of G2B service[1]

The messages system in transit procedure is built to require no additional oral or written communication between the participants of the proceedings. It includes a complete electronic exchange of messages between customs and the sender or recipient. The essence of communication between external users and customs is that the external user sends messages to the customs IT system, the NTA application, which takes care of the further exchange of messages and data, and then transmits them to all other systems necessary for the proper implementation of the transit procedure.

The transit procedure is initiated by the principal who is supposed to be sending electronic declaration to the customs IT system, and the procedure is terminated when the destination branch, which is in the same or some other state, sends a message to the dispatch office informing it that the shipment has arrived at the destination and that the goods are all right. When shipping office receives notice of termination by office of destination, the main taxpayer is informed about it by the national system.

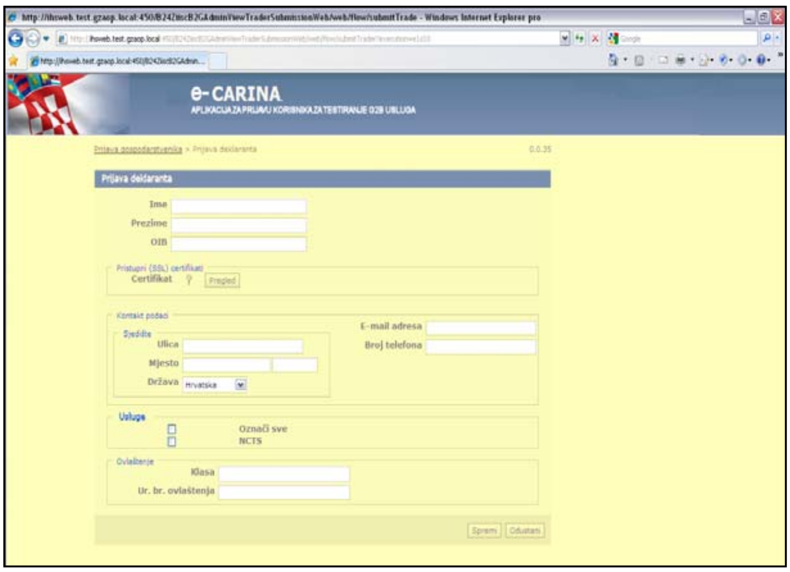

Figure 3 - Application form for registration of the declarant

3. REVIEW OF APPLICATION OF NCTS SYSTEM IN CROATIA

There are 304 entrepreneurs (declarants/dealers) in the Republic of Croatia who are registered for labeling data about the transit procedure in the NCTS system

Table 1 - Number of NCTS shipments by customs houses and offices in 2011.

NAME OF CUSTOMS HOUSE	DESTINATION	SHIPPING	TRANSIT	BY THE OFFICE	SHARE IN TOTAL TURNOVER
ZAGREB	125518	101176	240	226934	**25,89%**
KOPRIVNICA	4403	401	9	4813	**0,55%**
OSIJEK	21600	24247	14	45861	**5,23%**
PULA	10687	8742	30	19459	**2,22%**
RIJEKA	23962	43027	90	67079	**7,65%**
VARAŽDIN	41060	67034	32	108126	**12,34%**
KRAPINA	32840	53942	18	86800	**9,90%**
SLAVONSKI BROD	52081	43886	41	96008	**10,95%**
VIROVITICA	1111	1863	0	2974	**0,34%**
VUKOVAR	67190	53742	14	120946	**13,80%**
SPLIT	17313	11058	75	28446	**3,25%**
DUBROVNIK	5284	1416	6076	12776	**1,46%**
ŠIBENIK	2628	374	9	3011	**0,34%**
ZADAR	2882	479	12	3373	**0,38%**
PLOČE	10041	10489	6099	26629	**3,04%**
OTOČAC	3538	6315	0	9853	**1,12%**
KARLOVAC	8074	5406	7	13487	**1,54%**
OTHER OUTPOSTS*	123	4	0	127	**0,01%**
			total turnover	876575	**100,00%**

* The branch which is not in the codebook of the offices

Table 1. shows the number of shipments at customs houses and offices in the period from 1st August 2011 to 31st December 2011.

4. CONCLUSION

Benefits of NCTS are numerous, as for customs and for the economy, especially for shipping, also for authorized senders and recipients, as well as carriers, and other participants of the transit procedure. Businessmen from the NCTS system will communicate electronically and thus exchange data and information on specific transit procedure, so they will be timely informed about the progress of this process. Croatian Customs Administration will be the information source on all transit procedures through electronic message exchange with other European customs administrations and will enable continuous and uninterrupted movement of shipments from the point of shipment to destination.

To achieve these, business entities have advantages to develop their own IT systems compatible with NCTS as well as with external users to connect with the information system duties in a way that lets you send electronic messages to advance the accepted form and content.

Reducing the number and duration of customs procedures and border formalities between local businesses and their major trading partners (the EU) positively affects the speed of movement of goods and a better utilization of vehicles and generally has a positive effect on the carriers and transportation.

These procedures, ultimately, mean reduction in total operating costs and strengthening of competitive ability, which is the practice in the European Union.

ENDNOTES

[1] G2B service is part of the common infrastructure of the Information System of Customs Administration in charge of the Customs Information System interoperability with business applications management business on the principles of electronic document exchange.

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OVERVIEW OF PARCEL SHIPMENT TRANSPORT IN THE REPUBLIC OF CROATIA WITH PROPOSED IMPROVEMENTS

ABSTRACT

Research in this paper is focused on optimization of the parcel shipment distribution, i.e. increase of the shipment supply and delivery efficiency starting from the sender (manufacturer, importer, distributor) to the consignee (the buyer, the consumer). Increasing productivity in the parcel shipment distribution may be achieved by the optimal use of resources involved, primarily in the technological and organizational segment, as well as by optimal use of IT support.

Key words*: transportation, distribution, algorithm*

1. INTRODUCTION

Transport of parcel shipments is an important factor in supplying the everyday needs of people. It depends on whether a particular commodity will be at a specified time on the store shelf i.e. at the point of consumption. Shortening the duration and reducing the cost of logistics operations has a major impact on the success of the company.

The basic tasks of distribution, the effect of the supply chain generally consist of the following:

- Shortening the distance and the time travel necessary for the goods (or services) to arrive from the point of manufacturer to point of consumption,
- Increasing the competitiveness of goods,
- Temporal and spatial alignment of production and consumption,
- Production programming to the requirements (needs) of consumers,
- Placement of new product (or service) on the market,
- Creating and changing of consumer habits.

Croatia is, due to the specific appearance of its territory, complex for the organization of the optimal transportation of goods, e.g. the direction east - south (Slavonia - Dalmatia). Straight line between Osijek and Dubrovnik is about 450 km (via Bosnia), while the distance by road is about 850 km. Apparently there is a discrepancy in the distance which involves precise planning of transport by land to make it realize on time and with a high level of quality.

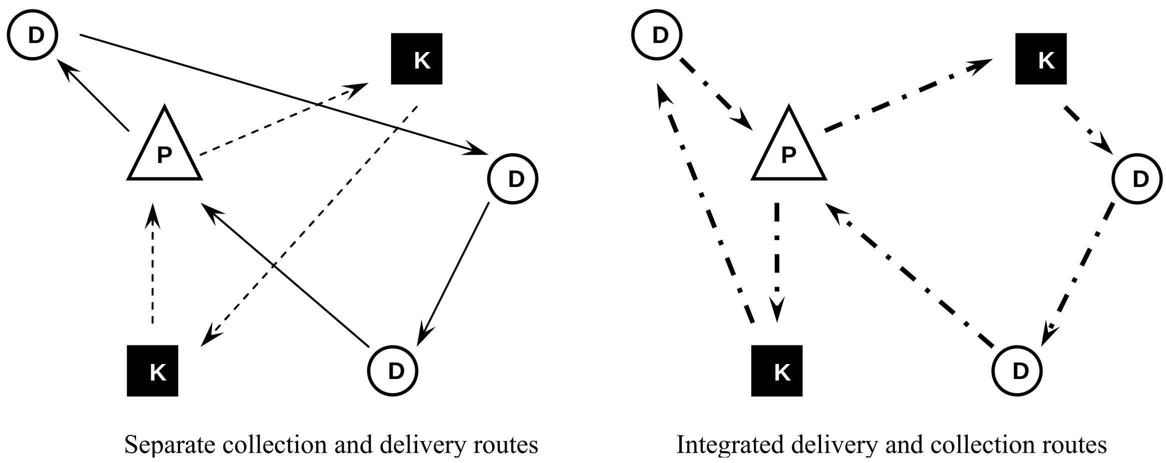


Figure 1 - Routing of delivery and collection of goods

Source - Stanković, R.: Utjecaj logističkog operatera na oblikovanje distribucijskih mreža, doktorska disertacija, Zagreb, 2009.

Furthermore this paper examines the way of transport shipments in specialized firms for such transactions. Of course, every company has its own mode of transportation, but the basic features are reduced to the three most common phases of implementation of transportation:

1. Receipt of shipment phase
2. Phase of processing shipment
3. Delivery of shipments phase

2. REVIEW OF THE ORGANIZATION OF PARCEL SHIPMENT TRANSPORTATION WITH REFERENCE TO THE REPUBLIC OF CROATIA

2.1. Receipt of shipments

Customer service in a specialized company receives a call from the client for transport of shipment at a specific location, and the call if the request can be accepted convert into a work order to transport of the shipment.

The same order is forwarded to dispatcher who, according to the address takeover, refers to the driver of a motor vehicle covered by this area.

The driver of the shipment must take into account the following:

- That the shipment is properly packed
- That all supporting documents to the consignment
- To properly fill the transport document (name and address of the sender, recipient, payer, and the type of shipment).

If the consignment is not properly packed, the driver will refuse to transport it. After that, the consignment that was taken is being transported with other shipments, taken that day, to the logistics and distribution center[1] for further processing.

2.2 Processing of shipments in logistics and distribution center

When unloading the shipment to logistics and distribution center and during its takeover by the warehouseman, he checks whether the shipment is delivered in good condition (i.e. the possible damage is checked). If not damaged, the shipment is weighed and dimensioned (the length, height and width of shipments are measured), then the requested data contained in a written document entered in transport software package on a computer for further processing (calculation of cost of transportation, and processing of all other data that are needed later to produce the ultimate cost of logistics services)

If the item was damaged during unloading, the relevant record there of is made, the transportation authority is instantly informed and the procedure of indemnity starts together with the agreement, what will be done with the damaged item.

The shipment, after having received a route of transport (to the next delivery or the next logistics and distribution center) is sorted according to a vehicle that is specified for that route (line), and thus boards the vehicle.

The vehicle is being checked upon arrival at the receiving center (logistics and distribution center). They are checking if all of seals are on the doors in case of a vehicle line[2], or whether all shipments are shipped in accordance with the submitted list[3]).

Also, during the unloading of the consignment, its regularity is being checked, and if it is damaged, the procedure to be performed in case of damage or shortage of shipment shall be repeated.

If the deficiency occurs in a vehicle, the shipping center is informed about that, because the listed item might not even have been loaded, by mistake, about which the record is composed thoroughly.

2.3. Delivery of shipments to the final recipient

At the reception center the consignment may have the following status:

- Transit (for shipment passing through this center and going to the following center)
- Delivery to the address (shipment that is delivered to the recipient in the listed center)
- Taking over in center / warehouse (where the recipient of the shipment himself comes in and takes over).

If the shipment in transit is passing through the center, the process of loading into the vehicle that transported the shipment to the selected destination is repeated.

For shipments to the delivery address, items are sorted according to the areas where they are delivered and loaded into vehicles which perform the delivery. Shipment will take place at the address and the recipient verifies the accuracy of the shipment and taking over of the shipment with his signature. Then a certified transport document is returned to the warehouse where the driver is discharged for the shipment received.

This document transport - carriers are deposited in the archives as later evidence that the shipment has been submitted to the recipient in good condition and proper quantity.

With taking over of shipment in the storage operations after unloading shipments from the line vehicle, the recipient is informed of the arrival of the consignment and notified that he can take over the listed shipment.

During taking over of shipment, the recipient verifies the transport document and the certification confirms that the shipment is taken over in good condition and in proper quantity.

This ends the process of transport of parcel shipments. Certified documents are stored in an archive, and kept as proof of the correctness of the transport process (accuracy of consignment, accuracy of quantity...).

3. DISPLAY OF ALGORITHMS OF PARCEL SHIPMENT TRANSPORT WITH PROPOSED IMPROVEMENTS

In accordance with these postulates and multi-year business practice, the algorithm shown below is an organization of parcel shipment transportation in which the possible highlighted improvements are directed to:
- Faster processing of shipments (unloading of vehicles, weighing, scaling ...)
- Reduction of data processing time (having optimal information system)
- Quality of routing vehicles that make deliveries / delivery packages

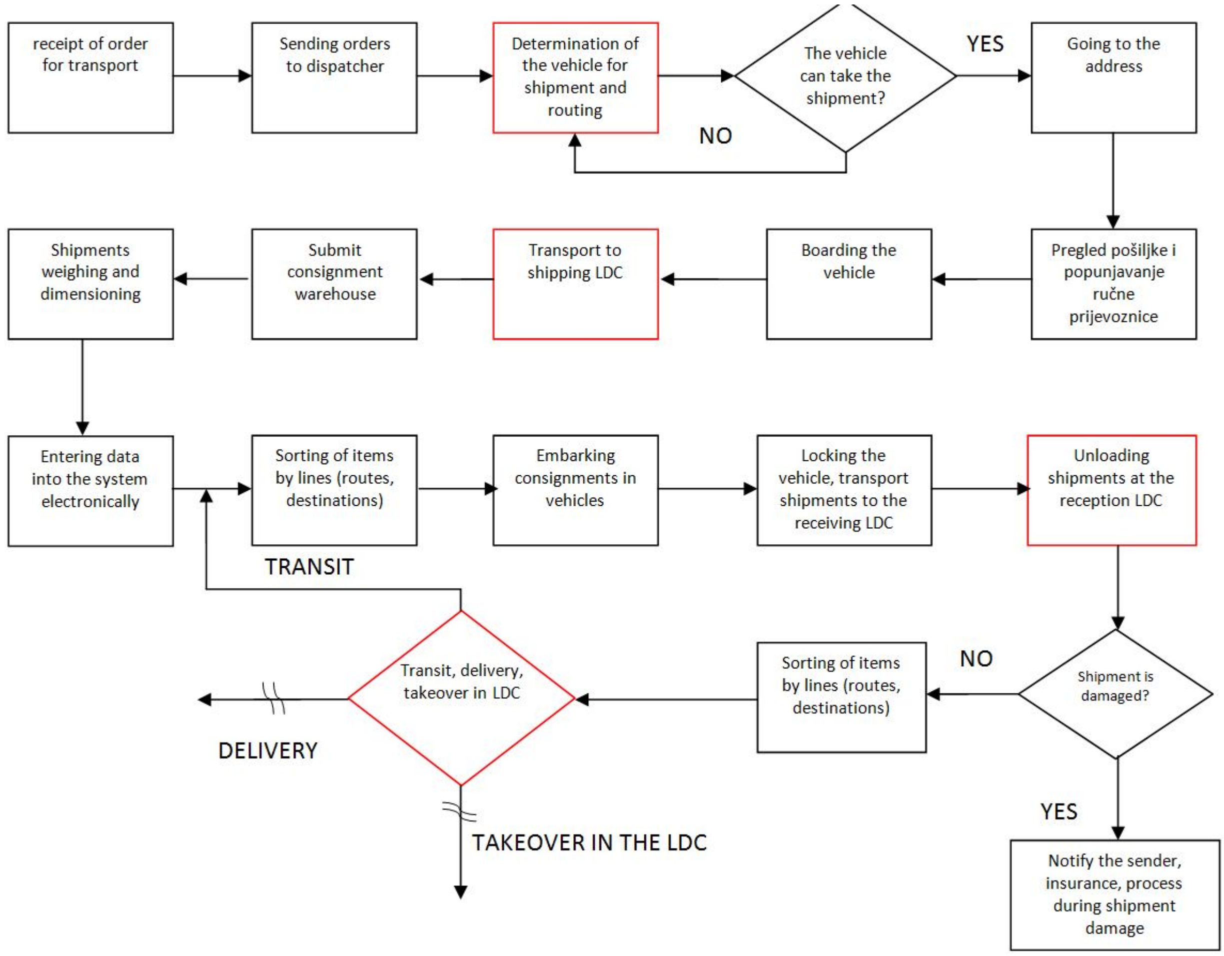


Figure 2 - The first phase of the distribution of parcel shipments

Source - created and customized by authors

From the aspect of (logistics distribution center) LDC's, the inbound transportation costs, are lower than the outbound transportation costs, per unit of a product which includes load parcel shipment, because the goods are delivered into LDC less frequently, but in larger quantities (aggregation of incoming goods flows), while the LDC dispatches are of greater frequency, but in smaller quantities.

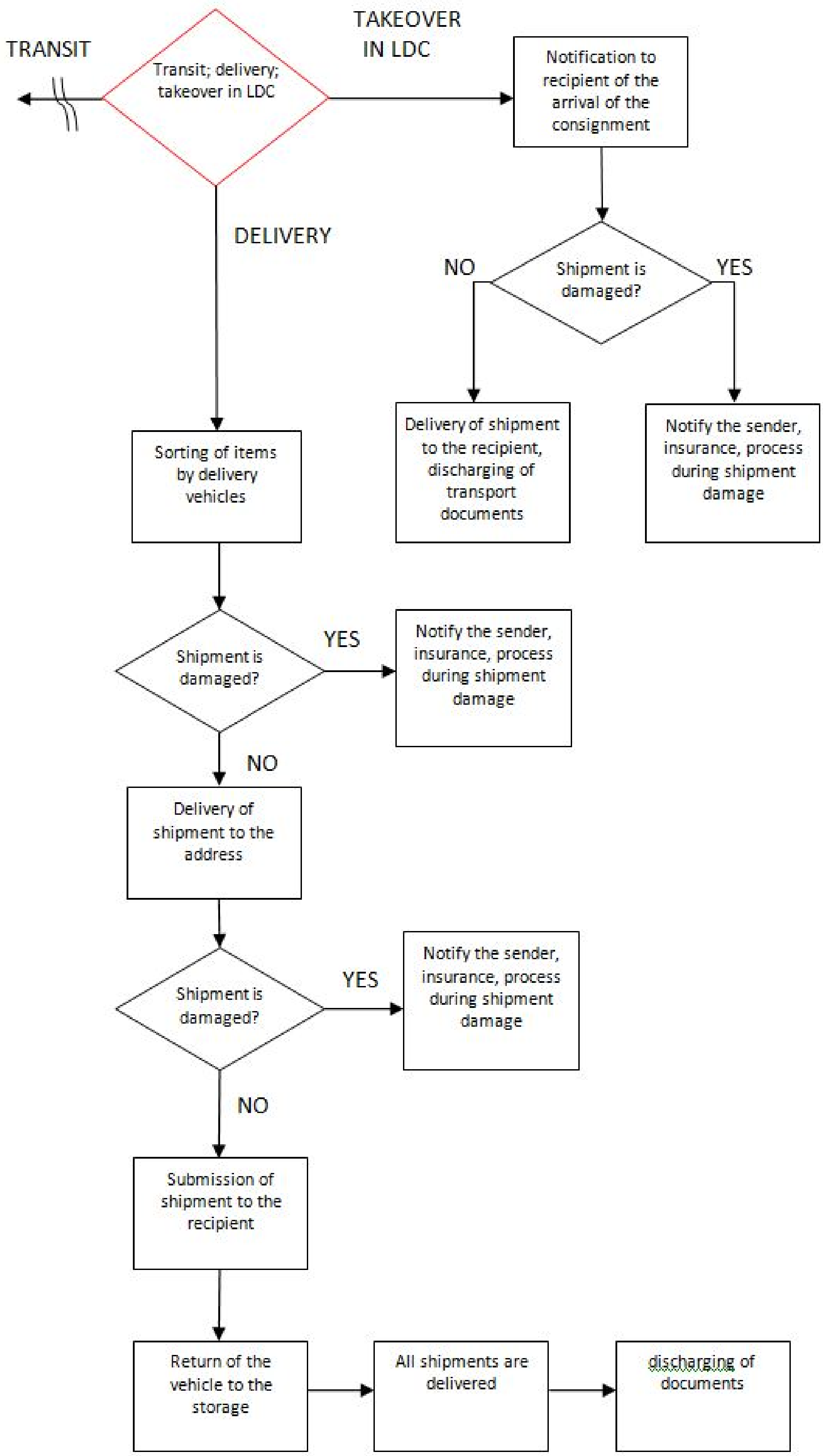
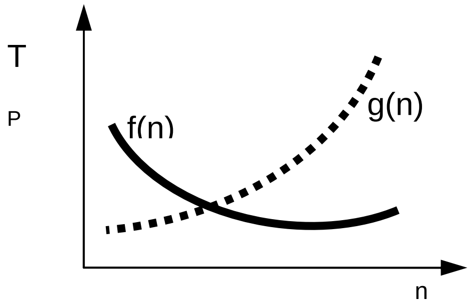


Figure 3 - Second phase distribution of parcel shipments

Source: created and customized by authors



$T_P = f(n)$; $T_L = g(n)$

where is:
TP – total transportation costs
TL – costs of LDC
n – number of location of LDC

Figure 4 - The ratio of total transport costs and LDC's by number of LDC locations
Source: Stanković, R.: Utjecaj logističkog operatera na oblikovanje distribucijskih mreža, doktorska disertacija, Zagreb, 2009.

From this block diagram and accompanying text, it is evident that the possibilities for the optimization of work processes required for the vehicle routing and business LDC. Optimization can be achieved by training staff and appropriate selection and application of IT support, which requires additional analysis, or as a subject of future research.

4. CONCLUSION

Improving the quality of work processes during the transportation of parcel shipments has brought about better efficiency, reduction of operating costs as well as increasing efficiency of transportation. If this part of the transport the chain is well balanced, the quality of delivery of goods will be higher. To achieve a higher quality of transport, it is necessary, along with well-trained workforce, to have a good technical support workflow and information system that will facilitate timely decision-making and improve the distribution of goods.

ENDNOTES

[1] Logistics and distribution center (LDC) is a system which in the physical and organizational terms is a strategic link between production and markets. That connection is accomplished through the functioning of the LDC, which includes infrastructure, superstructure, human resources and technology. According to the nature of business, LDC can be defined as a public provider of logistics services on behalf of their clients (service users) operating over a certain part of the supply chain and to charge the agreed fee as his business income. In practice, there are closed models of LDC's, set up for their own needs within individual companies (manufacturers, wholesale dealers - distributors...)

[2] A vehicle that connects the two logistic distribution center (eg logistics center in Zagreb and logistics center in Split). All goods collected during the day in Zagreb, and travels to the area covered by the LDC Split, at the end of the day he boards the "line car", a vehicle that runs from Zagreb to Split. This vehicle is not involved in the delivery, mainly they are tractors and wagons.

[3] Loading rate; ladelista or packing list, bill of lading (a list of items that are found in the vehicle, this is a specific name, because it works exclusively on the list that is used in regular vehicles, for delivery vehicles this list is called a bill of lading or waybill)

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EUROVIGNETTE - EU FRAMEWORK FOR LEVYING OF ROAD CHARGES FOR HEAVY VEHICLES

ABSTRACT

*Collection of tolls for heavy goods vehicles up to now has been associated with infrastructure costs of planning, building and maintaining roads on the principle of "user pays". Directive 2011/76/EU of the "Eurovignette" from the 2011th requires audits of toll charges in the EU on the principle of "polluter pays", but with the obligation to establish a system that will not discriminate certain customers. New legal frame will give Member States useful tools to manage the problems of congestions, such as variations in toll rates depending on time of day , week, month or season in order to remove heavy goods vehicles from roads in peak periods, and it will earmark resources to build sustainable infrastructure. Hauliers will be encouraged to improve their logistics processes and use "cleaner" vehicles. The costs of construction and maintenance, must be charged with toll based on mileage ("user pays”), and there is the issue of " cost "of air pollution and environmental noise, damage to crops and the health of the population, especially when we know that most of our highways pass through relatively intact and ecologically invaluable areas of Croatia. The aim of this paper is to analyze and review the calculation of external costs and a detailed review of the manner in which operators of highways in Croatia will be able to adopt the European model of charging tolls for heavy goods vehicles, and to suggest ways of increasing highway safety and quality of supporting services for heavy goods vehicles maximum laden weight over 3, 5 t, combined wit**h the new toll charging systems***

Key words: *toll levying, freight vehicles, environmental protection, air pollution, noise pollution*

1. INTRODUCTION

Promoting sustainable transport is a key element of the common transport policy of the European Union (hereafter EU). In this sense, the contribution of the sector of road transport, to climate changes and its adverse effects should be reduced, especially traffic congestion, which slows down traffic flow, and cause greater air and noise pollution, that impair human health and the environment. Environmental protection requirements must be integrated into the definition and implementation of transport policy in EU countries, including the common transport policy. [5]

As an immediate tool for achieving these goals of transport policy on 27th September 2011. a "Directive on toll road infrastructure in particular for heavy goods vehicles" 2011/76/EU was issued, as an amendment to Directive 1999/62/EC in 1999. [12], which was revised in 2006. (Directive 2006/38/EC) [11], and it provides a framework for the collection of tolls for heavy goods vehicles using the highway in the whole trans - European Road Network (TERN).

The Directive authorizes, but does not oblige Member States to collect "user charges" (time-based charges, eg daily, weekly, annually) or levying through tolls (based on distance traveled eg cost per kilometer) for goods vehicles over 3.5 tonnes maximum permissible mass, provided that this does not lead to discrimination against users, on any grounds, and that the fees set at a level that does not exceed cost recovery required solely for maintenance and reconstruction of road infrastructure.

The original aim of the Directive is to safeguard the smooth functioning of the internal market and prevent the installation of offensive and discriminatory charges by individual member states (eg EU countries impose higher fees on trucks from other Member States). Eleven EU member states currently apply tolls based on distance traveled (Austria, France, Germany, Czech Republic, Slovakia, Slovenia, Spain, Italy, Portugal, Greece and Ireland) and 10 apply user charges based on time period (Belgium, Netherlands, Sweden, Luxembourg , Denmark, Poland, Hungary, Romania, Bulgaria, Lithuania), of which two have already announced they will soon switch to toll (Hungary and Belgium), and Poland has recently introduced the "Eurovignette" for trucks over 3.5 tonnes. But the Polish system of prepaid devices in the vehicle is not fully interoperable with other countries (altough it have similar type of electronic devices and systems used by Austria and Czech Republic).

2. THE SIGNIFICANCE OF ROAD FREIGHT TRANSPORT IN THE EU AND ASSOCIATED COUNTRIES

In order to help perception of the importance of freight transport, and why toll system should be adjusted in Republic of Croatia (hereafter RC), and with those funds equip a certain number of rest areas for trucks, and to display a share of RC hauliers in road transport of goods in the EU, in Table 1. there is an overview of transport of goods in road transport in Europe. Despite a significant overall decline in trade in 2009. carriers registered in the Republic had a slightly smaller share from 2008. year, which amounted to only 0.37% of total road transport of goods to the wider European Union (1361 billion tkm).

In the total transport of goods on land, road freight transport, on average, participate with almost 70% (Table 2.), and although the financial crisis had resulted with decreased overall transport of goods in average -12% , road transport had a record share of 73,8 % and therefore the greatest impact on environmental pollution.

Table 1 - Road transport of goods in national and international traffic (billion tkm) for vehicles registered in EU countries and RC (HR), [10] page 38

	1995	2000	2005	2008	2009
EU-27		*1 088.8*	*1 229.3*	*1 269.4*	*1 154.3*
EU-15	*869.9*	*989.4*	*1 100.8*	*1 121.0*	*1 007.2*
EU-12		*99.5*	*128.6*	*148.4*	*147.1*
BE	18.62	19.75	19.28	18.21	17.60
BG		3.06	5.05	7.12	6.31
CZ		14.21	15.52	15.75	13.48
DK	9.33	11.00	11.06	10.72	10.00
DE	201.30	226.53	237.62	264.55	245.57
EE	0.45	0.72	1.85	1.83	1.33
IE	4.70	8.34	13.98	13.27	9.19
EL	*20.00*	*24.50*	*27.50*	24.35	24.23
ES	78.74	106.94	166.39	175.18	151.06
FR	135.30	163.16	177.33	181.88	156.02
IT	150.30	158.25	171.59	151.82	145.61
CY		*1.28*	1.37	1.30	0.94
LV		1.48	2.73	2.54	2.15
LT		1.53	2.14	2.56	2.63
LU	0.53	0.42	0.49	0.60	0.53
HU		12.15	11.39	13.04	12.17
MT		*0.20*	*0.20*	*0.20*	*0.20*
NL	26.68	31.54	31.83	32.01	31.34
AT	11.07	12.39	12.51	14.58	13.49
PL		*48.00*	60.94	71.92	79.21
PT	*16.50*	*17.06*	17.45	17.11	14.42
RO		9.88	19.40	23.19	20.88
SI		*1.90*	2.36	2.64	2.28
SK		5.06	5.62	6.32	5.52
FI	21.80	27.72	27.82	27.62	24.39
SE	28.36	31.45	34.70	37.95	32.12
UK	146.71	150.34	151.22	151.15	131.62
HR		1.91	4.39	6.45	5.13
MK					
TR	112.50	161.55	166.83	181.94	176.46
IS	*0.50*	*0.60*	0.74	0.81	0.81
NO		12.11	15.35	16.66	15.28
CH	8.36	8.93	9.12	9.81	9.70

Table 2 **-** *Transportation of goods by land transport sectors (billion tkm), [10] page 33*

	ROAD	RAIL	INLAND WATERWAYS	PIPELINES	TOTAL
1995	1 289	386	122	115	1 912
1996	1 303	392	120	119	1 934
1997	1 352	410	128	118	2 007
1998	1 414	393	131	125	2 063
1999	1 470	384	129	124	2 107
2000	1 519	404	134	127	2 183
2001	1 556	386	133	133	2 208
2002	1 606	384	133	128	2 251
2003	1 625	392	124	130	2 271
2004	1 742	416	137	132	2 427
2005	1 794	414	139	136	2 483
2006	1 848	440	138	135	2 562
2007	1 914	453	145	127	2 640
2008	1 881	443	143	124	2 590
2009	1 691	362	120	120	2 293
1995-2009	31.3%	-6.3%	-1.8%	4.6%	19.9%
per year	2.0%	-0.5%	-0.1%	0.3%	1.3%
2000-2009	11.4%	-10.4%	-10.5%	-5.1%	5.0%
per year	1.2%	-1.2%	-1.2%	-0.6%	0.5%
2008-2009	-10.1%	-18.3%	-16.3%	-2.9%	-11.5%

3. DIRECTIVE OF EUROPEAN COMMISSION ON THE APPLICATION OF TOLL CHARGING SYSTEMS FOR HEAVY GOODS VEHICLES - "EUROVIGNETTE"

Directive 2011/76/EU is a regulation known as the "Eurovignette", but name in fact comes from the common toll system for trucks over 3.5 tonnes maximum permissible weight, based on the time period for commercial vehicles in Belgium, Denmark, Luxembourg, the Netherlands and Sweden. Eurovignette is also the name of a label (or vignettes) that users of this program had to attach on the windscreen of their vehicle. However, by early 2008. In these countries Eurovignette is electronic system and physical vignettes are not printed. There are other EU member states that also have their own national vignettes systems.

Approximate length of roads in the TEN-T road network is about 84,000 km (TEN-T - strategic projects on flows of goods in Europe). About 30,000 km of motorways in the EU is under the regime of toll based on mileage. About half of them are in the TEN-T network, and therefore fall within the scope of the Directive on the Eurovignette in 2006. Under a new directive, the scope should be extended to the entire motorway network (Trans European Road).

Currently, the existing tolls on average varies between 15 and 25 cents per kilometer, depending on the type of truck and network. The new Directive would approve increased toll rates, from about 20 -30%, but only if individual state decide so.

Tolls are currently collected at the toll booth where the trucks have to stop or electronically via the "OBU [On-Board-Unit]," devices that perform data transmission from the vehicle by special receivers on the road. Separate Directive 2004/52/EC on electronic billing, provides technical and contractual obligations of interoperability at EU level and those of electronic toll collection systems, which must be honored by the end of 2012. (for trucks).

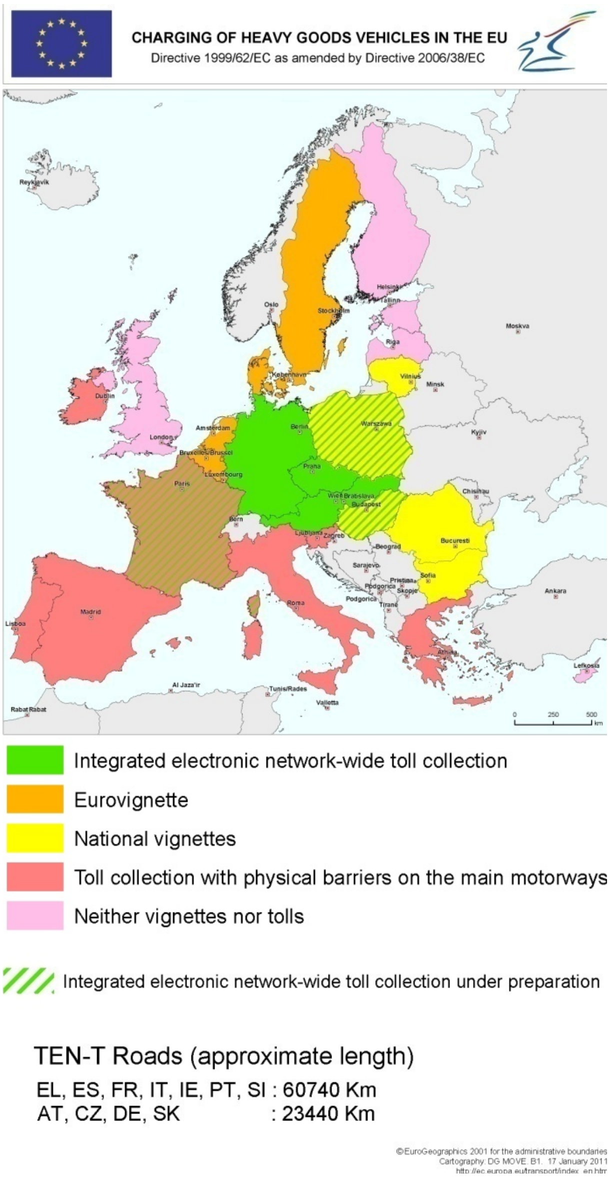

Figure 1 - Charges or tolls for trucks in the EU, the situation on the 7th October 2011 [15]

3.1. The main changes brought by Directive "Eurovignette"

The new rules will :

- Allow Member States to calculate the toll based not only on infrastructure costs, but also the costs of air and noise pollution caused by road traffic. Average external costs in the total amount of tolls will amount to about 3-4 cent/km (cents per km) depending on the EURO class of vehicle, location of roads and the level of traffic congestion. The fee must be collected through the electronic system that provides complete interoperability at European level by the end of 2012. with a clear separation of infrastructure and external costs to account for the toll, that carriers can transfer the costs to their customers.

- Allow a wider differentiation of toll revenues for the same level so that Member States can better manage traffic and reduce traffic congestion. In practice, higher rates may apply during peak periods , provided that the applied tariffs are lower outside the peak. Compromise ensures the neutrality of income and allows the higher rates of up to 175% above average rates for congested roads. That tolls must be collected over a period of up to five hours a day, and rest of the time lower tolls should be collected on the same section of road. Tariffs will be submitted to the Commission (EC), which will be regularly published on its website.

- Broaden the scope of the "Eurovignette", with only TEN-T - highway network (as currently is the case), on all highways in the Trans European Road network (futher TERN) of the EU in order to avoid discrimination against international carriers depending in wich state they had registrate their freight cars.

- **Revenues from tolls should be allocated and directed toward investments in improving the sustainability of road transport.** (Article 9 of the Directive) [1]. Specifically, following directions of investments are mentioned:

(a) facilitating efficient pricing;
(b) reducing road transport pollution at source;
(c) mitigating the effects of road transport pollution at source;
(d) improving the CO 2 and energy performance of vehicles;
(e) developing alternative infrastructure for transport users and/or expanding current capacity;
(f) supporting the trans-European transport network;
(g) optimising logistics;
(h) improving road safety; and
(i) providing secure parking places (Truck Parking Areas or special Motor Service Areas for freight vehicles) [2].

Regulation about the compromise gives member states a powerful incentive to use income from the new costs for investments in certain types of projects to improve infrastructure or to make transport "cleaner".

To implement this regulation about allocating resources, Member States may decide to allocate 15 % of the total revenue collected (from infrastructure fees and charges for external costs) to the TEN-T projects. However, Member States should transparently direct funds with regular reporting and auditing guidance by the Commission, and monitor how and where is the revenue from tolls used.

- There is specific provision for mountain areas in order to allow simultaneous use of existing marking of polluters with a new external cost for the classes of vehicles EURO 0, I and II and Euro III vehicles before the end of 2015th. Additional revenues in these areas will be spent on financing the TEN-T priority projects that are located on the same TEN-T corridors (mandatory "Miniearmarking" - allocation of funds).

- The agreement includes a "rendez-vous clause" so that the issue of internalisation of external costs are kept constantly under control. "Rendez vous" clause calls on the Commission (EC) to create reports about the internalisation of external costs, including those in other transport sectors, for other vehicles, and to achieve a harmonized approach to the same problem.

The deadline for making the report is 12 and 48 months after the Directive enters into force, the Commission will prepare bills with the help of those reports.

The Directive will apply to all vehicles over 3.5 tonnes of maximum permissible laden weight. This is important because it ensures that member states can not discriminate and charge a different toll for groups of vehicles over 3.5 t. However, the Directive also gives Member States the possibility to release payment for category of vehicles under 12 tons (Germany) for example, if the introduction of the vignette for the vehicle over 3.5 t can create a negative impact of diverting traffic or disproportionate administrative costs. Any such exemption should be applied to the Commission and had to be justified in a transparent manner.

3.2. The minimum requirements for collecting an external cost

Methodological approach to defining the road network that will cover "Eurovignette" is associated with other EU Directives on sustainable development and reducing the harmful effects of road traffic and local legislation, and recommend the calculation of the maximum average external cost should be based on the "Handbook on the calculation of external costs in the Transport secto" [3]. The Directive does not oblige the use of manual but provides maximum values.

3.2.1. Definition of the road network for the application of Directive

A Member State shall designate a portion or portions of its road network, which will be subject to application of charges of external costs, which will be determined on the basis of assessment, where it should be determined:

- That on roads that will be included in the application of Eurovignette occurs much more environmental damage than on other parts of the road or on roads where the same would not apply.
- That by imposing an external cost charge on certain roads or sections, traffic safety isn`t endanger or it doesen`t harm the environment on the rest of the road network, or whether the introduction and levying an external cost on the proposed section of the road incurre disproportionate costs

3.2.2. Vehicles, road and time period covered by the "Eurovignette"

Member States shall inform the Commission (EC) about EURO class of vehicle, and the exact intervals where the toll will vary. It will also inform the Commission about the location of roads, on which higher external costs would also apply, hereafter referred to as "suburban roads (including motorways)" and the road on which it will apply the lower external costs, hereafter called „Interurban roads (including highways)“, and day / night variation in densely populated areas where noise is a problem.

3.2.3. Definition of compensation amount

Member State or an independent body, determines the amount of external cost in the toll, based on mileage, according to the EURO class of vehicle (emissions level), the type of road and period of use (day / night, peak periods), then determines the structure of compensation of night tariff for noise pollution, and time periods for the usage of external costs of air pollution in the peak traffic loads.

The charge must be consistent with the risk of diversion of traffic to alternative routes and the impact on road safety and traffic flows in the network, and it should be revised every two years.

3.3. Factors of external cost

For efficient analysis it is necessary to use data that in the best way describes real situation. Combining different types of parameters and appropriate calculation methodology can greatly assist in the planning of road infrastructure and traffic management. When analyzing and monitoring the volume of trade of goods often are used tonne kilometers (tkm) and vehicle kilometers (vehicle.km) [4] (p. 51 and 96), and PCU / h (passenger car units / hour) [7]. These units, among others, are used in calculating the external costs of air and noise pollution of traffic.

3.3.1. Cost of traffic-based air pollution

When a Member State chooses to include all or part of the cost of traffic-based air pollution in the external-cost charge, the Member State or, if appropriate, an independent authority shall calculate the chargeable cost of traffic–based air pollution by applying the following formula (1) or by taking the unit values in Table 3. if they are lower :

$$PCV_{ij} = \Sigma_k \, EF_{ik} \times PC_{jk} \qquad (1)$$

where:
- PCV_{ij} = air pollution cost of vehicle class *i* on road type *j* (euro/vehicle.kilometre)
- EF_{ik} = emission factor of pollutant *k* and vehicle class *i* (gram/vehicle.kilometre)
- PC_{jk} = monetary cost of pollutant *k* for type of road *j* (euro / gram)

The emission factors shall be the same as those used by the Member State to draft the national emissions inventories provided for in Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants (which requires use of the EMEP/CORINAIR Emission Inventory Guidebook). The monetary cost of pollutants shall be estimated by the Member State or, if appropriate, an independent authority, respecting the state of the article.

The Member State or, if appropriate, an independent authority may apply scientifically proven alternative methods to calculate the value of air pollution costs using data from air pollutant measurement and the local value of the monetary cost of air pollutants, provided that the results do not exceed the unit values referred to in Table 3. for any class of vehicles.

3.3.2. Cost of traffic-based noise pollution

When a Member State chooses to include all or part of the cost of traffic-based noise pollution in the external-cost charge, the Member State or, if appropriate, an independent authority shall calculate the chargeable cost of traffic–based noise pollution by applying the following formulae (2) or by taking the unit values in Table 4. if they are lower:

$$NCV_{j\,(daily)} = e \times \Sigma_k \, NC_{jk} \times POP_k / WADT \qquad (2)$$

$$NCV_{j\,(day)} = a \times NCV_j$$

$$NCV_{j\,(night)} = b \times NCV_j$$

where:
- NCV_j = noise cost of one heavy goods vehicle on road type *j* (euro/vehicle.kilometre)
- NC_{jk} = noise cost per person exposed on road type *j* to noise level *k* (euro/person)
- POP_k = population exposed to daily noise level *k* per kilometre (person/kilometre)
- WADT = weighted average daily traffic (passenger car equivalent) [6] and [7]
- *a* and *b* are weighting factors determined by the Member State in such a way that the resulting weighted average noise charge per vehicle kilometre does not exceed NCV_j (daily).

The traffic-based noise pollution relates to the impact on noise levels measured close to the point of exposure and behind anti-noise barriers, if any.

The population exposed to noise level *k* should be taken from the strategic noise maps drafted under Article 7 of Directive 2002/49/EC of the European Parliament and the Council from 25th June 2002 [14] relating to the assessment and management of environmental noise.

The cost per person exposed to noise level *k* should be estimated by the Member State or, if appropriate, an independent authority, respecting the state of the article.

The weighted average daily traffic shall assume an equivalence factor "*e*" of no more than 4 between heavy goods vehicles and passenger cars.

3.4. Maximum weighted average external cost-charge

3.4.1. Maximum chargeable air pollution cost

Table 3 - Maximum chargeable air pollution cost

cent/vehicle.km	Suburban roads (including motorways)	Interurban roads (including motorways)
EURO 0	16	12
EURO I	11	8
EURO II	9	7
EURO III	7	6
EURO IV	4	3
EURO V after 31.12.2013	0 3	0 2
EURO VI after 31.12.2017.	0 2	0 1
Less polluting than EURO IV	0	0

3.4.2. Maximum chargeable noise cost

Table 4 - Maximum chargeable noise cost

cent/vehicle.km	Day	Night
Suburban roads (including motorways)	1,1	2
Interurban roads (including motorways)	0,2	0,3

4. CONCLUSION

It is important to remember that Member States may introduce tolls or user charges, which are beyond the scope of this Directive. In this case, the decision about the level of charge remains on the individual Member States, but in agreement with the Commission (EC). Parts of the road network or individual sections, which may be exempted from this Directive are also described. For example, urban areas are outside the scope of this Directive because of the principles of subsidiarity and the separate Directive on urban mobility. Charging system, which were introduced to prevent "urban" traffic congestion, such as those carried out in London and Stockholm are not covered by this Directive. For all the roads that are not covered by this Directive, the EU framework guidelines exist, among which, principles of proportionality and discrimination are also mandatory. In this spirit, and Republic of Croatia (RC) must adjust regulations and conduct the necessary research and calculation of external costs of road transport of goods, and on the basis of these values to determine the level of tolls based on mileage, axle load freight vehicles, vehicle emissions, noise, road location and time of use. Such toll differentiation can lead to transport patterns, which will be friendly to the environment. The positive impact could be achieved in logistics processes, and multi-modal and integrated transport. Realized gain from sale of external costs should be invested in the strategic objectives such is an arranging roadside service facilities for commercial vehicles. This is just one of the proposals that could increase the attractiveness of highways in RC and a prerequisite for increasing the transit freight traffic in the new conditions.

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ROAD TRAFFIC ACCIDENTS AND INCIDENTS IN THE SIBENIK – KNIN COUNTY

ABSTRACT

There is a clearly visible increase in the number of incidents and accidents in Road Traffic in the Sibenik - Knin County, related to the busiest months of the season. Statistical data of this types and the number of injuries were obtained from the General Hospital and Health Center Sibenik. The Data refer to the persons killed and injured in Road traffic accidents in the period from 2006 - 2011

Knowing this, specific measures of prevention, in addition to those applied on the national level, should be directed to prevent that many accidents in that period. Thereto, the precise periods of time when the increased tourist traffic takes place are known, namely in the time of the weekends on the change of guests. Whit better control and the presence of traffic police on these critical periods and in the critical areas could be achieved a lot. The construction of road transport infrastructure conducive to solving this problem should also be given priority. This refers mostly to the long-planned bypass of the town Vodice, which would relive one of the busiest and most vulnerable areas during the summer and the completion of the fast road Sibenik - Knin, which is, due to the relative high cost of the highway, very weighted in the summer months.

We should also be doing everything possible to deter motorized visitors from entering the center of Sibenik. In this sense, large parking lots on the outskirts of the city, from which you can by walk get to the center of the City in ten minutes, are still insufficiently exploited, either because the signaling is inadequate, or because of the high cost of daily parking tickets.

Key words*: road traffic accidents and incidents in the Sibenik – knin county, prevention activities*

1. INTRODUCTION

There are many participants in the Road traffic. Beside the driver and gust drivers there are passengers in urban, suburban and intercity traffic, and the pedestrians. We distinguish the types of vehicles on roads, those on two wheels, such as cyclists, motorbikes and mopeds, and buses and trucks.

Traffic accidents are happening in cities, the local, county and state roads.

The mission of this study was to present the epidemiological data of accidents and incidents in Road Traffic in the World and show the injuries of road traffic participants in the period 2006 - 2011 in the Sibenik - Knin County. It is also a task of this study to show and present risk factors of road traffic casualties and according to the results debate in the conclusion and propose possible preventive measures and activities.

2. STATISTICAL DATA

Sibenik-Knin County covers a total area of 5670 square kilometers, of which land area is 2994 square kilometers and has 5 cities: Sibenik, Knin, Vodice, Drniš, Skradin, and 15 municipalities in which according to the list of the 2011th year, lives 109 320 inhabitants. Sibenik-Knin County has an exceptionally significant traffic position: associated with coastal road, main road towards Knin and Bosnia, and the highway to the Croatian inland. The road and railway line to Zagreb and Split are very important. In maritime transport important are the port of Sibenik, and the ferry connections with Italy. The Sibenik-Knin County has good air connection to Zagreb and the world over the airport "Split" (45 km) and Zadar airport Zemunik (50 km). Density of road network in the county was 40.6 km/100 km2. It is on average less than in other parts of Croatia. National average is 48.4 km/100 km2, witch is significantly less than in the developed parts of Central and Western Europe, where the average is 77 km/100 km2. According to the Law on public roadways, all public roads in Sibenik - Knin County are divided into public (360 km or 29%), county (479.52 km or 39%) and local roads (395.90 km or 32%), which makes a total of **1235.42 kilometers.**

The overall road network has a satisfactory territorial position, but with low levels of modernization and rather poor state of the elements of technical / traffic support, except of the highway A1. This leads to low average travel speed, high transport costs and a high number of traffic accidents. The Sibenik - Knin County had **52 165** registered drivers of motor vehicles in 2010 and in the same year there ware recorded a total of **47 220** registered road vehicles. The Sibenik - Knin County has several medical institutions. Sibenik General Hospital is the largest and most important. Opened on 24 June 1883, and a good deal of the building from that time is in function even today. Hospital health care is organized into eleven wards for acute illness and has 356 beds. At the site of Sibenik there are 296 beds, and in the locality of Knin 60 beds. In Knin is a unit for subacute disease which has 80 beds. Another institution is the Health Center in Sibenik which integral part are the ambulance services. All times there are two teams of ambulances and a team in Vodice during the day, covering the entire road network of Sibenik - Knin County. The Ambulance service is located in the Sibenik hospital, next to the emergency surgical ward that is dealing whit the more difficult injuries of participants in Road Traffic accidents.

Statistical data on the types and number of injuries are obtained from the General Hospital and the Health Center. The data refer to persons killed and injured in traffic accidents in the period from 2006 - 2011 years who have passed through the emergency roam and the urgent surgical receipt. All data from these sources were obtained by manually extracting and counting the number and types of injuries in Road Traffic and separated from other injuries, from the associated protocol, specified separately for each year since no updated data of that kind are available for the Sibenik - Knin County. Extraction of these data was approved by the Ethics Committee at the request of MD. Magda Labor, specialist in anesthesiology, who participated in the data collection, provided that the study does not use any personal data of the patients, but only the type and the number of the injuries. From the same source, data of the period of injury were extracted, divided by month. In the process of gathering this information protocols for 5 years ware reviewed and from more than 6000 treated patients with mild and severe injury extracted data for 2763 casualties in Road accidents.

Other statistics were obtained from the Police Department of Sibenik - Knin and the Croatian Ministry of Internal Affairs. Data refer to the time period 2006 - 2011, and refer to the number of traffic accidents, the number and types of injuries, the number of fatalities, time events, age of participants and types of vehicles in traffic and accidents.

Data obtained from the medical institutions and the Ministry of Internal Affairs does not overlap entirely for a number of reasons. Injury are more than car accidents, because there are more easily injured in traffic seeking medical help without an inspection and report from the Traffic Police. Also, some very badly injured patients are not treated in medical institutions in the Sibenik - Knin County, regardless of the location of the accident, but immediately, due to the severity of injuries, are passed to the hospital in Split.

3. DRIVER AND PASSENGER INJURY IN TRAFFIC

Traffic accidents in road traffic are the cause of death of 1.3 million people annually (WHO). It is the main cause of death in the world among young people aged 15-29 years. Between the 20-50 000 000 people in the world sustain a non fatal injury, many of which are the cause of permanent disability. Road accidents have a significant source of material loss, both for the participants in them, and for their families and the whole society. Without taking significant action in the world for the prevention of such accidents, the predictions are that by 2020 the number of deaths in the world will exceed the number of 1.9 million victims pro year.

The large number and intensity of Road Traffic accidents are significant for each developmental stage of civilization. With the development of civilization the transport are develops to, the main actuator of development is expressed through the profit. In this development the human health and life were little valued, and it was the development of medicine that had shown all the disadvantages of such a behavior.

Delineation of various serious injuries is a problem both in theory and in practice. This particularly applies to the first report of traffic accident because later course of treatment can significantly affect the final classification of the injury. A special group of serious injuries are *polythraumas.* Those are multiple body injuries of which at least one is particularly difficult and directly threatens the patient's life. These injuries are frequent in modern traffic trauma.

Fatal injuries are injuries that cause immediate death at the site of an accident, or as recommended by the World Health Organization (WHO), no later than 30 days. After this time it is considered that death was due to some other additional diseases.

In forensic medicine death in a car accident can be divided into: Death on the site of an accident - death that currently occurs during an accident or immediately after, but certainly in time while the injured is at the scene. Death in transport - a death that occurs while transporting an injured person, from the place of the accident, to the health facility where the treatment should be done. Death in hospital - death that occurs during the treatment of the injured person, but in the time of thirty days, witch is practice in Croatia as recommended by WHO.

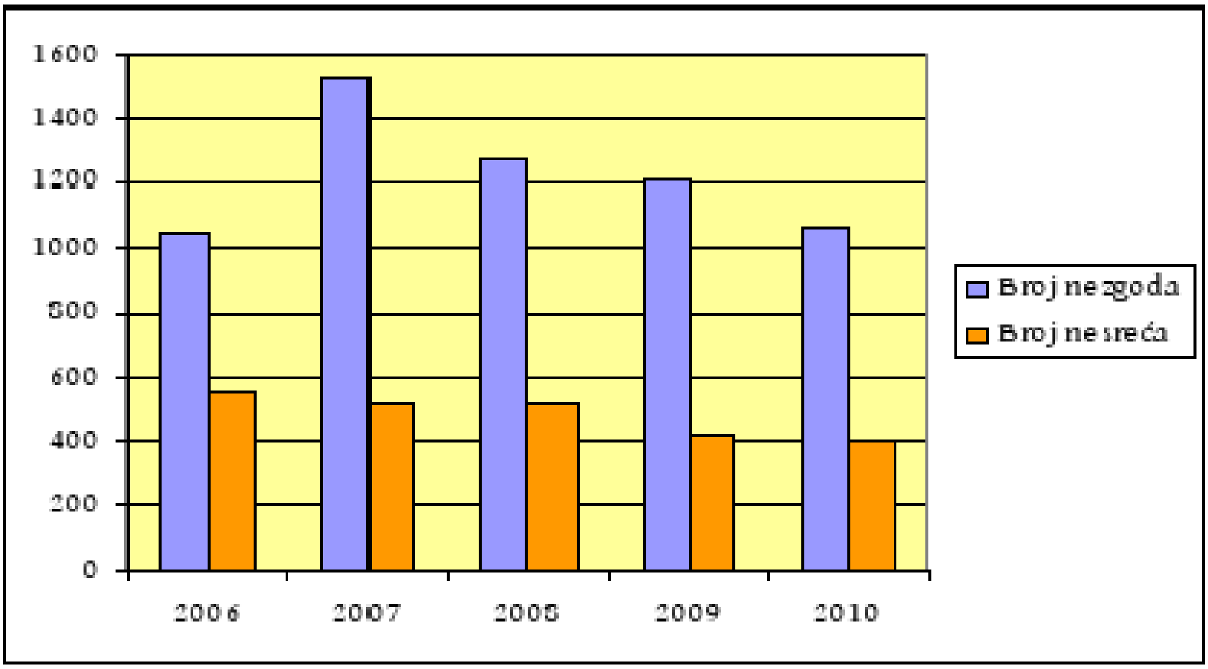
According to the report of the Croatian Ministry of Internal Affairs for the year 2010 improper driver behavior is the cause in 95.6% Road Traffic accidents, pedestrians are causing 3.2% traffic accidents, while only 1.2% are attributed to other causes such as unexpected occurrence of hazards and malfunction of vehicles. Special conditions of participants in road incidents and accidents are alcohol effects, the influence of drugs and disease, while alcohol is the biggest problem and cause more than 10% of all accidents. Under the influence of alcohol, the driver very quickly fails to be aware of his driving ability, relative risk and overestimate his driving ability, becomes careless and inclined to ignoring traffic laws and because of that alcohol can be directly blamed for a large number of traffic accidents.

Fatigue of Road Traffic participants has a major impact on traffic safety, it is a complex phenomenon that has many variations in terms of intensity. Fatigue significantly affects the quantitative and qualitative performance of an individual. The same is valid in Road Traffic, because driving is also an activity, and tires like any other work. The fatigue as a cause of accidents is much underrated. From the statistics in the Republic of Croatia we cud conclude that fatigue is the cause of a very small number of traffic accidents. But due to many reasons, it is impossible to determine how many accidents are caused by fatigue of the participants. From studies abroad we know that a large number of accidents are caused as a result of fatigue or sleepiness. The fatigue of drivers is caused by a number of psychological and physiological factors.

Post-traumatic stress of participants often occurs after the trauma in traffic accidents due to suffered pain and fear. Posttraumatic stress is a set of psychogenic reaction, which manifests itself in an uncontrolled behavior, with signs of psychogenic shock with a drop in blood pressure and fainting, but also in aggressive behavior that occurs immediately after the accident when the affected can physically attack the other participants in the accident. Such injuries are not immediately cited in the treatment of injuries sustained in a traffic accident, they are later established at the request of the injured by a psychiatrist who works as an expert witness. Because of that such injuries are statistically not covered, but they are extremely common in traffic accidents because they are mentioned in almost every claims for damages that injured later sent to insurance companies and therefore their cost is high, not only through the insurance companies that pay the compensation, but also indirectly for the whole society.

4. EPIDEMIOLOGICAL DATA IN THE PERIOD OF YEAR 2006 – 2011 IN THE SIBENIK - KNIN COUNTY

Information for Sibenik - Knin County are as follows:
In year 2006 the number of accidents was over 1000, while the next year, 2007 a sharp rise is recorded, almost to 1600, but in the future there is a gradual decrease of that number. The number of accidents in this period, slowly but steadily falling from almost 600 to 400



Graph 1 - Relation between the number of accidents and incidents in the Sibenik - Knin County for the period from year 2006 - 2011. From (8)

Analyzing the data from Tbl.3.1 we see that the injury has fall: year 2006. -1104 to 804 in year 2010. The most numerous are the head and neck injuries, but it is encouraging that they are in gradual decline.

Table 1 - Distribution of body injuries in the period from 2006 - 2011. in the Sibenik - Knin County.

Injuries	2006 g	2007 g	2008 g	2009 g	2010 g
Heads	352	363	317	308	222
Neck	198	176	154	148	154
Chest	127	125	101	108	90
Shoulder, clavicle and upper arm	50	53	58	57	50
Elbow and forearm	76	75	54	60	71
Abdomen	27	13	21	23	7
Spine	16	18	11	8	19
Hip and thigh	43	39	42	38	34
Knee and lower leg	119	99	100	80	83
Pelvis	8	5	20	8	6
Hands	48	33	30	37	36
Feet	35	24	35	29	24
Polytrauma	5	6	8	6	8
Total	**1104**	**1029**	**952**	**910**	**804**
Total Injury	**4799**				

The number of accidents with serious and minor injuries, in this period is also in a gradual decline, although still at a high level, which were 540 in year 2010. Especially concerning is the fact that the number of seriously injured road participants, yet quite high at 179 in the last observed year 2010.

Table 2 *- Number of accidents with serious and minor injuries in the Sibenik - Knin County in the period 2006 - 2011.*

	2006 -	2007	/2008.	2009	2010
Number of injured	599	566	513	545	540
Sunday and	254	296	263	235	179
Easier injured	850	733	689	675	625
The total number of injuries	1104	1029	952	910	804
The number of injuries per patient	1.8	1.8	1.8	1.7	1.5

The number of fatalities in this period fell by 50%, and this trend should be increased by our preventive activities for the benefit of the whole society.

Table 3 - Killed in traffic in the Sibenik - Knin County in the period of 2006-2011.

	2006 -	2007	/2008.	2009	2010
Killed	22	19	28.	21	11

5. DISCUSSION

Traffic accidents, apart from material damage, are causing irreversible damage due to loss of human life, and emergence of permanent disability. That is why today, all developed countries and almost all European countries are attempting more measures to prevent accidents and incidents making that their global policies, all in order to reduce the casualties in traffic accidents. Croatia is one of the first transition countries to introduce a program for combating the negative trend of traffic accidents and incidents whit a preventive action regime. For this purpose a "National program for road safety in the Republic of Croatia 2006 - 2010" was introduced.

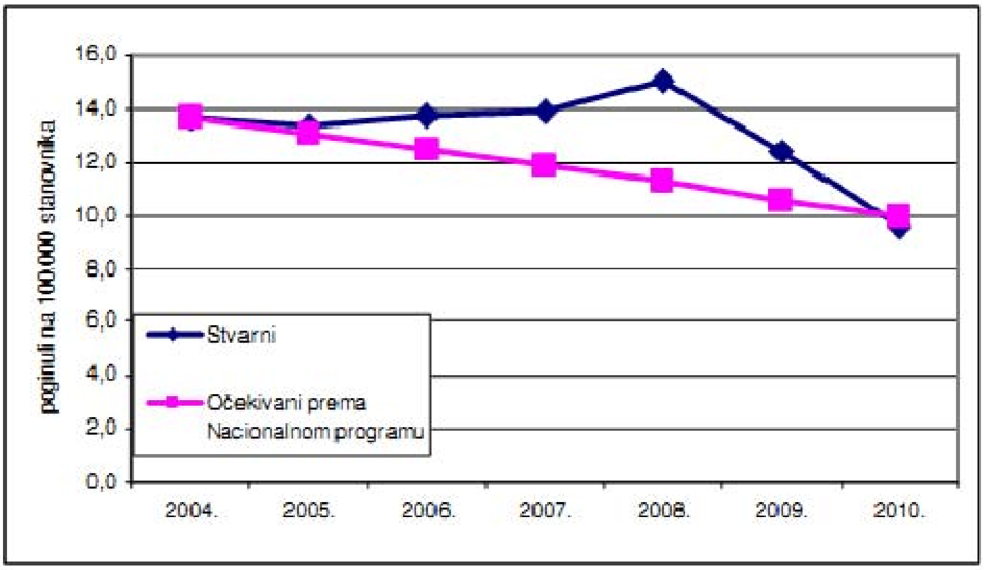
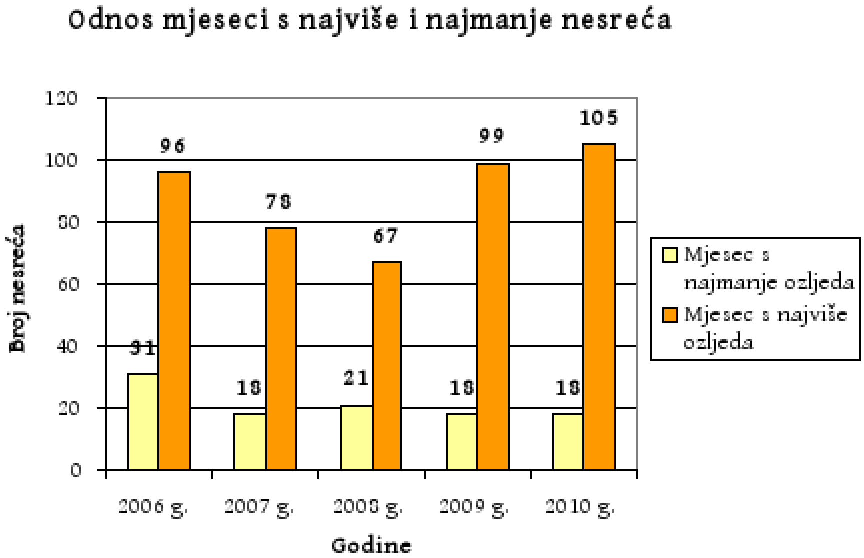


Figure 1 - Graphical presentation of actual and expected mortality ratio in Croatia in traffic accidents from 2004-2010. From (7)

In this sense the records of the Croatian Ministry of Internal Affairs show a significant decline in traffic deaths and thus the success of the National Program. However, given that even 2008th the number of killed was 664 people, more than at the beginning of the decade, and was on the rise, the question is whether the trend will continue, since in developed countries where prevention has been systematically implemented for decades, traffic deaths recorded almost a continuous decline in the last three decades. Reducing the number of deaths in the last two years could be the result of the crisis, which stopped the growth in sales of new vehicles and as a result had a substantial increase of fuel price.

In the Sibenik-Knin County are no significant statistical variation of the number of road accidents or constant decrease in the number of these in the past five years, especially consider that the number of registered vehicles from 2008 to 2010 have fallen by nearly two thousand.

A participant in traffic still remains the most important factor since the majority of traffic accidents and incidents are cause by the behavior of traffic participants. The primary cause of traffic accidents and incidents is inappropriate traffic speed, which is responsible for a quarter of all road traffic accidents. Therefore, respecting traffic laws, adjusting to the specific circumstances in traffic, cultural behavior and a trim vehicle are postulate for the reduction of road accidents and incidents. The Sibenik - Knin County has a discernible rise of traffic accidents during the summer tourist season, which is considerably larger than the increase of accidents in the same period in other parts of Croatia.



Graph 2 - The ratio of months with the most and least accidents in the period from 2006 - 2011. in the Sibenik - Knin County. Source: (5 and 6)

Because of a significant increase of population in the Sibenik - Knin County during the summer months, which unfortunately does not follow an adequately increase of officers and police cars and, which is perhaps even more importantly, the ambulance services in these summer months, when the number of people and vehicles on the roads increases, is still working with the same number of personnel and vehicles that are barely sufficient for the needs of the residual population in the time outside the tourist season.

This is certainly a specificity that must be considered and an important factor in the number of traffic accidents and incidents and their prevention efforts.

6. CONCLUSION

Road Traffic accidents represent today a hidden epidemic in the world. The directly material damage in the world is estimated at over $ 500 billion annually. Indirect damages resulting from participants injuries sustained in the accident, their treatment and absence from work places, are not included in the sum. Most casualties were in fact people in the prime working years. Croatia is not an exemption of the world trend, even for its traffic regulations it belongs to the developed countries, but by the development of road network, vehicle fleet age and education of road users, however, is lingering the richer societies.

Therefore, the prevention of traffic accidents and incidents are the most important thing in planning and managing road traffic. That's why one of the main factors in prevention must be better education of present and future participants in Road Traffic, in which health workers can play an important role. All developed countries are working a long time on preventions and their solutions are, largely depending on available resources, applicable in Croatia.

To understand the prevention of Traffic Road accidents it is necessary to have knowledge of its users, vehicles in traffic and Road infrastructure elements witch are the common factors of occurrence of traffic accidents and their prevention. Given the number of casualties and injuries that occur on Traffic Roads accidents preventing them should be not only a problem of Traffic experts, but also of the whole society. Developed countries, after decades of investing in the prevention of road accidents, have proved that it is possible and that every investment in it, considering the price that society pays for the accidents, pay out, not only because the human life and health, have no price.

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CONTRIBUTION TO TRAFFIC PLANNING METHODOLOGY IMPROVEMENT

ABSTRACT

The subject of this paper is the influence of regional traffic planning on the global development of a selected regional community by monitoring the effects of the construction of the traffic infrastructure. The alterations in local and regional strategies made in order to improve the model of the traffic plans and implement the process of strategic and project management are also analysed. Feasibility / Justifiability studies of the capital traffic infrastructure usually do not comprise either the analyses of the qualitative and quantitative development improvements due to the construction of the infrastructure, or their effects on the economy. The absence of planning and monitoring the impact of the large-scale state projects on the local community poses a special problem. It makes setting strategic goals on the part of the local community particularly difficult. The analysis of the traffic plans and strategies clearly shows that local economic potentials have not sufficiently been taken into account. Therefore, the basic idea is to amend the methodology of devising traffic strategies. The interaction of the traffic and other economic activities is also analysed.

The agreement of economic indicators harmonized in the European traffic flows is a precondition for starting logistic industry in the Karlovac County as a selected regional community. The traffic position of the Republic of Croatia, the existing regional and local strategies are analysed from the point of view of their quality and the correlation of foreign trade and the demographic distribution. The application of various scientific methods and fundamental research that has been carried out show the necessity of introducing innovative methods in the process of strategic planning. The authors suggest improving methodologies in drafting traffic strategies and the application of the strategic and project management.

Key words*: strategic planning, traffic flows, logistic, foreign trade, project management, feasibility studies*

1. INTRODUCTION

In the strategic planning documents the Karlovac County is defined as a region of a balanced economic development accompanied by high-quality education programmes and as a desirable tourist destination. It is based on the principles of a sustainable social and ecological development. The following goals have been defined:

a. Creating preconditions for the economic development,
b. Sustainable management of natural resources and environment protection promotion,
c. Improving the quality of life and educational system, and the development of civil society.

The key advantage of the Karlovac County is its geo-traffic position in the Republic of Croatia. The vicinity of Zagreb and the Rijeka port, the intersection of the main roads and the border with Slovenia and Bosnia and Herzegovina, the probability of positive effects on the Karlovac County enhanced by the growth of Zagreb, as well as a favourable location for companies that export their goods via the Rijeka port, are all the factors of its strategic advantage. The development of traffic is a very important component within the main goals of the social and economic development. It is aiming at connecting all the parts of the region thus ensuring rational cohesion between production and consumption in order to contribute to the effectiveness of the industrial development, a balanced regional development and the imperative environment protection. The existing infrastructure on the local and state level is in accordance with these goals, and the reserves for better fulfilment of the vision and the development of the community goals are in better and more comprehensive programmes, projects and development studies. The role and importance of the Karlovac County in the implementation of the traffic development strategy of the Republic of Croatia is particularly important as the development of the local traffic infrastructure and its share in the overall national infrastructure development has an impact on the economic and social growth and development. Therefore, a particular attention should be paid to the drafting of the local traffic strategy in the context of the overall economic development. A convenient natural and geostrategic position has resulted in infrastructure corridors of strategic importance for the Republic of Croatia. These corridors are the only connection between the continental and coastal part of the region within its borders. The justifiability of the geo-strategic position is based on the achieved results within the road infrastructure which are measured according to different criteria. Within the transport network of the Republic of Croatia, the road transport develops faster than the other sectors. The road network length is constantly growing and the quality of its exploitation and the necessary maintenance is improving.

2. REGIONAL TRAFFIC STRATEGIES

The process of globalisation is the main postulate in analysing big economic and social changes as in our modern world, the restrictions in the flow of goods, services, people and ideas between countries and different parts of the world, disappear. The regions which are either directly or indirectly connected cannot be isolated from the global changes, and although they cannot have a major influence on their overall development, they can be a part of the process and contribute to it. At the time of great social and economic changes new opportunities and challenges are created. In these circumstances, the Republic of Croatia defines its own way and possibilities in finding its path in securing a full membership in the EU. Creating competitive advantages requires establishing our own economic and social advantages, but it is also raising awareness of our disadvantages and weaknesses, which are the obstacles to a full and efficient exploitation of opportunities opening up for the economy and the society as a whole.

The basic document of the present and future development of the region regarding economic and social issues is "The strategic framework for the development until 2013. " This document defines the factors of progress in the competitive market economy within a welfare state adapted to the conditions of this century. By adopting the document on strategic positioning of the regional economy into European and worldwide economy, the comprehensive vision has been created and the priorities of the further economic development defined.

The existence and availability of the infrastructure are the basic conditions in creating positive trends of macro-economic factors with a great impact on the quality and diversity of business policies and also on the attractiveness of a certain country in terms of cooperation and possible investments. Furthermore, the development of infrastructure has to be in function of a sustainable and balanced development of the country and its integration in the European market. The geo-strategic position of the country is an important factor which presumes certain specific conditions for the development of the traffic infrastructure as well as other closely related resources. The development of the Croatian economy is hugely dependent on the adequate and available traffic network of all means of transport with the appropriate technical base which may be achieved by the construction and maintenance of the traffic network. Further development of the traffic infrastructure is based on the following postulates: the strengthening of market mechanisms in the construction and utilisation of the infrastructure; modern system of infrastructure management based on information technology, and the sustainable system of financing the construction and necessary maintenance. Its characteristic is homogenous connecting, as it enables better traffic system integration within the country and also enhances the availability of European traffic corridors. It also creates the complementarity of the regional traffic network and the neighbouring countries in a wider region.

3. REGIONAL TRAFFIC PLAN MODELLING

The development of the traffic plan requires the inclusion of the elements which have marked the changes in the environment according to the multi-criteria principles. The economic criterion, which defines the influence of economic aspects on the local community development, is one of the most relevant factors. In this context, the traffic strategy represents an instrument of the development and realisation of the regional development strategy and the economic development strategy of a certain region. It is also defined as an integral part of both strategies. From the point of view of planning and realisation it represents an interconnected and continuous process. In the defining and drafting strategy processes so far, the concept of one-time basis has been applied. This process has been based on initiating and drafting strategies without any significant involvement of the local team of experts and the appropriate institutions. Therefore, the effects of the work of the team of experts and the application of the strategic management process have been neglected. The strategies implemented so far have usually been the result of the work of the national team of experts who had no insight into the detailed and continuous monitoring of the local or regional elements (e.g. local and regional development strategies). In order to clarify the process of the development of this traffic plan model, the procedures testing the potential effects of the new traffic strategies and methodologies of traffic forecasts were implemented.

Within the context of economic development, the traffic strategy is defined as an integral part of the regional and physical planning development strategy in order to create high-quality physical plans for a certain region. The contribution in defining and creating a new traffic strategy is visible in introducing the process of strategic project management as an inevitable element of a high-quality and definitive mode of strategic development of the local community. A new model of the traffic strategy has been created based on the elements of the strategic management processes. The analyses of the natural indicators have been carried out, and the mission, vision and goals have been defined while the parameters of the continuous adjustments of the strategic plan with the final results of their application have been evaluated.

By introducing the elements of the strategic and project management the long-term guidelines of the overall development of the region, including the economic effects, are determined. Specific goals are set, and the strategy and/or strategies to reach the above-mentioned goals, including all the relevant internal and external circumstances are developed. Furthermore, the tactic activities in order to fulfil the set goals are pursued. In order to present and analyse the mentioned phases of the model of a new traffic strategy, the following has been taken into account:

- Environment analysis
- Setting and directing the organisation while defining the mission, vision and goals.
- Forming the strategy within the framework of the regional traffic planning based on defining and drafting the traffic study and technical traffic study.
- Implementation of the strategy which defines the dynamics and the leaders of the future programmes and projects
- Control and evaluation

Environment analysis implies the analysis in the internal and external environment, which is best shown by the SWOT analysis. By analysing the favourable opportunities and possible threats, potential strengths and weaknesses, the goals of the future traffic development are set. The future development strategy is based on them.

Economic development, which is a precondition of the overall development, is an integral part of the analysis in the process of drafting the traffic strategy. Economic potentials of the region are presented through the possibility of developing certain economic sectors and the so-called “opportunities“ for the development of the logistics industry are analysed from the point of view of the traffic and transport development. Geostrategic position simply implies certain solutions in planning and evaluating traffic solutions. The same applies to the development of the economic infrastructure in the form of industrial zones, business and residential zones and tourist potentials etc. It is worth pointing out that the local infrastructure should be accepted and the development of such projects made possible in real time in order to avoid any future lengthy procedures to change the existing traffic and physical plans in the process of starting new investment projects. The experiences so far show that starting a new project (e.g. a logistic distributive centre with a business zone, next to a traffic junction, that has not been included in the traffic study and physical development plan) would take between 3-5 years. Such a lengthy procedure is totally unacceptable to any serious investors. In such a context, the traffic study comprises the following:

Travel generating - drafting the documentation based on:
- Existing physical planning documents and studies analysis,
- GIS bases analysis,
- Traffic research,
- Economic development plans analysis.

Travel distribution based on:
- Existing traffic demand analysis,
- Generating and attracting traffic analysis,
- Defining basic modelling elements - traffic zones.

Travel allocation based on:
- Existing infrastructure capacities analysis,
- Infrastructure development needs analysis.

The continuation of the process, after the completion of the traffic study and physical - technical study, is linked to the activities and tasks of the multi-criteria analysis. According to various definitions it is a procedure of selecting the best solutions or the selection of the acceptable versions which offer the optimal value according to the beforehand determined criteria (Figure 1).

The decision regarding the choice of the optimal solution is based on various elements while taking into account both positive and negative effects.

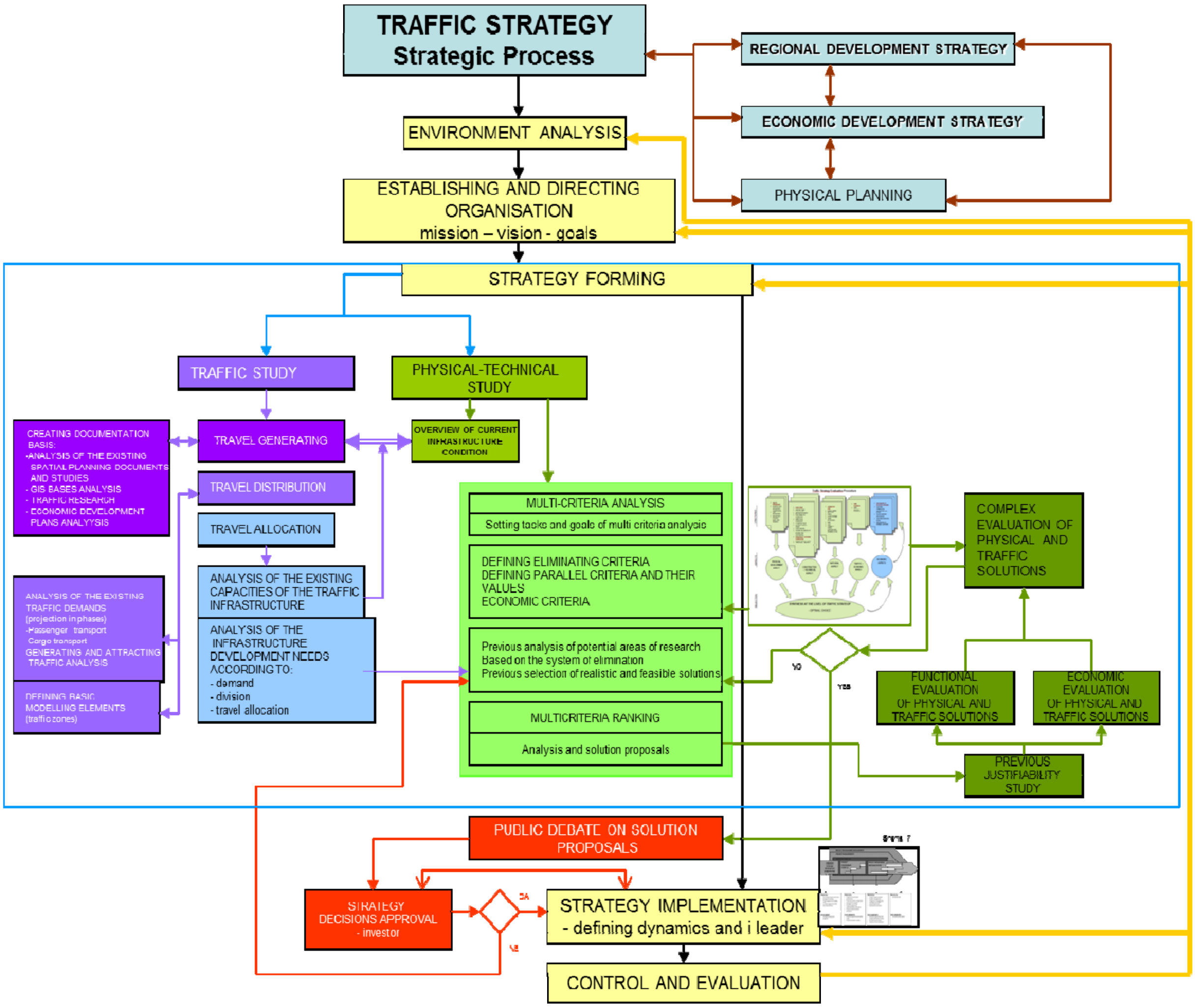

Figure 1 - Process of Traffic Strategy

Since there is a vast number of techniques and influences on the development trends, risk insurances and ways of utilising local advantages, it is necessary to take into account the methods that are focusing on practical elements of intuition, experience and professionalism. The procedures of multi-criteria optimisation and solution selecting, require the existence of certain preconditions. First it is important to define the criteria and draft various solutions through the cooperation with different professionals and experts from the local community. In order to reach the final decision, all the plausible solutions go through the procedure of public hearing thus creating the conditions for accepting the decision on the future strategy. Determining the policy for the development study realisation is an inevitable step in the regional traffic planning procedure.[4] Based on the public hearing, it is possible to foresee the measures which will ensure the realisation of the future development goals. While selecting the final version of the physical traffic solution, it is important to take the following factors into account: social, economic, financial, administrative, legal etc. In this way it is possible to ensure high-quality strategy implementation.

Approval of the decision on the strategy is the last step in the overall procedure of drafting it. It means that accepting the decision on the strategy, (i.e. the regional traffic system plan), is a result of the joint work of the expert services, while the final goal is the social and political communities' framework. The interconnection and reciprocity are the basic postulates of functionality in the process of decision making. The basis of success and the speed of decision making depend on having sufficient and relevant information, which means that the procedure of the previous justifiability study and complex evaluation of the traffic and physical solutions have to be carried out in a high-quality and professional manner. All these are preconditions for approving the decision on the strategy.

Approval of the decision on the strategy may be done in one of the three below mentioned ways:[6]

- Direct adoption of one of the suggested solutions as final
- Combining elements or components of several versions into the final plan
- Re-defining and formulating the strategy proposal based on the suggestions received form general public and suggestions given by planners which have arisen in the process of preparing and evaluating possible alternatives.

By regarding the implementation of the strategy as a special phase in the process, the emphasis is placed on the transformation of the created strategy for further business activities while certain preconditions are being noted. First and foremost, it is necessary to compare the existing organisational structure with the goals of the new strategic solution in order to achieve positive results. The next step is to divide the defined strategy into a series of specific steps and present the necessary activities through the system of detailed plans. Another important element is defining the critical points of success, but also controlling compatibility of the processes during implementation. It is important to monitor the planned values and act if necessary by introducing modifications if new circumstances occur.

4. CONCLUSION

The geo-strategic position of the Republic of Croatia is to a greater extent already estimated in Pan- European Corridors. The Karlovac County has the central position in the Republic of Croatia and it contributes to the overall economic development, but it also provides new perspectives in the sphere of logistics. The historical analysis of the impact of traffic on the development of Karlovac and the Karlovac County has shown the need for strategic thinking, planning and permanent monitoring of its influence on both regional and national traffic infrastructure development programme. On the regional level, the lack of the strategic approach in drafting and implementation of the traffic strategies is obvious. This results in already mentioned inconsistencies and absence of continuous modernisation in accordance with the needs of the local community, and the lack of the solutions imposed by the high-ranking plans. The analysis of the intensive development of the traffic infrastructure, especially road infrastructure, in the Karlovac County proves that the construction of the traffic infrastructure will have a crucial impact on the economy. The essence of the strategic development planning on a regional level is based on the analysis of all the potentials present in the local community and its environment. The suggested methodology of the traffic modelling is based on the presence of the above-mentioned strategies, their interconnection and continuous innovation. In this way, the traffic strategy becomes a *modus vivendi* of the economic growth. The innovative approach does not only contribute to the quality and integrity of the strategy, but also offers opportunities to beneficiaries, users and potential investors in the region to better prepare their projects.

The traffic strategy methodology development is based on the principles of strategic management through its phases thus ensuring permanent involvement in creating, implementation and control. Active role and involvement of local officials, investors' representatives, local institutions and companies representatives as well as local experts is crucial at a regional level. The applicability of the results of this research is evident in the possibility of defining strategic guidelines in creating traffic plans and strategies, especially with the regard to overall economic potentials. The results of this research may be used as a basis for further researches in this area. The potential users may include scientist, local officials, planners and company managers when drafting internal activities plans.

Methodological and scientific foundation of this paper shows the need for systematic traffic planning and the need for physical - traffic, integral studies, which would provide the basis for the strategic physical planning documents. Therefore, all the competent authorities involved in traffic planning activities on both macro and micro levels must have the adequate explicit and multi-disciplinary skills and understanding of the traffic phenomena and flows in general, especially with the regard to traffic offer and demand.

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ANALYSIS OF REVERSE LOGISTICS ON THE CROATIAN MARKET

ABSTRACT

Although a new segment of logistics activities, reverse logistics activities in Croatia are improving customer satisfaction, ecological conscience and level of profit, but are in its very beginnings. Reverse logistics is characterized by the fact that returned products in Croatian companies are a problem that is solved as an issue at a time. The uniformed procedure very rarely exists and every product is handled differently, by different person and often just preceded to someone else to solve it. Development of reverse logistics uniformed systems based on researches could improve routing of different goods that entered reverse direction in a channel that will provide proper activity for each of those goods. The right decision and the right routing about every case (product) can be critical for the firm and affect amounts unnecessarily directed to landfills.

Key words: *reverse logistics, logistics systems, business development, reverse logistics activities*

1. INTRODUCTION

In year 2011.research conducted for the purpose of evaluating development of reverse logistics in Croatia, implicated that some activities, when compared with results from 2010., are on higher level. Conducted research in 2011.included 25 companies and 700 examinees, for the benefit of seeing the concept of reverse logistics from two different aspects, customer point of view and companies point of view. In 2010.results were indicating that the primer goal of reverse logistics in Croatian companies is to keep the profit inside the company and to avoid returns in any case. Also, companies mentioned that they are not interested in development of activities of reverse logistics, and that some of them already exist. As some basic barriers for implementation of new reverse logistics activities and reorganization of their current supply chain, in 2010.,companies mentioned lack of financial resources and companies policies. Customers were not satisfied with strategies of reverse logistics chain (even 59% of examinees) and often mentioned that return policy should be more liberal. In developing logistics systems, customers are seen through the lance of end consumer, but not potential and equal subject in existing supply chain. Including consumer in activities of reverse logistics could result in fewer items unnecessarily directed to landfills because consumers are trying to make an impact to be sure that environment will be safe and healthy. The trend of ecological awareness connotes to properly dispose every product, but also could connote to return the used product to reverse logistics system for the benefit of re-using. Re-using the product or its parts can be observed from any aspect when directing it by a professional evaluator to any reverse logistics channel that will provide maximal added value for returned product.[1]

2. REVERSE LOGISTICS CONCEPT

The separation of logistics on forward and backward one has begun and is making a bigger distance for the benefit of providing reverse logistics activities with the same excellence. Although the priority in distribution logistics, tendency is to handle returns quickly and efficiently because of ability of returned products to lose value when unnecessarily retained in reverse logistics chain. The main difference between distribution and reverse logistics is that all the products in the reverse chain have to be individually manipulated because each of those products has specific reasons why it was returned and how it needs to be dispositioned. After returning a product in a company, the firm has many options, but depends which reverse logistics channel company included in their chains. Some of those channels are return to supplier, sell through outlet store, resell, remanufacture, refurbish, landfill, etc. Recapture value or proper disposal are two main channels in reverse logistics. When implementing reverse logistics activities, managers in companies often mistakenly believe that outbound operations can also handle returns simply by running everything in reverse. Reverse logistics operations must manage a number of unique functions that are not included in outbound operations: collection of outdated, unwanted or damaged products as well as packaging. Except perfectly organized activities that must be created based on the company's needs, a good and effective reverse logistics must provide information system that will follow existing program to reduce costs.[2]

Some of the strategic directions for the company are to develop a reverse logistics chain with uniformed procedures, educated employees, to consider a creation of a collection point, which is in ideal circumstances, for managing all products that entered reverse logistics chain a centralized return center.[3] Also, in planning a reverse logistics concept, company should also pay attention to implement activities that will support green logistics management.

3. REVERSE LOGISTICS ACTIVITIES ON THE CROATIAN MARKET

3.1. Implementation barriers

Many of Croatian companies (excluding multinational) did not implement advanced reverse logistics activities in their systems because they do not yet recognize them as strategic. Main barriers are the lack of interest, lack of systems, company's policies, management inattention, financial resources and lack of educated personal.[4] Figure below presents results of conducted research in year 2010. and 2011. It is visible that more companies are interested in development of reverse logistics processes, but even 40% of examinees are not implementing those activities because of company's policies. Although results present that awareness of importance is higher than in 2010., not implementing activities results in the fact that none of examinees think reverse logistics information system is not necessary.

Table 1 - Barriers for implementation of reverse logistics

Barrier	2010.	2011.
Activities exist, not interested for development	47%	54%
Company policies	25%	40%
Lack of system	2%	0%
Competitive issues	2%	10%
Financial resources	19%	27%
Personnel resources	1%	9%

Source: Authors

3.2. Location for return

As uniformed procedures are not specific for reverse logistics systems in Croatia, consumers are often returning products to different locations. The most common one is to return a product to a location where it was bought. This location was a choice of even 76% of examinees (they returned a product to retail), while 10% returned it directly to official service. When asked, examinees specified that returning to retail location was a logical choice, although research implicated that 16,5% of those examinees were directed from retail to another location to claim the product. Redirecting consumers has a negative effect on disposition cycling time and also affects customer satisfaction.[5] These redirected customers were unsatisfied with return policy and noted the occurred lack of information about return procedures.

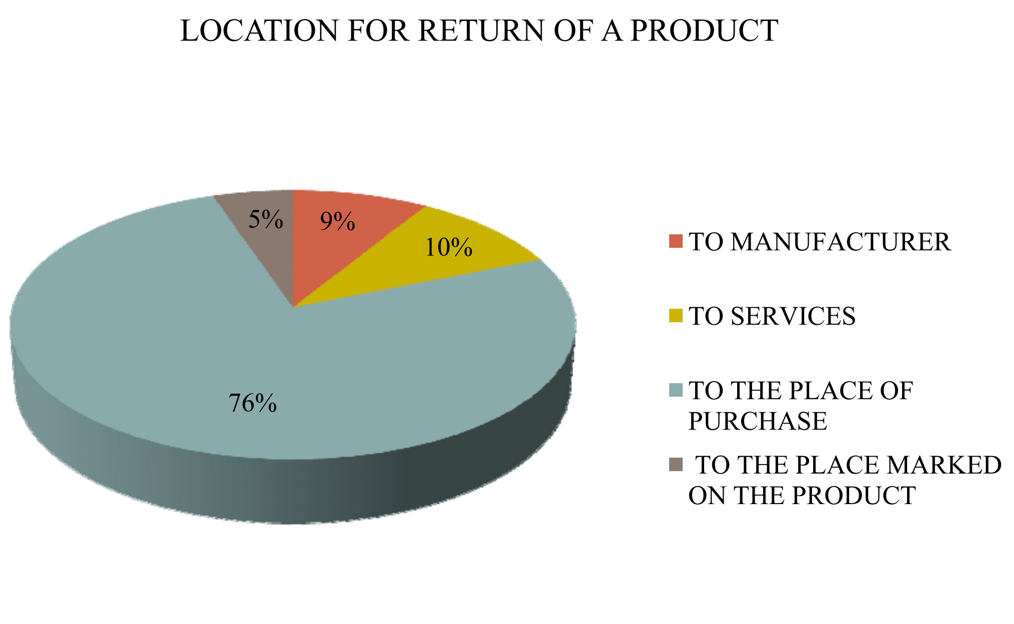


Figure 1 - Location for return of a product
Source: Authors

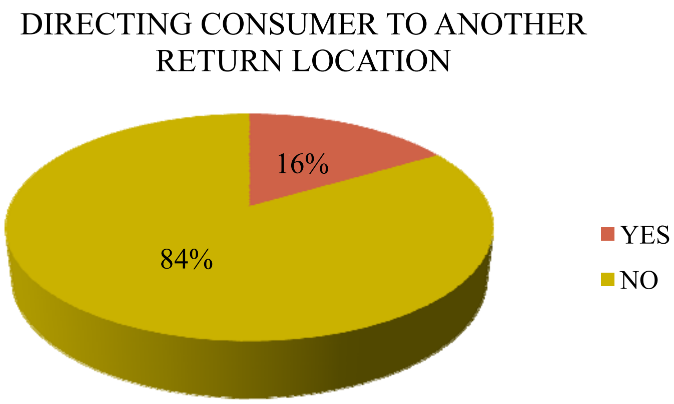


Figure 2 - Directing consumers to another return location
Source: Authors

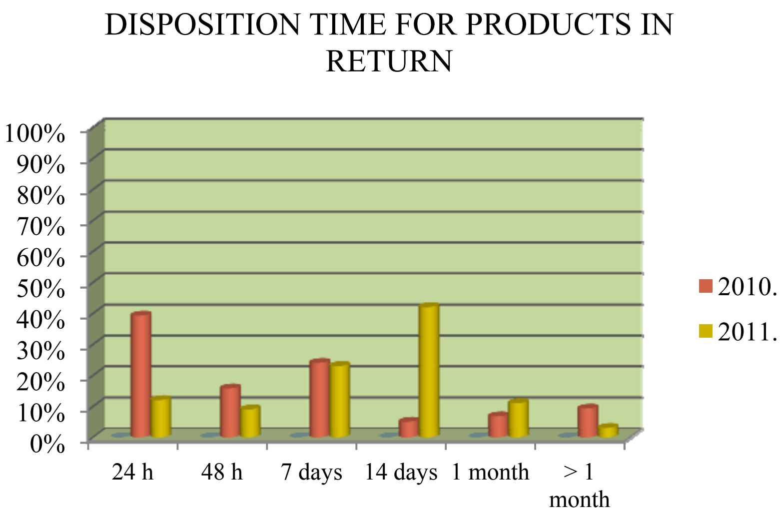
3.3. Disposition cycling time

Disposition cycling time is a process that effects on service quality and possibility of enabling highest recovered value for the product. Extended DCT can result in unnecessary logistics cost, finance issues (poor management), extended decision making about the condition of the returned product, lost opportunities and business, inefficient warehousing and dissatisfied and lost customer.[6]

Reverse logistics operations in Croatia are on the base level where they exist and are operated as a current need that is solved by issue at a time. As whole reverse logistics system is in its very beginnings, disposition cycling time is unnecessarily prolonged. DCT can be shortened by providing uniformed procedures, educating employees and having well informed consumers.

Research implicated that returned product is in system on an average 7 – 14 days. Although consumers do not expect return in one day, the existence of a fact that some of the consumers waited for return over a month is an issue that should be solved.

Shortening disposition cycling time will be adjusted by globalization and increasing consumers and demands for a better service.

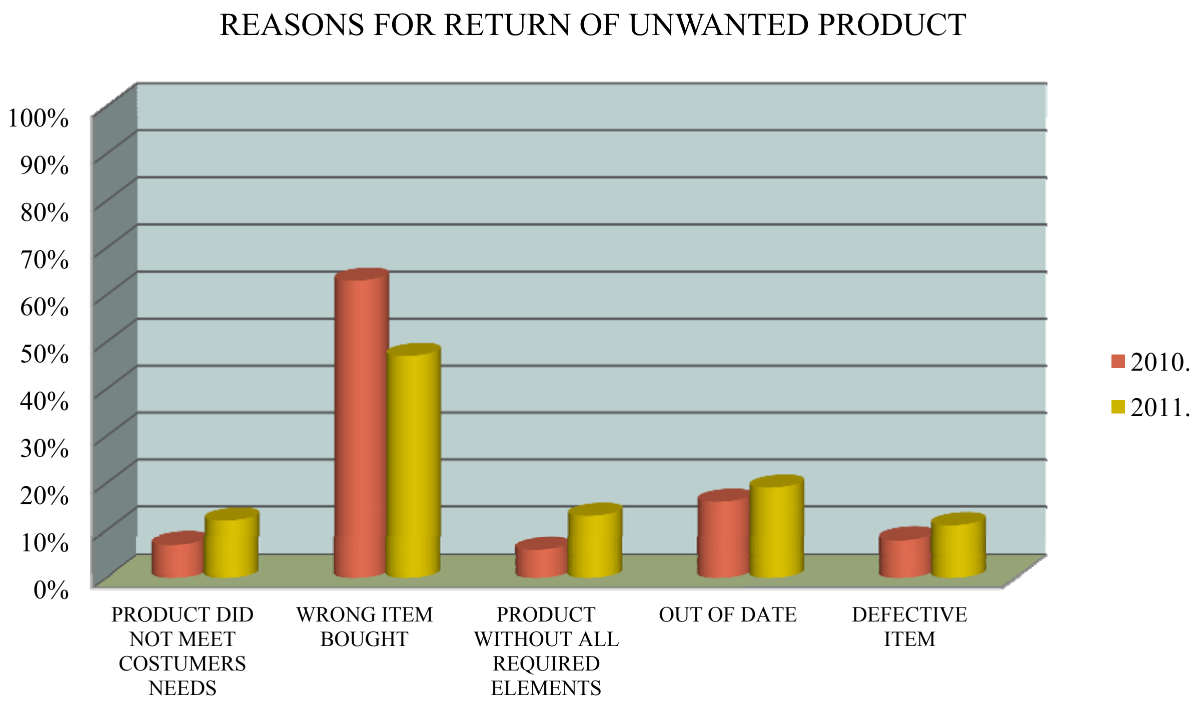


Graph 1 - Disposition cycling time
Source:Authors

4. CUSTOMER AS A PART OF REVERSE LOGISTICS PROCCESES

4.1. Reason for return

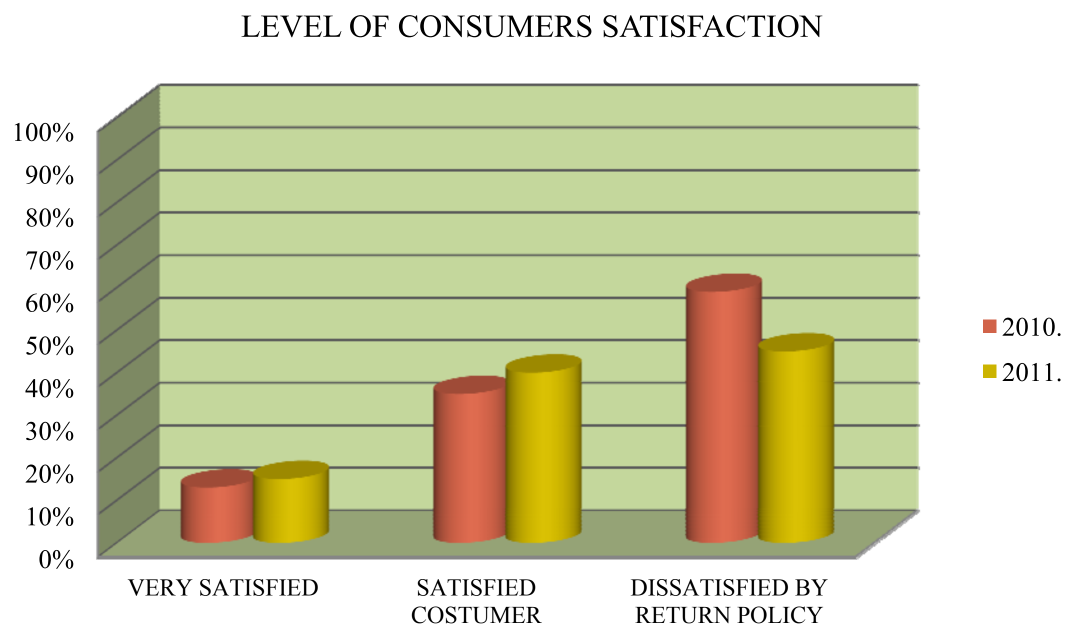
Level of liberalization has a great influence and partly classifies the level of development of complete reverse logistics system. Figure presents the reasons for returning the products from the aspect of consumers, where the number of returned products, because of not meeting consumers need, implicates the level of liberalization. When liberalization is on higher level, consumer can return a product from any reason, even if he doesn't like it. The number of returned products that did not match consumers needs in 2010.was only 7%. As reverse logistics activities are starting to be strategically observed, companies are trying to slightly liberate possibility of return to have a locked consumer. From the other point of view, consumers are returning products more often and are more aware that possibility for return must exist. In 2011.conducted research implicated that the return of a product that did not meet customer needs increased on 12%. The classification for "wrong item bought" is specific for not liberal return, because it is determinate as an excuse for returning an item. In 2010.the amounts for this category were 63%, while in 2011. these amounts decreased on 47%.



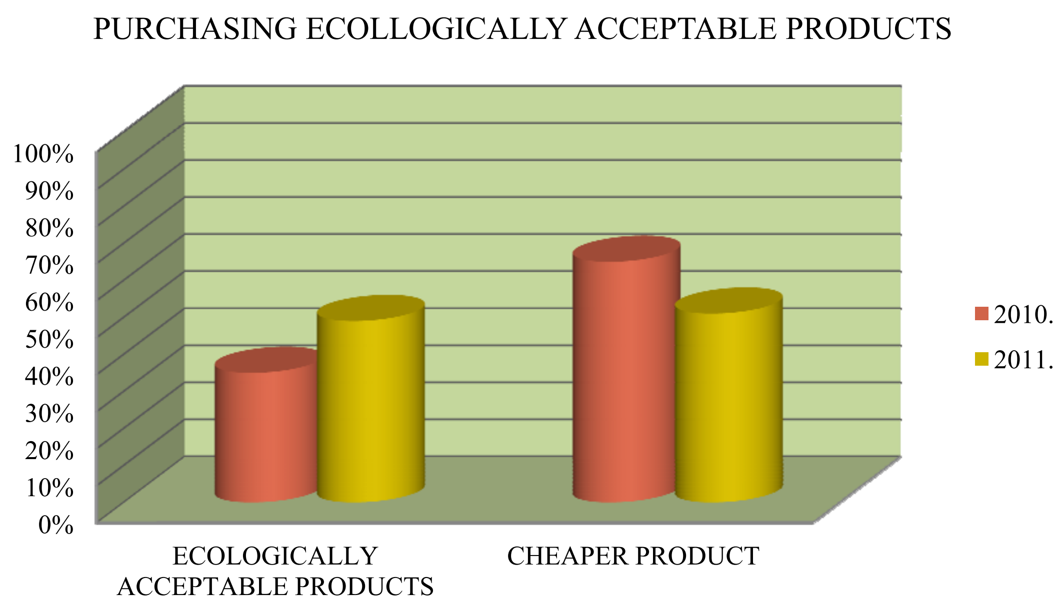
Graph 2 - Reasons for return of unwanted product in Croatia
Source: Authors

4.2. Ecologically acceptable product

Conducted researches implicated that consumers in Croatia are not well informed about reverse logistics activities. Croatian companies based their reverse logistics strategies on keeping companies profit primer issue that automatically sets consumer satisfaction as secondary matter. In 2010.and 2011. very satisfied consumers counted 13% and 15% of total examinees. Also, as increase in level of consumers satisfactionis noted, conducted research implicated that consumers are ecologically sensitive, and in 2011. even 49% percent of examinees would rather purchase ecologically acceptable product over the cheaper one. Results of the questionnaire conducted on one hundred random examinees in 2010. implied that even 35% of examinees would rather buy ecologically acceptable product than the cheaper one. Ecological purchasing is small step of everyday consumer, but it will make a difference when in a future 90% of purchasing is made with ecological thinking.



Graph 3 - Level of consumers satisfaction with return policy
Source: Authors



Graph 4 - Purchase of ecologically acceptable products
Source: Authors

5. CONCLUSION

Although reverse logistics processes in developed logistics systems has already established a concept of return that will provide a secure profit, image of know how company, satisfied customer, possibility of upgrading, etc., Croatian companies are just recognizing strategic variables of implementation of RL activities.

Returned products in Croatian companies are still a problem that is solved as an issue at a time. The procedure does not exist (or very rarely) and every product is handled differently, by different person and often just proceeded to someone else to solve it.

Activities that, according to the questionnaire conducted in 2010. and 2011. exist, are mainly only a fact that a customer actually can return a product. This return of a product will provide some kind of activity but not in a way that will result in a maximal added value of each product or proper disposal in every case. The positive aspect is a fact that in every researched segment of reverse logistics, in year 2011. is noted progress. Companies are more aware of the need to implement activities of reverse logistics and understand barriers for implementation. Croatian companies are tending to indulge consumers through liberating the return policy. Financial issues are noted as a barrier, as in companies while implementing activities, but also among consumers while purchasing ecologically acceptable products which are more expensive. Issues as prolonged disposition cycling time, unorganized flow of returned goods, not educated personnel and consumers are still present and typical for developing logistics systems as Croatian.

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RETURN CENTERS CONCEPTS ON THE CROATIAN MARKET

ABSTRACT

*Strategy of designing a green supply chains is to raise the level of environmental conscience, as a matter of thinking and as a marketing strategy on competitive global market. This strategy is a result of the need for a perfectly closed green supply chain***.** *Reverse logistics is a part of green logistics that sugest movement of goods from destination to origin to enable reprocessing, remanufacturing, repairing, reusing, recycling, disassembling or disposing. As forward logistics procceses include an organization of warehouse procceses based on market and optimization requirements, reverse logistics warehouse requirements depend on organization of evaluation and specific procceses for each returned product. When combined with forward logistics, reverse logistics flow comes of secondary matter, so interaction while warehousing and evaluation should be strictly separated. Developing logistics systems often combine forward and reverse warehouse procceses, which results with ununiformed flow and not optimized reverse logistics concept.*

Key words*: return centers, reverse logistics activities, warehouse capacity, logistics channels*

1. INTRODUCTION

Reverse logistics processes tendency is maximization of recovery values of each product that entered reverse channel. Main differences between distribution and reverse logistics are quantity and specification of subjects in chains. Distribution logistics mainly procceses larger amounts of goods, while reverse logistics processes include each good returned in chain for a different reason and from a different source. As reverse logistics procceses needs to be specifically dedicated on each and every returned item there is a significant impact of procces organization on aims of reverse logistics that include satisfied consumer, company's profit and ecological aspect. To satisfy aims of reverse logistics, organized activities need to be accompanied by reverse logistic process improvements as gate keeping, reduced cycle time, returned product decision, movement and processing. Reverse logistics operations, especcially in developing logistics systems, as Croatian, are at the very begginings, solved every time differently, with no educated personnel and no optimization wanted because of the lack of interest for it. Ununiformed procceses that are being provided on different levels of supply chain for a product in return include returning products to vendors, manufacturers, services and wholesalers. Organization of a collection center for returned items would provide uniformed reverse logistics activities for every product, resulting less items entering reverse chain, higher recovered value of returned product, educated personnel, less items unnecessarly directed to landfills, etc.

2. REVERSE LOGISTICS CRITICAL PROCCESES

Proccesses that are critical when organizing reverse logistics flow are gatekeeping, decision making, disposition cycling time, planning and monitoring. These procceses can directly affect on efficiency of whole reverse logistics chain.

2.1. Gatekeeping in practice

When having optimization issues in reverse logistics processes, one relevant point that is often not monitored, is the entering point of the chain. Gatekeeping assures supervision and classification of returned product. Even developed reverse logistics systems consider this point relevant and find it crutial in minimizing amounts of not authorized products entering the chain. Every product that enters wrong channels, or enters channels at all, can provide additional costs and affect companies business. Gatekeeping point also will assure that non defective defectives (products that are not defective but are returned because of lack of consumer's knowledge) do not enter reverse logistics chain. These returns are labeled as returns that have no functional or cosmetic defect. Researches present a number of reasons why non defective defectives returns occur, including installation difficulties, product performance incompatibility with consumer preferences and remorse. For example, reserch implicated that HP's non defective defectives returns can account for up to 80% of their inkjet printer returns. Since HP's total consumer product returns average slightly higher than 6% of sales, non defective defectives returns average approximately 5% of sales.[1] Non defective defectives represent even 20% of returned product in developed reverse logistics systems.[2]

2.2. Decision making

Further flow of the product that entered the chain includes decision making about the condition and the channel where it will gain the maximal value. Channels offered as a solution for each and every product can be different, depends on the company strategies. Typical channels that disposition includes are the return of goods to the warehouses for storage purposes, return of goods to the original manufacturer for the return purposes, sales of goods on a secondary market, recycling of goods or combination thereof which will result in maximal value of the key product.

Assuring that the product in return is an obligation of the company and assuring that this returned product will be routed to a channel where it will gain the highest return rate is one of the strategic decisions for implementation of good reverse logistics activities into companies business.

2.3. Speed in processing – Disposition cycling time

Although there is a huge difference between forward and backward logistics there is a connection not only in the same products that they are processing – one to the customer, one from it. The speed in processing those products is one of the crucial characteristics that affect the quality of the chain. Disposition cycling time (DCT) is a reverse logistics process that effects on the recovered value of the returned product that entered reverse logistics chain. If reduced and strategically implemented, DCT can improve companies profit by providing the highest return rate. One of the ways to enhance the disposition value of refurbished goods is through speed.[3] Disposition cycling time more than 40% of developed reverse logistics systems considers as one of the challenges of reverse logistics process organization.[4]

2.4. Planning, forecasting and monitoring

Implementation of software for forecasting and planning of reverse logistics processes is complex because of impossibility of controlling the return from consumer, documentation issues, returning location, return reasons, etc. When designing a reverse logistics strategy for company development, implementing information system after organization of required processes is of crucial matter. Every optimization must have some kind of information technology back up, so this software is also essential for control and transparency all along the reverse part of the chain. Choosing software that will provide right information at the right time for a specific company can be challenging because of availability. Appropriate information technology should integrate and standardize reverse chain processes (what is untypical for reverse logistics). Except for optimization, information system must grant statistic activities, so every mistake or a fact must be recognized by administrator or personnel and be removed or optimized. Statistic will provide foundation for better and upgradable planning.

3. REVERSE LOGISTICS ACTIVITIES IN RETURN CENTERS

When product is returned and observed as an individual unit, basic reverse logistics flow includes: return from the consumer, inspection by the professional and then streaming to the path that will yield the highest recovery rate for that unit. The disposition of the product includes all the processes that product will pass in reverse logistics channel. Tendency is to minimize disposition cycling time for the benefit of customer satisfaction, losing value and optimization of processes. The product can be directed in different channels: the return of goods to the warehouses for storage purposes, to the original manufacturer for the return purposes, sales of goods on a secondary market, recycling of goods or combination thereof which will result in maximal value of the key product.

Organization of reverse logistics chain in developing logistics systems often provides only basic, ununiformed activities, with no educated personnel and return center for returned items. This kind of flow will result with high return amounts, unnecessary transport costs, minimal or no value recovery for returned products, prolonged disposition cycling time, lower level of consumer's satisfaction, higher amounts directed to landfills, etc. Typical unorganized reverse logistics flow is visible in figure below.

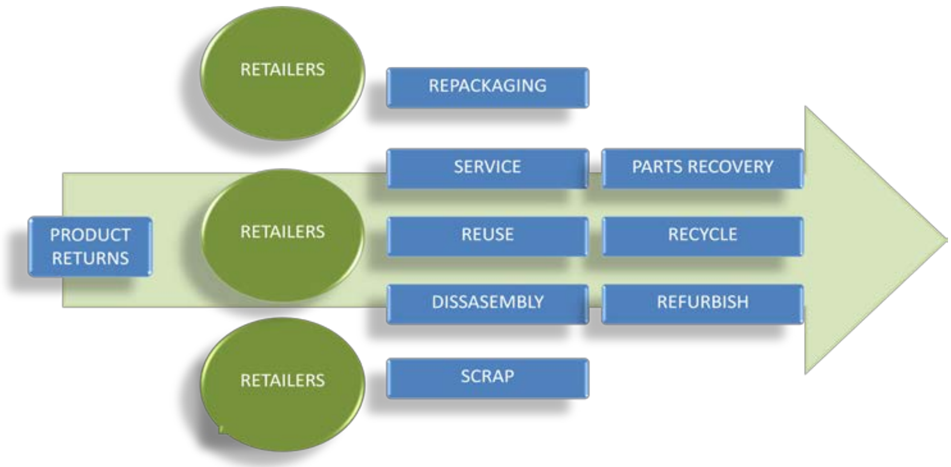

Figure 1 - Unorganized reverse logistics flow
Source: Authors

To optimize reverse logistics processes, companies can provide central facility for managing returned products. Physical separation and focused control on the flow of returned goods and employees can improve management information, decrease amounts of goods that are directed for landfills, reduce store level costs, form upgraded returns inventory control, simplify store procedures etc.

Basic activities in return centers provided for returned products are sortation, storage, evaluation and directing to channels. To optimize critical processes for all returned products return center will provide specified, uniformed procedures based on product specifications. Returned products are inspected by educated personnel in gate keeping process, and then are sent to storage location. Evaluation process for returned product also includes educated personnel that will provide high accuracy evaluation in short time and direct it to the channel where it will gain maximal value.

Except basic activities, company can provide activities in return centers based on the needs, trends and specification of products in return. Some of additional activities that can be provided are:

Refurbish- most of the structure of the product is untouched, the product gets its "as new„ condition by some cosmetic changes such as minor repairs, new paints, cleaning, removal of stains, scratches, etc.

Recondition – product overhaul, but not manufacturing process. The basic structure remains the same, but the worn out or failed parts are removed or replaced with new ones.

Repair – Replacement of faulty or failed parts to make the product usable again

Dissasembly – Removal of parts from used products without damaging the parts. These parts are later reused or recycled, the rest of the product being either recycled or disposed.

Reuse – use the product again without any alterations (includes transport packaging)

Recycle – collection of used and faulty products so they can be used again, either in the same form or in a different form.

Disposal – directing to landfill after only non salvageable material is left

Providing central return center company can also optimize transportation processes, by consolidating return items by aggregating small shipments into a large shipment and routing them only to one destination. Transportation costs can only increase when evaluation results with decision to direct item to landfills.

4. UNIFORMED CENTRALISED WAREHOUSE CONCEPT

Research conducted among Croatian companies and consumers resulted with the fact that procedures in reverse logistics existing systems are not uniformed and that the item is mainly returned to the location where it was purchased. Consumers rarely know the procedure of return in specific company and 60% of examinees are not satisfied with provided service. Some of the examinees waited return for couple of months, often when service was included. Flow of returned items was not uniformed in 2010. in 20% of examined companies, while this number increased at 86% in 2011. Consumers were sometimes directed from one place to another to return item. Educated personnel in companies for return products in 2010. had only 2% of companies that were included in surveys. Number of educated employees increased on 32% in 2011.

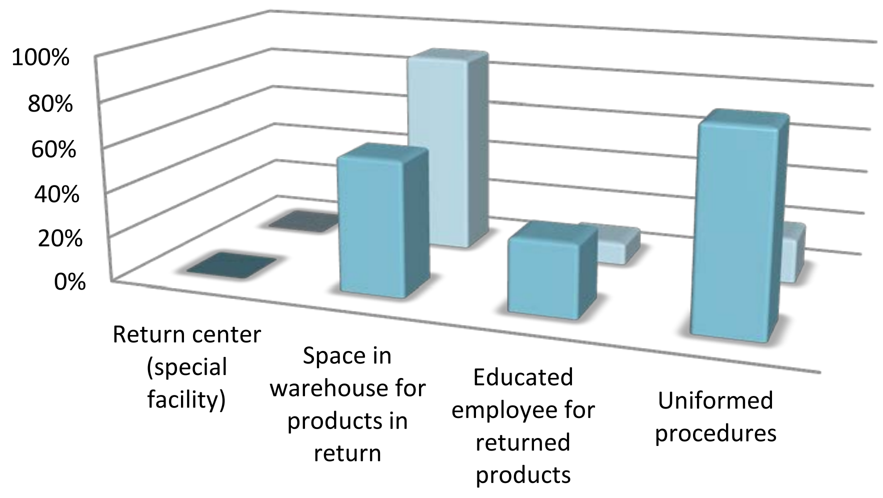

Figure 2 - Reverse logistics warehouse issues in Croatia, research conducted in 2010. and 2011.
Source: Author

Customer service is provided in retail and by different and often not educated employees. Conducted research implicated that centralization of return flow on the Croatian market would be beneficial from different aspects. Companies should optimize the flow by organizing return center as a part of existing warehouse if facility is not necessary (depend on returned amounts). Return center should include basic processes (sortation, storage and evaluation). If amounts are not high, the same and educated employee can provide sortation and evaluation process. The positive impact of employee that is dedicated only to return processes is continuous specialization in decision making. Channels provided for directing the product must be organized from the aspect of product specification and market demands. All the required channels must provide possibility for directing every returned product in a channel where it will gain maximal potential value.

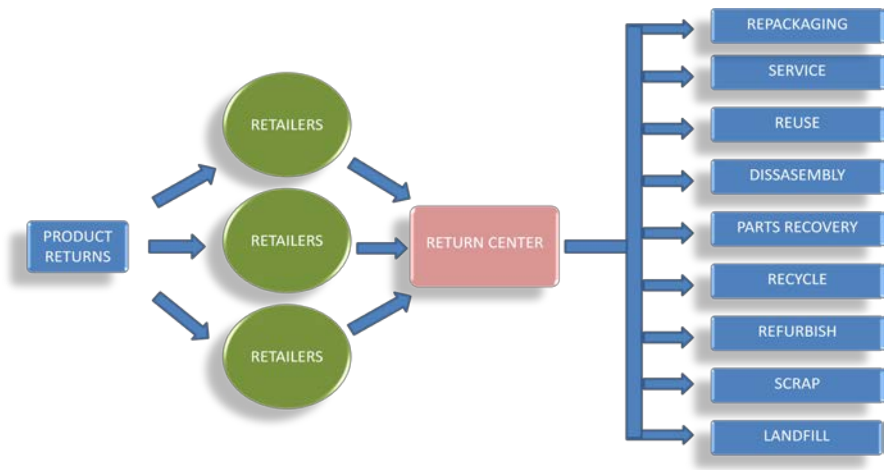

Figure 3 - Centralized return flow
Source: Authors

After organizing the flow of returned items, company should optimize processes that are typically critical in reverse logistics (gate keeping, decision making, disposition cycling time, support system and planning). For evaluating reverse logistics processes in developed logistics systems, company's continuously conduct researches among consumers, trace their returned products and make financial reports in this segment. Also, because of trend of ecologically acceptable business, companies measure ecological impact of dedicated processes.

Although reverse logistics process organization in Croatia is developing, companies should follow trend of developed reverse logistics system that are characterized by 93% of satisfied consumers, 4.42 average days part return time, 21% decrease in cost per RMA over the past 12 months. Although those companies are labeled as best in class performance, conducted research presented in figure below implicated that existing challenges still exist in developed reverse logistics systems and are tendency to minimize amounts of non defective defectives, reducing disposition cycling time, establishment of customer service for return procedures, etc.

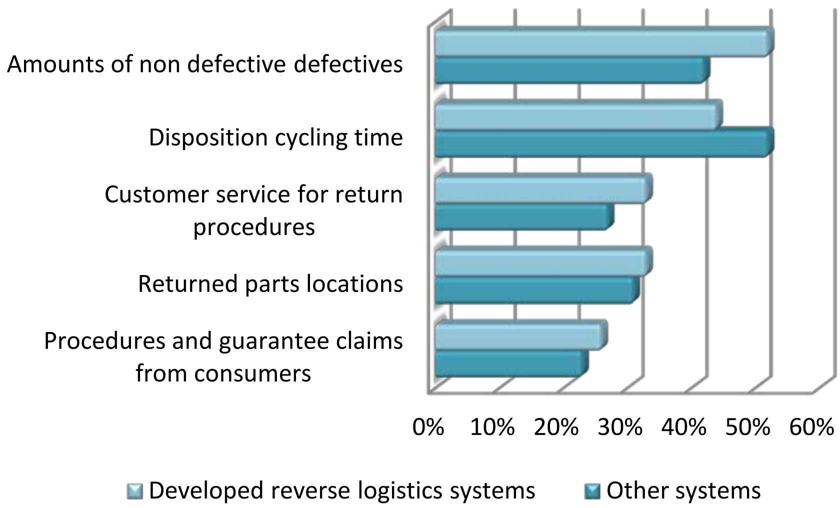

Figure 4 - Challenges while organizing reverse logistics chain
Source: Aberdeen Group, A Harte Hanks Company: Reverse Logistics, Driving Improved Returns Directly to the Bottom Line, Underwritten by Flash Global Logistics, On Process Technology, Aberdeen Group, Inc., Boston, USA, 2010., 071309b

Organization of return centers should be based on conducted researches of specific business and organized as upgradable because of possibility for continues improvement of reverse logistics processes. All processes should reduce reverse logistics costs and be developed as customer and environmentally friendly.

5. CONCLUSION

Tendency of greening the supply chain and continuous optimization of it, in forward and reverse logistics, implicates that warehouse processes issues must be developed to maintain the basic objectives of reverse logistics. Centralizing flows of returned goods and directing them into return centers can provide consolidation of transport processes but also evaluation procedures based on specifications of a returned item. Providing high accuracy evaluation will result in directing returned items to channel where it will gain maximal value from the aspect of reusing it, selling it on secondary markets or using their parts. Every conducted evaluation will result in smaller amounts directed to landfills that are already overloaded.As forward logistics warehouse issues are storage space, speed in processing, automatization, etc., reverse logistics optimization includes authorization, evaluation and directing returned products to channels. Creating a return center that provides special handling and educated personnel would grant more free locations in already overstocked warehouses, lower transportation costs because of centralizing the flow and higher level of customer satisfaction because of smaller disposition cycling time. Although centralized return centers can provide all activities of reverse logistics, the organization highly depends on organizational structure, expected returned products and their structural specifications. There is a whole variety of possible activities implementation. Besides the fact that centralized warehouse for returned product can provide all the needed activities, organizational structure can customize reverse logistics processes in return centers by outsourcing those which are not strategically important or are not cost effective.

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CONSTRUCTION OF KUTINA INDUSTRIAL AND LOGISTICS CENTER FOR DEVELOPMENT OF TRAFFIC AND ECONOMIC POSITION OF MOSLAVINA REGION

ABSTRACT

One of the most important features of the Moslavina region is its extremely advantageous traffic and geographical location, which is primarily reflected in the passage of international rail and road corridor X in the west-east direction and vice versa. It is also important to emphasize the regional traffic flow from Hungary in the north, through Virovitica and Garešnica, towards the Jasenovac border crossing, and further on through Bosnia to the south. Kutina is located on important roads to towns Novska, Lipik, Pakrac and Daruvar, and towards Sisak and Petrinja. Besides the traffic junction, Kutina is in economic terms known for one of the largest Croatian companies, Petrokemija d.d. Kutina. In the future, the development of the logistics center in Kutina could significantly affect the development of the Jasenovac river port on the navigable river Sava.

With such favorable geographical, traffic and economic features, the construction of the logistics center is a logical step in the development of the Moslavina region. The construction of the Kutina logistics center should be divided into two phases: preparation of project documentation and the actual physical construction of the logistics center, thus strengthening the traffic position of the Moslavina region. Apart from the activities on the construction of the logistics center in Kutina, the logistics development is followed by the development of additional supporting services: construction of access roads, construction of supporting facilities (hotels, restaurants, services/repair shops, etc.), development of local public transport and finally the training of the local population in logistics at the Kutina Open University.

And finally, at the time of crisis and recession in Croatia, the preparation of development projects supported by the EU funds is of great importance. With financial support from the EU funds, the logistics center in Kutina can develop into a major traffic and logistics center in this part of Europe.

1. INTRODUCTION

One of the most important features of Moslavina region is its extremely advantageous traffic and geographical location, which is primarily manifested in the intersection of major roads in the west-east and north-south directions. In the west-east direction, there is the X rail and road corridor, and in the north-south direction the regional traffic flow passes from

Hungary and Virovitica, via Garešnica and Kutina, towards the Jasenovac border crossing and further on through Bosnia to the Adriatic Sea. Kutina has also access to important roads which lead to Novska, Lipik, Pakrac, Daruvar and also to Sisak and Petrinja. Besides it being a traffic junction, the city of Kutina is known in economic terms for one of the largest Croatian companies, Petrokemija, d.o.o. Kutina. With such favorable geographic, traffic and economic features, the construction of logistics center in Kutina is a logical step in the development of the Moslavina region and its transport position. The construction of the Kutina logistics center is divided into two phases: first, the preparation of the project documentation, which has been completed, so that all the prerequisites for the phase of physically constructing the logistics center have been met.

Apart from the actual activities connected with the construction of the logistics center, the development of logistics business in Kutina is accompanied by all the supporting and additional services: construction of access roads and supporting facilities (hotels, restaurants and other services), development of local public transport and finally the training of the local population in logistics at Kutina Open University. In the future, the construction of logistics center in Kutina could significantly affect the development of the river port Jasenovac on the navigable Sava river. And finally, today, at the time of crisis and recession in Croatia, the preparation of development projects funded by the EU funds is of great importance. With the financial support from the EU funds, the logistics center in Kutina can develop into a traffic and logistics center of this part of Europe. This paper therefore deals with experiences in the construction of the Kutina logistics center as a positive foundation for the development of logistics systems throughout Croatia.

2. GEOGRAPHICAL, TRAFFIC AND ECONOMIC IMPORTANCE OF MOSLAVINA AND KUTINA

2.1 Geographical and traffic significance of Moslavina

Moslavina is a historical and geographical region of the northwestern Croatia, the territory betweenthe Sava and Drava rivers that includes the area of Lonja-Česma basin, i.e. the whole of Moslavina mountains surrounded by the Česma river in the north and west, rivers Lonja and Trebež in the south and the Ilova in the east. It covers an area of 1,850 km² and the largest settlement in this region is Kutina with about 24,000 inhabitants. In the nineties, the area of Moslavina was administratively divided into three counties: the Sisak-Moslavina county (central Moslavina), the Zagreb county (western Moslavina) and the Bjelovar-Bilogora county (eastern Moslavina). The central part of Moslavina is Moslavačka Gora Mountain (the highest peak is Humka, 489 m). Kutina is the largest town, as well as transport, economic and commercial center of the region. Other major towns in Moslavina are: Čazma, Garešnica, Popovača, Križ and Ivanić-Grad in western Moslavina. There are significant sources of oil and gas in the Moslavina area, which are a part of the Lonjsko Polje Nature Park. In Moslavina, viticulture and agriculture are very strong and recently tourism is being developed as an industry that uses the natural environment of the Moslavačka Gora Mountain and Lonjsko Polje.

Moslavina has a dense network of roads. On the southern edge, there is the A3 Zagreb - Lipovac highway that is an integral part of the 10th Pan-European Transport Corridor. In the west there is the D43 state road Đurđevac (D2) - Bjelovar - Čazma - junction Ivanić Grad (A3), in the east there is the D45 state road V. Zdenci (D5) - Garešnica - Kutina junction (A3), while in the north there is the D26 state road Vrbovec (D28) - Čazma - Garešnica - Dežanovac - Daruvar (D5) which encircles the Moslavina region into one traffic unit and connects major towns of the region: Kutina, Garešnica, Čazma, Ivanić Grad, Novoselec and Popovača, with other towns outside the Moslavina region (Zagreb, Bjelovar, Daruvar, Lipik). The D36 state road Karlovac (D1) - Pokupsko - Sisak - Popovača junction (A3) branches off at Popovača and connects the Moslavina region with the southern parts of Croatia.

The M1 railway line Zagreb MS - Vinkovci -Tovarnik (the state border), which is part of the 10th Pan-European corridor, passes through the southern part of Moslavina region, near the A3 motorway, and it connects the Moslavina region with Zagreb in the west and Slavonija in the east. The Sava River passes through the southern part of Moslavina all the way to Sisak and, as it is in this part navigable, one should not exclude the possible use of this waterway for the purposes of the future logistics center in Kutina. The local L205 line Banova Jaruga - Daruvar – Pčelić, starts from the Banova Jaruga railway station and connects the region with the cities of eastern Slavonija (Daruvar, Lipik and Pakrac). Figure 1 shows the location of Moslavina region in relation to the rest of Croatia.

Figure 1 - Location of the Moslavina region in relation to the rest of Croatia
Source: [4]

2.2 The economic importance of Kutina

Kutina is a major urban and economic settlement in Moslavina. Moslavina occupies the central (main and connecting) part of the Croatian area. Kutina is a town located 82 kilometers from Zagreb. It is situated in the south of Moslavina, along the M1 Zagreb MS-Vinkovci- Tovarnik railroad (the state border) and the A3 Zagreb - Lipovac motorway, to which the D45 state road towards Garešnica, Daruvar, Bjelovar and Virovitica is also connected. This makes Kutina very well connected with surrounding towns. With 15,000 inhabitants, Kutina is the largest business, commercial and administrative center in Moslavina, where many county services and largest companies in Moslavina have their headquarters. According to the 2001 census, the town has 14, 814 residents and 24, 597 people live in the City of Kutina area.

The most important companies in the town are:

- Petrokemija, d.d. - 2650 employees, chemical industry, 70% export to world markets,
- SELK d.d. - 1800 employees, electronic industry, 100% export to world markets.

In addition, in Kutina there are small and medium enterprises and the Association of Craftsmen of Kutina has approximately 480 active crafts and trades. There are about 150 small and medium-sized enterprises, of which about 50% actively export more than 75% of their products (e.g. ALMOS d.o.o. - aluminum foundry, 120 employees and 100% of exports; TURBO-MEHANIKA d.o.o., mechanical engineering in the EU market, and others).

In Kutina, the railway and bus station are located in the town center and are close to each other, which is good for the development of public transport system. Also, there are two secondary schools; a technical school and a high school, which are attended by a large number of students who travel from nearby villages by public transport. There is also a number of large shopping centers (Kaufland, Pevec, Lidl, Plodine and KTC) which are located near busy roads.

Among other towns located in the Moslavina region one should also mention Popovača, Ivanić Grad, Garešnica and Čazma, with which Kutina is well connected and which in their development rely on small and medium enterprises, agriculture, wood processing industry and tourism.

3. BUILDING A LOGISTICS CENTER

Since 2000, with the Government's incentive, there is a systematic approach to planning and implementation of business zones in the whole area of Kutina. The development of Kutina business zones was defined in 2001by the Programme for Economic Development Incentives in Kutina. "Business zone (small businesses zone) is part of the economic zone within which Kutina finances or co-finances the construction of municipal infrastructure, encourages the building of facilities designed for economic use, financially stimulates business investments, allows tax relief and creates other benefits for entrepreneurs-investors. Business zones are planned plan in accordance with regional plans and the specific needs of entrepreneurs. The business zone function is to ensure ongoing business activities by (giving) benefits prompted by the city of Kutina with systematically designed measures."[6]

In 2011, after two stages of development, the Kutina business zones development programme was adopted for the period 2011 to 2015 (projection 2016 to 2020) which regulates the development of existing and new business zones and defines:

- the location of business zones;
- financing and project costs, the dynamics of business zone construction;
- state of municipal infrastructure, planned areas in the zone and lot assignment in the zone;
- encouragement and incentives for entrepreneurial programmes development in the area and other.

Business zones of Kutina are planned and carried out within the Economic Zone of Kutina, a separate part (designed) for the systematic development of economy and activities of economic entities.

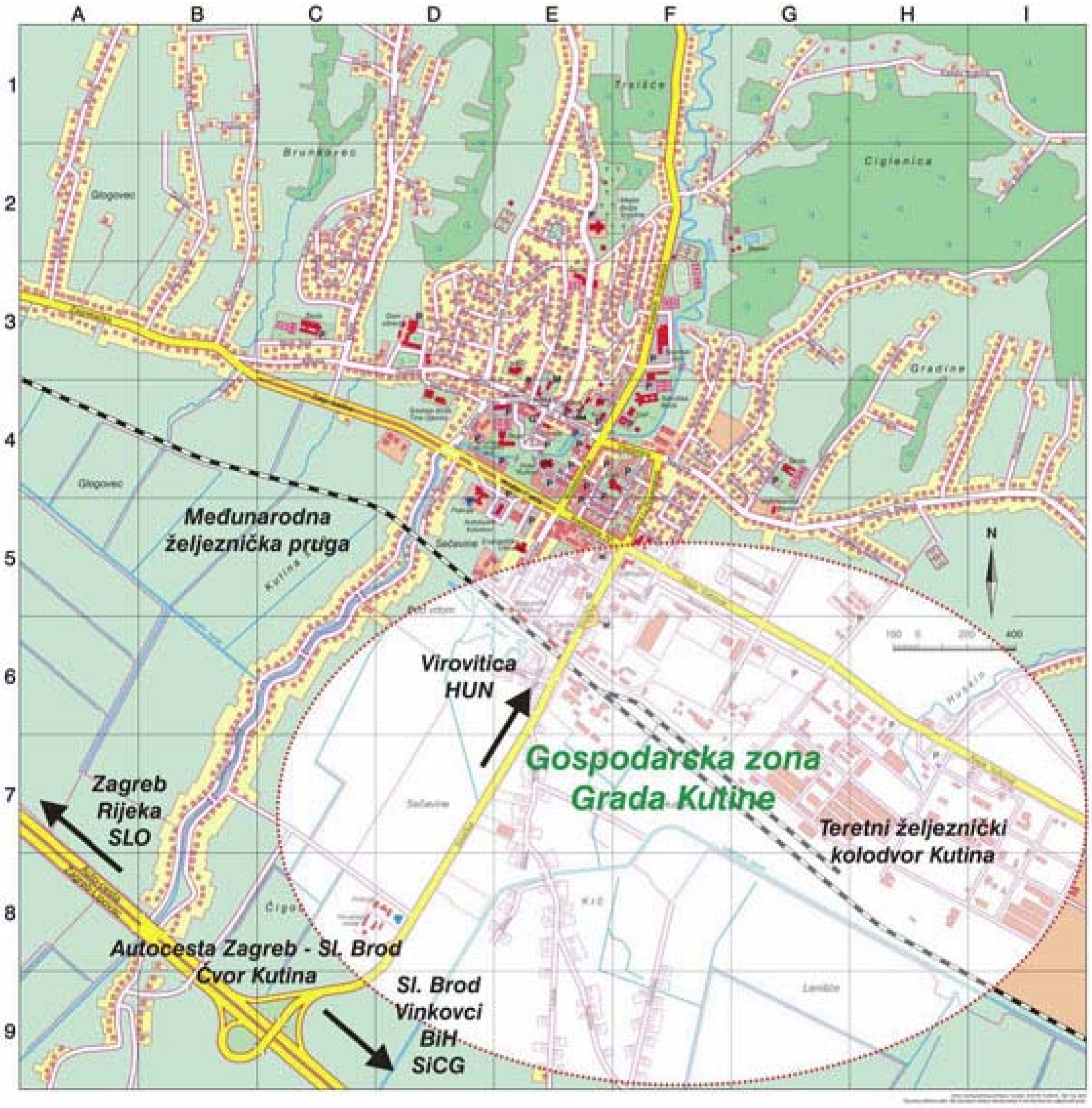

Figure 2 - Economic Zone of Kutina
Source: [6]

The Economic Zone is composed of separate parts specialized for particular segments of the economy such as:

• business zones: Kutina I Business Zone (KIBZ), Kutina II Business Zone (KIIBZ), Kutina III KRČ Business Zone (KIII-KRČBZ), Kutina IV Business Zone (KIVBZ)

• Kutina industrial and logistics zone (KILZ)

• other areas: the free zone, commercial zone, technology parks etc.

There is a brief overview of basic information about the location and purpose of business zones in Kutina in Table 1.

In order to have more efficient and high-quality environment that is subjected to the development of economic infrastructure, spatial planning documents define features related to urban planning, utility and energy infrastructure, traffic and other industries. In business zones, it is necessary to build roads for communication within the zone and access to the zone, water supply systems, sewerage, heating systems, street lighting and electricity supply networks.

Table 1 - Basic information about the business zones of Kutina

Business zone	Location	Purpose of facilities
KIBZ	Eastern part of town Within the Economic Zone	production and workshops, commercial and service industries, special purpose and labour-intensive industries which encourage new employment in their programmes
		does not apply to the construction of stores, warehouses, sawmills, independent parking lots and similar commercial or service industries
KIIBZ	Eastern part of town Within the Economic Zone	production and workshops, commercial and service industries, special purpose and labour-intensive industries which encourage new employment in their programmes and the possibility of selling part of the lots for commercial and service purpose
		programmes that are harmful to the environment are excluded
KIII-KRČBZ	South-eastern part of town Within the Economic zone	production and workshops, special purpose and labour-intensive industries which encourage new employment in their programmes and the possibility of selling part of the lots for commercial and service purpose and specially for transport and logistics investments
		programmes that are harmful to the environment are excluded
KIVBZ	Southern part of town Within the Economic zone	project in the preparatory phase – defining in the spatial planning documentation and land acquisition

3.1 Implementation and management of industrial and logistics zones of Kutina

The current body in charge of the planning, construction, management and development of the Kutina business zones is the Department of Development, Economy and Asset Management whose one of the main objectives is:

• purchase of land within business zones in the Economic Zone of Kutina;

• elimination of administrative barriers to investment in business zones and the establishment of the Administrative Office for the implementation of spatial planning documents and construction within the City Administration of Kutina.

Given the complexity and the scope of work, the possibility of establishing a separate company by 2015 is being considered. Based on the Kutina Business Zones Development Programme for the period 2011 to 2015, the mentioned company would have the following tasks:

• promoting Kutina's economic potential;
• attracting new investors;
• managing the business zones after their construction;
• providing funds for further construction of zones;
• advising the investors.

3.2 Industrial and logistics zone of Kutina (ILZ)

The Kutina industrial and logistics zone is formed at the site located in the southeastern part of the town, within the Economic Zone of Kutina, near the Kutina freight railway station, and along the edge of a future bypass road around Kutina – D45 Kutina - Virovitica state-level road.

Figure 3 - The ILZ Kutina area
Source: [6]

For better communications of the Kutina industrial and logistics zone, a road needs to be build that is both part of the D45 Kutina - Virovitica state route and a bypass road around Kutina. With the road construction, the necessary utilities and power connections should also be built. Via this road, the location is directly connected with:

- A3 Zagreb- Slavonski Brod - Lipovac motorway (distance 2.5 km)
- Customs Office Terminal (distance 2.5 km)
- Railway Station (distance 0.5 km)
- D 45 Kutina state road Kutina - Virovitica (Hungary) (distance 2.0 km).

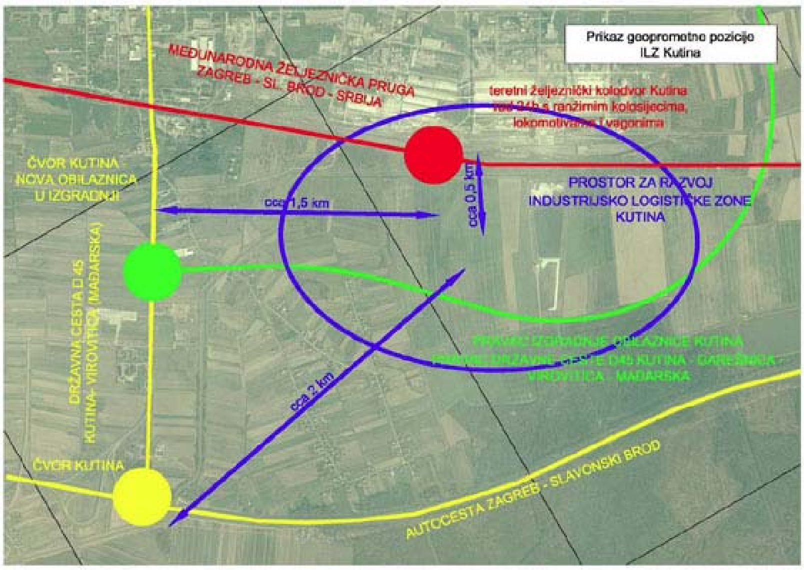

Figure 4 - Traffic position of the ILZ Kutina
Source: [6]

The areas that are adjusted to the industrial and logistics zone purposes are obtained by the adopted spatial-planning documents. These lots would have the following characteristics:

- Lot 1 - area approx. 107,200 m^2
- Lot 2 - area approx. 151,200 m^2
- Lot 3 – area approx. 62,200 m^2
- Lot 4 - area approx. 237,100 m^2
- Lot 5 - area approx. 61,000 m^2
- Lot 6 - area approx. 75,000 m^2
- Lot 7 - area approx. 41,500 m^2.

Traffic solution – lots are accessible through a junction that is separated from the D45 bypass road and secondary roads connecting the lots.

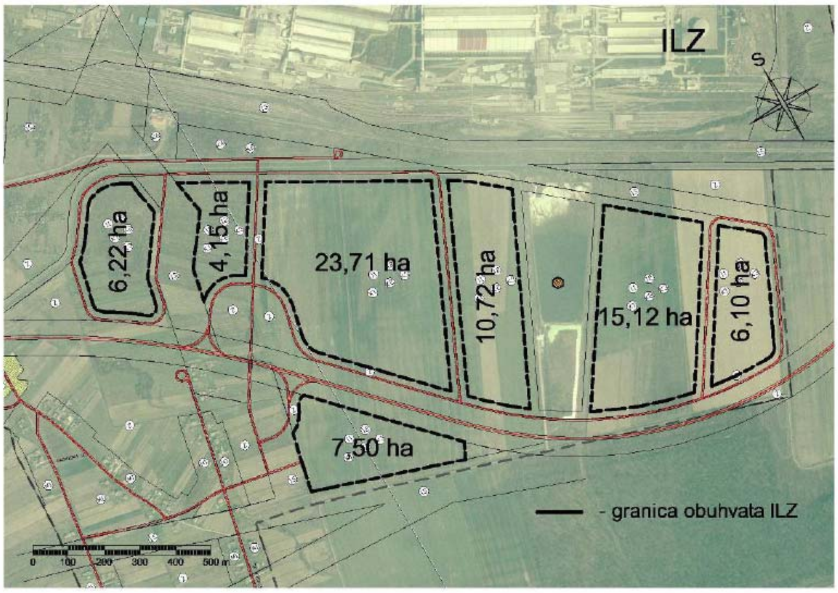

Figure 5 - The ILZ Kutina – DOF
Source: [6]

The Kutina industrial and logistics zone is designed for medium and large businesses. It is intended for building large-surface logistics terminals, storage - handling facilities, factories and industrial plants.

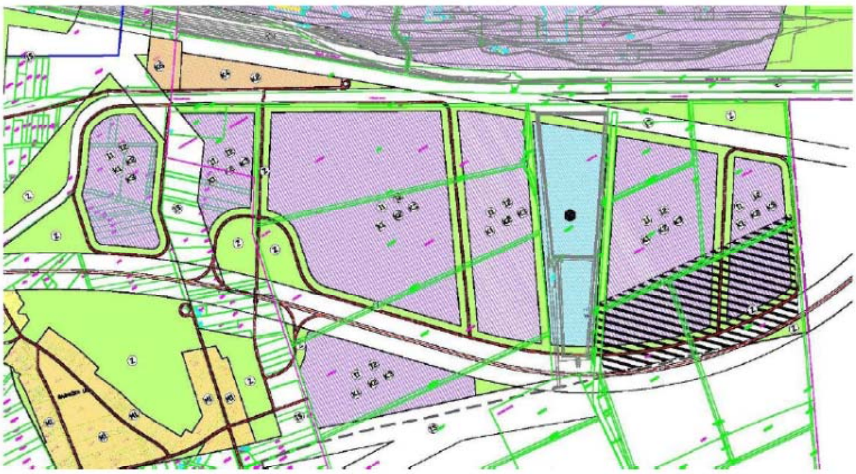

Figure 6 - ILZ Kutina – GUP
Source: [6]

Besides the logistics infrastructure, the development of supporting industries is also planned, although to a lesser extent. These include gas stations, repair shops, restaurants, etc. Investment in plants for energy production from renewable sources is particularly stimulated and programmes that are harmful to the environment (pollution of air, water, noise and vibration) are being cancelled regardless of the purpose of their business.

3.3 Training for logistics business in Kutina

Despite the favorable geographical, traffic and economic position of the Moslavina region and the current investment in the City of Kutina, a safe development of the Kutina industrial and logistics zone is not guaranteed. Therefore, a course in Business Logistics, Transport and Shipment has been established within the Business Economics studies at Libertas Business College in Kutina. The course objective is learning about the implementation of the logistics system in a company, logistics application within the national framework, introduction to the basics and concept of logistics as well as logistics strategy training for performing the basic functions of logistics management. This course covers the contents of some of the following units:

- strategic importance of logistics for a company
- logistics system and areas
- elements of logistics services
- storage and distribution logistics
- organization of business logistics
- basic features of transport and logistics chains and supply chains
- management of logistics networks in logistics systems
- information technology and business logistics
- establishing and developing logistics partnerships and logistics challenges in the future.

The development of knowledge in the field of logistics systems will greatly assist the development of logistics and transportation industry in Kutina, both for the needs of Petrokemija, d.d. as the largest manufacturing facility and for other businesses in the Kutina area and beyond. Logistics challenges in the future will largely be based on virtual logistics centers as the Kutina ILZ opens a large space in connecting Hungary with Bosnia and the south of Croatia.

4. FINANCIAL INVESTMENT AND SUPPORT THROUGH EU FUNDS

To form the Kutina industrial and logistics zone, the following investments need to be made:

- purchase of necessary land from private and other owners (most has already been done);
- the ILZ Kutina feasibility study;
- Web site for the ILZ Kutina project implementation;
- marketing zones and selection of the main investor;
- development of project documentation for the construction of infrastructure;
- construction of roads, water, gas and sewer networks;
- construction of industrial railway track;
- construction of a substation and low voltage network for electricity supply;
- construction of public lighting;
- arranging horticultural areas.

The total investment of ILZ is estimated at HRK 19.0 million. As much as HRK 2.0 million has so far been spent so total investment will be about HRK 21.0 million. In terms of financing the Kutina industrial and logistics zone it is necessary to consider the following three sources that are planned for the completion of the project:
• funding of the Kutina local government (HRK 4.0 million)
• Government funding (HRK 12.0 million - includes funds for construction of the new Kutina D45 bypass which is also the main access road to the ILZ Kutina - therefore maximum economic valorization of transport infrastructure is planned)
• financial resources from the EU structural funds (HRK 5.0 million).

Table 2 - Assessment of revenues upon completion of the project

Indicators	Amount	Comment
direct ILZ Kutina revenues-lump sum	HRK 15,000,000,00	land lots sale, utility fees, fees for connection to utilities infrastructure, company tax
Indirect Budget revenues-annual	HRK 3,000,000,00	surtax, income tax, utility fees and cost of utilities

Besides the revenues, it is estimated that entire utility and other infrastructure needed for the development of entrepreneurial activities will be built and that the expected number of companies will be established: from 5 to 10, and the expected number of jobs: 300 to 500.

5. CONCLUSION

Permanent changes to which the contemporary world is subjected, whether it is globalization, opening of new markets, the economic crises and development, the reduction in traditional energy sources, etc., they all need the fastest and most effective solutions to all challenges. One such solution is the development of logistics business, where the preferred way of doing business is partnership and a "win-win" strategy in which all the links in the logistics chain should have an interest. Thus, the development of logistics centers becomes a strategic direction in Croatia, which is manifested in the Government support programmes.

Despite the support of the Government and a great geographical and traffic position of Croatia and some local governments, the logistics development in Croatia is not going quickly enough. Therefore in this paper, a review was made of all the necessary steps for the development of the Kutina industrial and logistics zone as a positive example of logistics development. The paper deals with the following essential steps: (1) recognition of Kutina's favorable geographical, traffic and economic position, (2) decision on constructing the Kutina Economic Zone with all the necessary facilities, (3) purchase of land in the Economic Zone area, (4) elimination of administrative barriers to investment in business zones, (5) promoting economic potential and attracting investors, (6) construction of roads for communication within the zone and for access to the zone, as well as water supply, sewerage, gas supply, street lighting and networks for electricity supply , (7) business zone management, (8) securing funding for further development of the zone. Finally, despite the favorable geographical, traffic and economic position, the local government support for the logistics development, the construction of the logistics center and attracting the investors, there will be no lasting development without professional and qualified staff who will know how to turn this potential into the logistics capital.

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POSSIBILITY OF IMPROVING PASSENGER INFORMATION SYSTEM IN BUS TRANSPORT USING CLOUD SERVICES

ABSTRACT

Every day we are witnessing the breakthrough of new technologies in all forms of passenger transport. The meaning of technology, future development, and application are based primarily on the finding of methods how to make life easier. Today's development of information and communication technologies is directed to wide population of users equipped with sophisticated terminal devices. The starting point has been guided by the idea that the implementation of new technologies should fulfil the users' requirements: what they want, where they want it and in the best possible way in which they want it. The research in this paper is directed to the problems of informing the passengers in the domain of bus transport. According to the ITS concepts an attempt is made to improve the fleet management systems, first of all through interactive participation of the drivers in the transport process, navigation of vehicles/drivers and telemetry (remote vehicle diagnostics). The preconditions of this type of management are mobile communications of the vehicle/driver with other participants in transport/traffic process. Mobile terminal devices installed onboard vehicle itself are becoming the elements of ITS communication infrastructure.

Unlike static information systems in bus transport, telephone or internet information about timetables and fares, with more efficient usage of ITS modules in the transport process the user can be provided access to a wide range of useful information before the trip and on the trip, and downloading of historical data on the trip itself.

The paper presents the new concept of providing information services in passenger transport based on the location of vehicle as transport entity by implementing cloud computing infrastructure.

Key words: *traffic information, tourist information, fleet management, cloud computing, ITS, LBS*

1. INTRODUCTION

Today we are witnessing an ever faster development of information and communication technologies. The restrictions of the classical approach to the development of the traffic system have led to the requirements for new coordinated solutions in road and other branches of transport.

The upgrade of the classical transport system, called Intelligent Transport Systems (ITS), has enabled a new approach and implementation of advanced control, and technical and technological solutions, achieving greater safety, efficiency and reliability of transport.

The transport profession which plans the ITS development has to have the knowledge about the possibilities of new technologies at their functional level. To fulfil useful functions, ITS technology requires connection of participants in the information chain by implementing the module for data collection, fusion and processing of data, by implementing communication infrastructure for data transmission and distribution of information offering a series of communication services.

The mobility of transport system users means the application of different mobile communication systems with the respective services. The users today want everything and on the spot, with minimal waiting for the delivery of information. They want access on the move, constant connection and accessibility, and "customized" service.

Using the cloud computing model, the companies that are involved in the passenger transport can significantly raise the quality of service they provide to the passengers with significant reduction of initial capital costs. This lets them focus on the core activity itself, and minimize the resources necessary for work and control of IT infrastructure.

Under the condition of Internet connection accessibility cloud infrastructure allows fulfilment of users' expectations and needs.

2. SYSTEM FOR PASSENGER INFORMATION IN CROATIA

2.1. Existing information system in bus transport

The provision of bus transport services should already be more than just transport. Higher quality of provided service does not only mean the quality of the transport means and relation to the user; today, the passenger expects more. By implementing innovative technologies in the provision of services it is possible to occupy a significantly better position on the market. The breakthrough of new technologies into this branch of transport on the Croatian market has not broken through in the real sense and therefore has large potential. Regarding the information level of the users the currently accessible are mainly pre-trip information and in the majority of cases they are not free for the user.

The currently available channels of pre-trip information of passengers in bus transport in Croatia are telephone and internet information, information by arriving to the information counter, and at some selling points of public display which is not interactive.

Passenger information in bus transport, especially on the Croatian area has not advanced except for the introduction of Internet pages which make information available *although* they have not been completely mutually integrated.

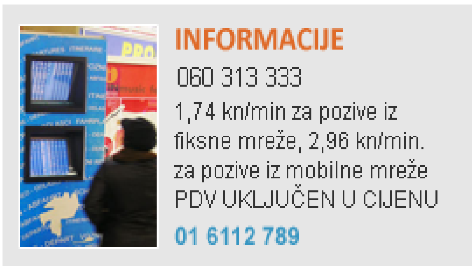

Figure 1 - The existing pre-trip information systems – counters and information distribution system by means of so-called "display information"

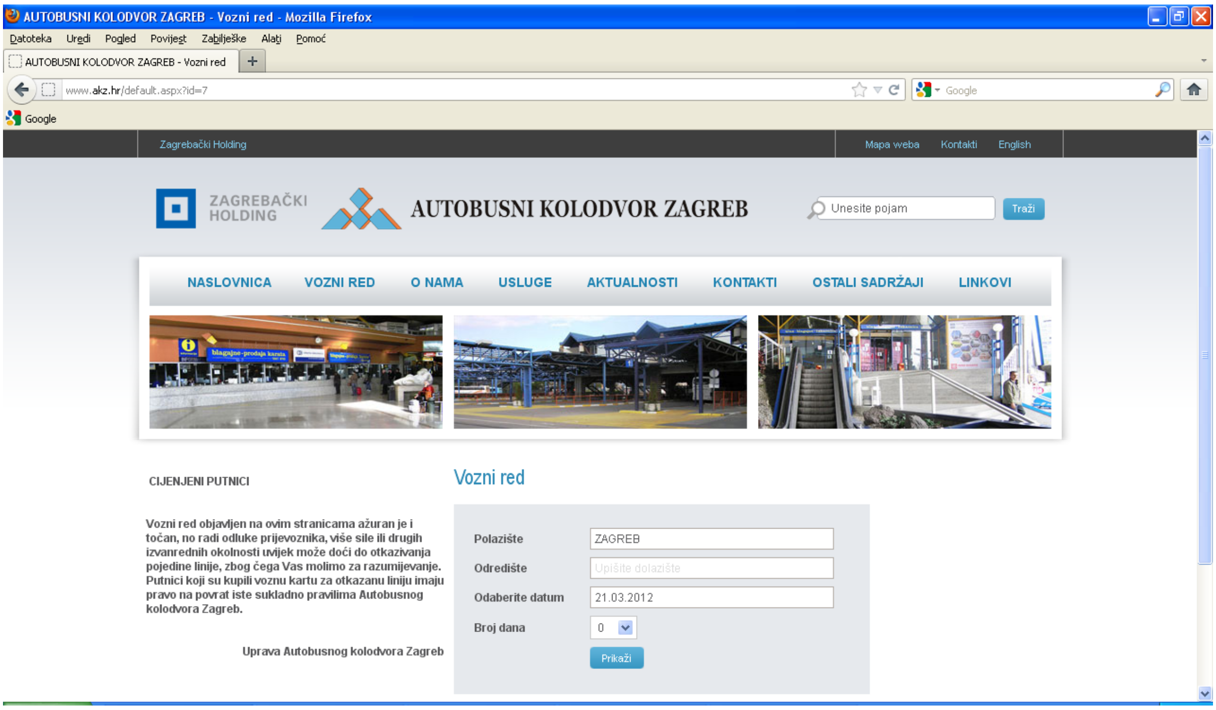

Figure 2 - Internet portal with information about passenger transport

The available information channels in bus transport do not dispose of detailed information required by the user. The information has not been integrated with all the necessary data, and often it is neither precise nor updated.

In order to improve the service of informing the users, the application of new technological solutions in bus transport allows fulfilment of the users' expectations regarding timely and complete information.

2.2. Advanced information systems supported by ITS modules

The passenger information service in ITS system includes the static and dynamic information about the transport networks, pre-trip and on-trip information services, as well as support to services that perform collection, saving and managing of information for the planning of transport activities.

The essence of ITS lies in the systemic management, and information-communication solutions built into the network infrastructure, vehicles, control centres, and various communication computer terminals. They encompass a wide range of new tools for transport network control, as good services for passengers.

ITS tools are based on three key notions:

- information,
- communication, and
- integration.

The notion intelligent denotes the ability of adaptive action in variable conditions and situations, where it is necessary to collect sufficient data and process them in real time. Although the human represents an intelligent element of the classical traffic system, the impossibility of networking and of using on-line information results in waiting, delays and finally inefficient transport.

The collection, processing and integrating data and information supply are the essence of ITS. The availability of the real-time information about the current traffic conditions on the network provides real-time information for trip planning.

By analyzing the existing specifications of trip information services, it may be concluded that they are oriented to satisfying the requirements of passengers and drivers in road traffic, but there are also connections to other branches (modes) of transport.

The trip information specification:

1. Pre-trip Information,
2. On-trip Driver and Passenger Information,
3. On-trip Public Transport Information,
4. Personal Information Services,
5. Route Guidance and Navigation.

The ITS pre-trip information service (*Pre-TripInformation* - PTI) is the first in the functional area of passenger information (TravellerInformation - TIITS). The purpose of PTI is to provide the users before starting the trip with high-quality updated data, i.e. information that will result in making a better decision and preparation for the trip.

The information can refer to planning of the trip by public transport means, road conditions, weather conditions, possible parking places, traffic queues, tourist and catering facilities and other information.

The key technologies that allow the realization of pre-trip information are information technologies (central database, provider computers, PCs, etc.) and telecommunication technologies (fixed and mobile telephony, GSM/UMTS, Internet, radio, TV-teletext, RDS, etc.).

On-trip information includes real-time information about the trip, estimate of travel time depending on the current conditions, availability of parking places, traffic accidents, etc. The information is provided via terminals at bus and railway stations, on squares, transit points, displays onboard vehicles or portable personal terminals. Using the advanced value chains in the distribution of information to the passenger's terminal device in bus transport, it is possible to equip the vehicles with interactive devices at minimal costs or even without any cost at all, and make the trip for the passengers significantly more entertaining or more informative.

2.3. Reasons for improving the current information systems in bus transport

The reasons for improving the current information system and introducing new services are to provide the users with easier and improved access to real-time information, increasing the mobility and the level of users' information, which is very important to the new generations of passengers who find this most important. Thus, significant comparative advantage is realized in relation to the providers of the same or similar transport services.

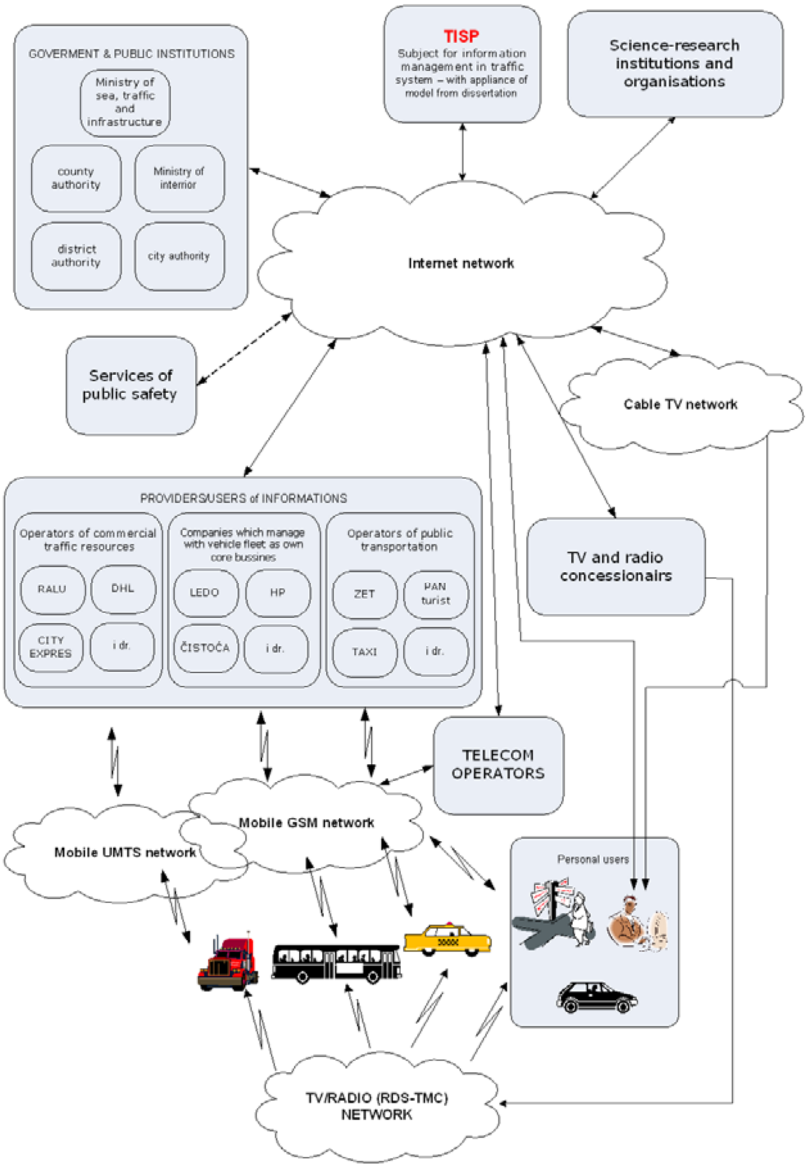

Figure 3 – Generic presentation of the information-communication connection system of the transport entities

Information should reduce uncertainty in travelling and a better choice of transport modes, route selection, departure time, change of mode, guidance (navigation) to the destination, etc. based on updated information about the traffic system condition. The assumption is that better and faster information will create preconditions for better operation of the business subject. A satisfied passenger becomes a faithful user of the transport service provider and a continuous source of revenues, which is in fact the main goal in doing business.

3. FLEET MANAGEMENT IN BUS TRANSPORT IN PROVIDING INFORMATION BASED ON VEHICLE LOCATION

Fleet management are such systems that use satellite tracking of vehicles and some of the available mobile technologies of data exchange (GPRS) to forward real-time information about the vehicle and allow constant and full control of the fleet. Such specialized service assists significantly in monitoring the efficiency and control of the fleet and the drivers. The new business concepts in telecom sector have opened up the possibility of offering new services based on the known information of the traffic entity. Using the advanced communication technologies it is possible to improve the information level of the potential users based on the Location Based Services (LBS).

For the LBS to be available, it requires the infrastructural elements: mobile device, applications, communication network, location components, server, service.

GPS location is one of the major subjects in using LBS services but not the exclusive method of locating the object in space. Using the Fleet management service by GPS technology or triangulation within the network elements of mobile communication systems, by means of mobile unit onboard vehicle the information about the vehicle or the entire fleet can be shared with other interested parties who may make use of the information in performing their activities. There are numerous such initiatives, e.g. ZG Traffic application (powered by SkyTrack.com). However, these are no professional solutions that would enable control and integration into the ITS system module, but rather they function by the distribution of contents via principles of social networks.

Apart from the fleet management service, the system has a huge potential by means of which it enables realization of the exchange of messages and mobile Internet service (MMS, e-mail) in the sense of information harmonized with the region in which the user is located, e.g. information about the history of the area through which one travels and cultural data about the location, tourist and gastronomic offers, meteorological, geographical, and other characteristics of the locality.

Presentation of the mentioned information are useful not only for the passenger but also for the promotion of the locality, even the space as a whole and finally they can be of wider economic significance.

With the fast development and widely spread information and telecommunication technologies integrated into mobile terminal devices, determining the location on the move has become everyday practice. The technologies include the Geographical Information System (GIS), Global Positioning System (GPS), Radio Frequency Identification (RFID), and various other technologies for positioning with more or less precision, coverage or costs of installation.

In introducing LBS service, important is the characteristic of the mobile devices whose hardware and software properties may satisfy a certain level of quality of using LBS services.

Mobile terminal devices feature high accessibility, significant implementation by the users, they are used within a huge part of the geographic area, and by using adequate applications they may become the sensors of the traffic system and the environment. The infrastructure of mobile terminal devices is shown as a platform that yields the best promise in the function of applying LBS. The success of LBS is direct value noticed by the user regardless of the technical complexity and current precision of results. If even an approximate result is observed as useful, the users will use the service again.

Depending on the design method we distinguish between two types of LBS applications: ***push*** **and** ***pull***.

- ***Push services*** – imply that the user receives information as result of the user's current location, which the user had not actively requested previously. The information can be sent to the user in compliance with a previous consent (e.g. information on certain threats) or without consent (e.g. various types of advertising when entering a new city).
- ***Pull services*** – the user actively uses the application and "pulls" the information from the network. The obtained information can be used in the context of better usability of the current position of the user (e.g. information about the nearest cinema).

Based on the numerous past studies several important factors for the success of location-based services have been noted. Among other things, that they are of direct advantage for the user, easy to use, provide fast processing of data, low in price or completely free service, etc.

The development methodology of the system allows simple adaptation and application with necessary improvement of the distribution methods through cooperation with the operators of mobile communication systems.

4. APPLICATION OF CLOUD COMPUTING PRINCIPLES IN PASSENGER BUS TRANSPORT

The notion of cloud computing is a model which allows access to the network at user's request, more precisely access to computer resources such as access to servers, applications and services. The users can use "cloud" services when they want it, and the only thing the user needs is Internet access.

Cloud computing for the end user or provider of a part of the services applicable in passenger transport, means that there are no hardware purchasing costs, no more software licences or upgrades for the control, no new employees or consultants that need to be employed, no possibilities of leasing, no capital costs of any kind and no hidden costs. One uses only what one needs, and pays only for what one uses. It is precisely for these reasons that Cloud Computing represents a great advancement of IT evolution since it changes the way of thinking, developing, implementing, updating, maintaining and paying for the applications and infrastructure on which the service has been started.

Everyday problems that trouble the bus transportation, such as the decreasing number of passengers using public transport service, increase in competition, constant investments into maintenance and restoration of the fleet, constant growth of the fuel prices, etc. do not leave enough space for investments into new technological solutions. The application of new services according to the cloud paradigm does not represent CAPEX financial cost for the implementation into numerous transport means, but rather expansion of the supply of passengers within the same transport cost. This raises significantly the level of the quality of the offered service.

The companies that cannot afford capital investments into "traditional" information technologies are logical users of cloud services (i.e. cloud software solutions). However, this group includes also companies that deal with activities that are in their nature mobile, such as e.g. bus carriers.

Owing to cloud infrastructure the users can access the data in the "cloud" by means of different devices, anytime and anywhere, regardless of whether they are using desktop or portable computer, mobile phone or tablet.

By expanding the provided service for the bus transport users, using CLOUD infrastructure, the company has not only a more satisfied customer but also a database on their customers based on the digital identities applied during transport, which may be used for various marketing actions with currently available offer, such as e.g. last minute offers, loyal customer club, etc. Of course, ON-LINE purchase with instantaneous confirmation of ticket purchase on the mobile device of the user and of the service provider (bus driver and company headquarters) represents a step into the future technological development and service extension.

In Croatia one of the telecom operators offers fleet management services according to cloud principles. The currently available functions, applicable also in the control of transport entities for passenger transport include:

- Current location, speed and status of the vehicle in Croatia and abroad;
- History of the movement of vehicle by plotting the vehicle route;
- Detailed reports and statistics on the usage of vehicles on a daily, weekly and monthly basis:
    - Total distance and time of driving;
    - Location and time of vehicle stopping;
    - Speeding;
    - Visits to objects of interest or set movement zones;
    - Statistics and analytics of using the vehicle during and outside working hours;
    - Automatic sending of reports to e-mail addresses (XLS, PDF, etc.);
    - Interactive graphs of the speed and altitudes with location represented on a map;
- Selection of the travel type: private, on business, or locco ride;
- Administration of data on vehicles and drivers;
- Administration of user's rights for inspection of vehicles and locations of interest;
- Simple export of all the reports in Excel and PDF and other formats;
- Information / Alerts on using the fleet by SMS or e-mail:
    - Entry/Exit from arbitrarily defined movement zones;
    - Usage during and outside working hours;
    - Speeding;
    - Announcement of vehicle servicing intervals;
    - Stopping at location longer than the time given;
    - Stopping at non-defined locations;
- Simulation of vehicle movement on a map;
- Presentation of optimal routes to the selected location on the map.

By additional integration of the obtained information on this principle, an entire series of new information functions for the driver as well as for the passengers onboard vehicle is possible. By fusion of the information about the travelling of the transport entity along the traffic network it is possible to offer additional services to all those interested in the condition within the traffic network. The transport entity here occurs as the sensor of the transport network, and for the fusion and distribution of the information obtained in this manner, it is additionally necessary to study the possibilities of implementing social networks as one of the most present communication platforms of today.

5. CONCLUSION

The notion "cloud computing" first came to life in the narrow, professional IT circles, and then for quite some time it was a purely marketing notion that failed to be understood by the majority of users. The development of cloud services made it clear that it was not just another marketing trick, but rather services that can significantly reduce IT costs and allow huge advancement in the operation of transport companies since it changes the way in which the advanced terminal equipment and services are purchased and implemented in the transportation process.

In the meantime "cloud computing" has become so significant that the discussion about these technologies is raised also to a political level in the European Union. At the World Economic Forum it was emphasized that in the context of European digital agenda a joint cloud computing strategy has to be developed. By exchange of the value chains in the process of delivering telecommunication services, the offer of information services for the needs of transport companies can represent a pure profit, rather than cost in implementation.

The issue of security and privacy is especially important from the perspective of successful ranking of the new "cloud" services on the market. It is, namely, precisely the issue of security and privacy which may represent a barrier for some users.

Information is power, and therefore the economic subject, in this case the bus carrier, with the application of new technological solutions and improvement of the provided service of informing will occupy a better position on the market. The breakthrough of new technologies in this branch of transport on our market has not made it yet in its full sense and therefore has an even greater market potential.

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THE DEVELOPMENT OF LOGISTICS CENTRES THROUGH IMPROVING THE INVESTIGATION OF RAIL ACCIDENTS ON INDUSTRIAL TRACKS

Abstract

Transport of freights in the modern world today is improved through investment in logistics centres. These are the points where they various forms of transport meet. The competitive advantage of road transport compared to rail is primarily manifested in the easy availability of the road transport vehicles to end-users which means that the construction of industrial tracks is very important for the future development of freight transport by rail. By opening the EU market new relationships have created which increase the complexity of development and construction of industrial tracks so that now in the whole transport chain are managers of rail infrastructure, rail carriers, logistics centres owners, owners of industrial tracks and ultimately end-users of transport and logistics services. Insufficiency of investments in industrial tracks necessarily leads to lower quality of logistics and transportation services. Besides the improvement of industrial infrastructure it is necessary to do administrative upgrade that is manifested primarily through improving the investigation of rail accidents on industrial tracks. This improvement is primarily related to the application of the provisions of the Ordinance of accidents in railway traffic and newly established relationships between entities in the transport chain. This work presents the analysis of the situation in terms of conducting investigations of accidents and propose measures to improve the investigation of accidents on industrial tracks.

1. INTRODUCTION

In the last twenty years of the last century, many changes occur in the shares of total land freight transport - once mass transit by railway becomes less but more efficient road carriers take advantage in transportation because the road infrastructure is more contemporary and better connected than the railway infrastructure.

Such a development of road transport leads to more frequent services" door -to -door", so end-users will have significant savings in the organization but also in financial and time aspects.

The competitive advantage of road transport compared to rail is primarily manifested in the much easier availability of road transport vehicles to end-users. The railways have been forced to construct and build the industrial tracks. Industrial tracks became very important for development of rail freight in the future, particularly by major users and in the ports and quays.

Today transportation systems in the modern world are improved through investment in logistics centres and services. These are the points where the various forms of transportation meet. Through the development of logistics centres and services, rail and road modes of transportation now are becoming partners in the entire supply chain. Logistics centres are the main links in the connection of rail and road transport operators and the overall quality of logistics services depends on the quality of the logistics centres.

From the standpoint of rail transportation, industrial tracks are becoming more important for the connection of logistics centres and railway junctions.

By opening the EU market new relationships are created which are increasing complexity of development and construction of industrial tracks, so that now the whole chain are managers of rail infrastructure, rail carriers, logistics centres, owners of industrial tracks and ultimately end-users of transport and logistics services. Development and construction of industrial tracks is necessary to observe through the improvement of infrastructure of industrial tracks and through improving the administrative level - safety on industrial tracks. Insufficiency of investment in industrial tracks necessarily leads to lower quality of transport services to the end-users, which is evident through the current condition of industrial tracks in Croatia.

Without permanently investment in the maintenance of industrial tracks in logistics centres there are or no good quality logistics services.

Beside the improvement of industrial infrastructure it is necessary to do administrative upgrade that is manifested primarily through the redefinition of the ownership structure of industrial tracks, the operating procedures of the industrial tracks and through improving the investigation of rail accidents on industrial tracks. This improvement is primarily related to the application of the rules of the Ordinance of the rail accidents in railway traffic and emerging new relationships between subjects in the transport chain. The work presents an analysis of the situation through the view of conducting investigations of rail accidents and propose measures to improve the investigation of rail accidents on industrial tracks, with the aim of improving safety and quality of logistics services.

2. INDUSTRIAL TRACKS

Industrial track is railroad track which is not public property for public use, and it is connected to the railway line and it is used for entering and leaving freights by rail vehicles for the legal person of the owner of this track and the industrial railway which can do the transport for their own use. Industrial tracks are privately owned by various companies, mainly big users in the area of seaports, river ports, logistic centres, oil companies and various production activities where there is demand for mass transport of freight.

Industrial tracks are connected with railway network with main siding track. In the area of users industrial tracks are divided into various groups of tracks intended for handling activities of the owner.

Setting and turning out the wagons on industrial tracks can be performed by the user or the railway carriers, which is regulated by a agreement of using of this track. The places with higher range of freight transport such as logistics centres, it may appear more users of industrial track. Users which are not owners of industrial tracks also can use that industrial track, but they must have a contract with railways and with the owner of industrial track.

2.1. Advantages of using industrial tracks

Industrial tracks are extremely important, both for users and for the entire rail transport system.

In today's era of dominance of road transport enabling services " door-to- door". This is necessary in order to strengthen the competitiveness of the transport market an to return to the leading position in land freight transport which objectively does belong to the railways because of the many numerous advantages, and to encourage complementary relationships of these forms of transport from the macro-economic point of view. If in the technology of transporting goods industrial tracks are identified as the start and end points of the process, it can enumerate the benefits that apply to users and to rail (table 1).

Table 1 - Advantages of industrial tracks

For users	For railways
direct delivery of wagon consignments loads to the place of production activities within the company	Disburdening of station handling tracks
shorter time of goods handling (mostly is excluded reloading) for possibility of using machinery which is particularly pronounced in bulk cargo	Possibility of starting direct trains
Damage are rare because there is no transfer of goods	Shorter time of wagon turnover
Avoiding of handling costs (road-rail and vice versa)	Direct connection of internal and international rail transport
Saving on handling costs by using adequate proper machinery	Formation of a solid and permanent contact with the big users
Lower total transport costs due to the selection of railways	

2.2. Condition of industrial tracks on Croatian Railways' network

Today on the rail network in Croatia is connected 870, mostly dilapidated industrial tracks, and of that number, 64% of industrial tracks are abandoned. On Croatian rail network there is 166 official places that are open for freight operation with registered 277 basic industrial tracks with 126 co-users, and currently more than 40% of them do not perform the work. Construction and maintenance of industrial tracks require large financial investments which are not in favour of the railway sector, which also seeks to retain existing and attract potential customers. When the potential user realises how expensive it is to build the tracks they often give up and orientate themselves to the usage of other modes of transport. The trend of leaving the industrial tracks by the existing users to a large extent is caused by changes in the economy for which the existing network of industrial tracks no longer meets their actual needs, as well as the high costs of maintaining and updating where are the users are financed by they owners. The designed parameters of industrial tracks that were built in previous years were consistent with the parameters of connecting railroad.

Reconstruction of railroad in recent time generally do not include the renewal and modernization of related industrial tracks thus undermine their technical and exploitation characteristics. Permitted axle load on industrial tracks is no longer in accordance with the reconstructed track which limits the maximal usage of wagons, a low level of maintenance of old infrastructure impact the security threats as evidenced by the occurrence of rail accidents on industrial tracks.

2.3. Trends in the development of industrial tracks

Relations between every participant of transport chain are very important for the development, construction and maintenance of industrial tracks. The manager of rail infrastructure, rail carriers, the owners of logistics centres and industrial track owners should definitely recognize the importance of investing in the industrial track whose condition and diversification ultimately affects to the quality of transport and logistics services. Railway carriers and infrastructure managers must be in agreement with the owners to prevent further deterioration of existing and find a way to encourage construction of new industrial tracks.

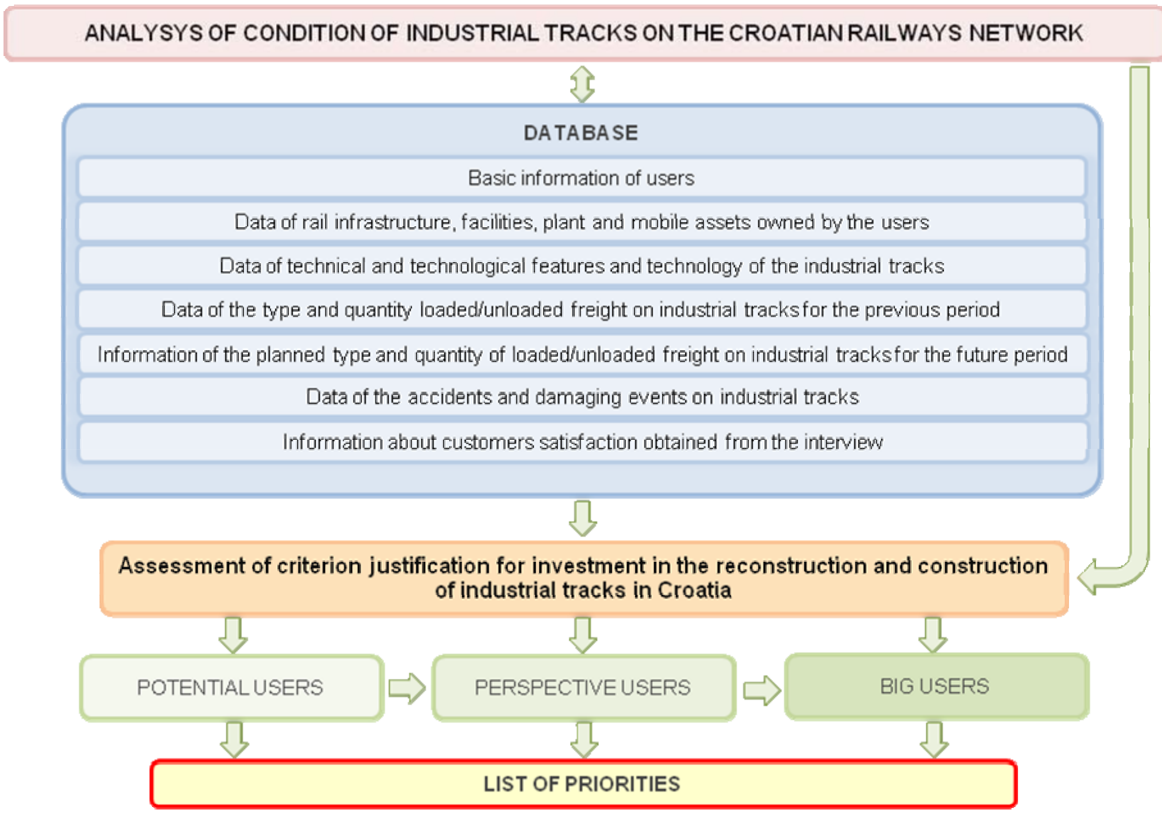

Figure 1 - Model of determining feasibility of investment in the industrial tracks

In planning the reconstruction of certain route sections and associated stations, industrial tracks which are located in this part of the network must be treated as integral parts of these railroad or sections. Otherwise, in the technical-technological point of view they will become incompatible with the restored railroad and as such represent a limiting technological factors in the transport process. Therefore, during the planning the reconstruction of the railroad it is desirable to promptly notify the owners of the intended works and encourage them to renew simultaneously their tracks.

The assumption is that the greater number of owners, with agreed financial support of the infrastructure manager and railway carrier, will decide to rebuild their dilapidated railway infrastructure, which would also be the guarantee of retention in the future. With respect to each investment and financing the maintenance, renovation or construction of industrial tracks must be justified, it is necessary to determine the criteria by which to choose priorities for the reconstruction of individual tracks. Detailed analysis of the current state of the track is required in order to find appropriate solutions to problems and determine the criteria for priority construction, reconstruction or repair track individual user groups (figure 1).

With the opening of EU market and the liberalization of rail transport, all subjects in transport chain must be involved in reviewing existing legislation and administration.

3. CHANGES IN THE INVESTIGATION OF RAIL ACCIDENTS

Until 2005 Croatian Railways was unified company, and then the investigation of rail accidents was organized in such a way that all accidents were investigating by Croatian Railways. The person who led the investigation in front of Croatian Railways in almost every case was the chief of the station, as a competent person and he was responsible for establishing the cause and responsibility for any rail accident that occurred at the station, and in the area of industrial tracks that are under the station jurisdiction. But if some extremely difficult accident was happened with extensive damage, or with dead and wounded, for that would be big public interest and then the commission would be established by Croatian Railways, which was investigating accident. In that case the chief of the station was a member of the investigation committee.

By dividing Croatian Railways to carriers and infrastructure manager in 2005 new relationships have been established within the previously unified company, and industrial track owners as independent legal entities are now fully responsible for the condition of railway infrastructure systems and subsystems of its industrial tracks, as well as traffic safety on industrial tracks.

Due to the same, it was necessary to change the way of the investigation of rail accidents, because the changes are occurred in the relationships and correlations between the earlier parts of a unified railway system and the owners of industrial tracks, as well as transport users and the legal entity which performs traffic on its railway tracks.

3.1. The way of the investigation of rail accidents before dividing Croatian Railways on carriers and infrastructure manager

Investigation of rail accidents while Croatian railways was unified company was defined by the Ordinance of the investigation of accidents and Instruction on procedures during accidents and incidents investigation and the holder of the investigation was always Croatian Railways. When rail accident on the industrial tracks was happened, chief of the station who had jurisdiction on that industrial track definitely had to be informed from the owner of the industrial track. The chief of the station immediately had to inform about the rail accident: department of traffic safety control , operating department, the head of the transport area, the train traction, district inspector, engineers for investigation of accidents, and other entities depending on the type of accidents.

Depending of the type of accident, Croatian Railways has established an investigation committee and chief of the station was involved in the same committee, mainly as a committee chairman or member. Provisions concerning the investigation of rail accidents with the specifics of individual industrial tracks were described in detail in each Operating instructions of industrial track, but the investigation has always been guided by Croatian Railways.

3.2. The way of the investigation of accidents in the new conditions Croatian railways division to different companies

Croatian Railways Ltd. is divided on the infrastructure manager (HŽ Infrastruktura Ltd. -railways infrastructure) and 3 carriers (HŽ-Cargo Ltd. – Freight transport, HŽ Putnički prijevoz Ltd. - Transport of passengers and HŽ Vuča vlakova Ltd. - train traction).

According to the new regulations and laws of Croatian republic each of these companies have an equal responsibility for the performance of rail traffic. Industrial track owner is also a legal entity engaged in railway transport, and as such he is equal with the rail carriers resulting from the former Croatian Railways. All acts which regulate rail transport, including the Ordinance of accidents in railway traffic are relevant for owners of industrial tracks also. Rail accidents are now reported to the relevant departments of legal entities engaged in railway transport, and independent investigative body of the Croatian Railway Safety Agency, depending on the location of accident being placed. Thus the rail accidents that happened in the area of Railway Infrastructure jurisdiction are reported to the competent authorities of Railways Infrastructure, which then lead the investigation. If the accident occurs in the area that belongs to one of the Railway carriers (depot of locomotives, workshops for repairing wagons etc.), then rail carriers have to perform the investigation. If the accident took place on industrial tracks, a legal person who carries out rail transport for own account, or owner of the industrial track is the holder of the investigation of rail accident, but not Croatian Railways, or derived companies from former Croatian Railways. Of any accident with severe consequences (dead, wounded or major property damage) Croatian Railway Safety Agency must be informed about it.

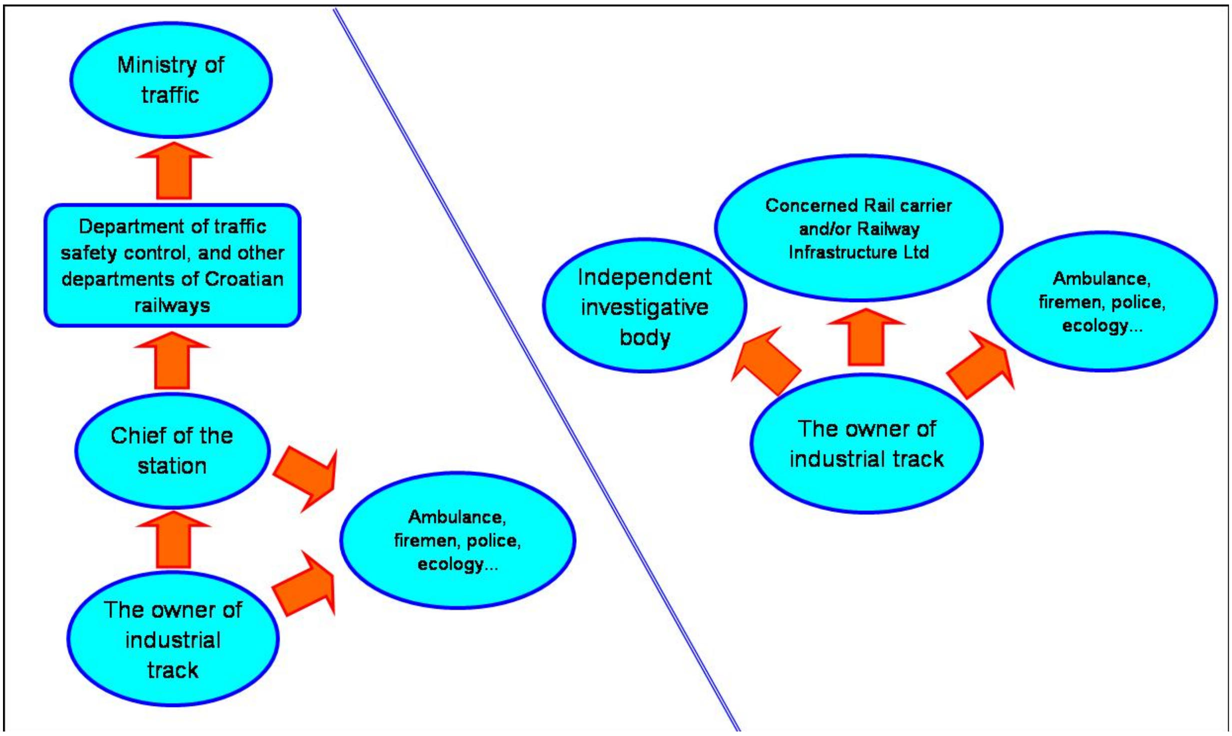

Figure 2 - Informing and investigation of accidents before and after entry of new Railway Safety Act

If accident occurs on industrial track, in most cases railways carriers will be involved in that accident, because of their personal, wagons or locomotives if the owner of industrial track has no its own locomotives. The investigating committee will be determined by agreement between the interested parties, based on the Ordinance of accidents in railway traffic and Operating instructions of industrial track in which can be specified certain specifics that affect to the investigation, and which can be applied in the investigation. The owner of industrial track must also keep records of all prescribed in the Ordinance of accidents in railway traffic, and comply to all rules and regulations that apply to the performance of railway transport as well as in the investigation of accidents.

3.3. Summary of the accidents on industrial tracks

From the short analysis of the accidents and damage events on industrial tracks showed that in the last seven years on average there were 2 accidents and 1 damage event per month on industrial tracks with a total annual material damage estimated at 40.000 Euros. In the review of the types of accidents, the highest rate of 83.7% refers to the disturbance, then it was 14.2% of accidents and the rest were avoided accidents.

Table 2 - Accidents and damage events on industrial tracks

Year	Accidents	Damage events	Total
2005.	23	17	40
2006.	18	24	42
2007.	29	16	45
2008.	19	13	32
2009.	20	5	25
2010.	29	7	36
2011.	3	8	11
Total	141	90	231

In Table 2 significant indicator are only 3 accidents in 2011, which does not mean that is reduced number of accidents but that have already been changes to the Ordinance of accidents in railway traffic and Railways Infrastructure Ltd. (HŽ Infrastruktura Ltd.) has no longer guided all investigations of accidents. In that interspaces, between the entry of this new Ordinance of accidents in railway traffic and adjustment of railway carriers to the new situation, there is a danger of neglecting the necessity of adopting and implementing the security recommendations of the investigation of accidents.

Table 3 - Responsibility for the accidents on industrial tracks

Responsibility	Percentage(%)
Owner	52,48
HŽ Cargo Ltd.	25,53
HŽ Infrastruktura Ltd.	5,67
HŽ Vuča Vlakova Ltd.	8,51
Other	2,13
Unknown	5,67
Total	100,00

In Table 3 there is a short overview of responsibility for the accidents on industrial tracks. According to the specified percentage it is evident that for more than 50% of the accidents on the industrial tracks are owners responsibilities. Damages on industrial tracks that are the most common cause of accidents are ruptured rails, improper or open dilatations and other technical malfunctions.

4. CONCLUSION

Industrial tracks are the integral part of any logistics centre. Therefore, the level of railway safety which will take place on industrial tracks within the logistics centre is of very big importance for the development of logistics centres and their structure, work organization and quality of service that will provide to end-users. As a precondition for the development of logistics centres it is necessary to define the safety aspects of the railway traffic and the ways of the investigation of accidents, which is important for the safety of rail traffic. The latest Ordinance of accidents in railway traffic and other acts that regulate the performance of railway transport, require owners of private industrial tracks to become carriers of the investigation of accidents that happened in their area, for which most they are not ready, and some of them still do not know that they are now have their own duties and responsibilities. Until the new regulations concerning traffic safety, the investigation was still performing by the relevant service from Railways Infrastructure Ltd. and chief of the station, while the industrial track owner was a member of the committee. The new provisions regulate that owners of industrial tracks must accept the changes that have occurred, and prepare to carry out future investigations. For this purpose, they must do certain organizational changes in business, and identify and train workers who will conduct the investigation, provide material resources, equipment and current records and forms used in the investigation of accidents. The new situation forces the owners of industrial tracks to carry out the investigation of accidents, but they are not sufficiently trained and experienced in performing those investigations, therefore it will certainly be good that chief of the station continues to be in each committee for the investigation of all accidents on industrial tracks. Chief of the station would be able to indicate the important elements of the investigation and coordinate investigation in order to better determination of responsibilities, eliminating the consequences of accidents, and improving the quality of the investigation. The role of the chief of the station for the investigation of the accidents is necessary to define and revise in the existing regulations.

Also it is evident the fact that there are still plenty of unresolved property issues and problems with the ownership structure of industrial tracks that are located on the railway network in Croatia, which leads to the problem of determining responsibility for the investigation of accidents, and in producing unforeseen costs that can not be charged, because it is unknown who must pay this costs.

To avoid these problems, it is necessary to define the ownership structure, border areas between the Railways Infrastructure Ltd. and owners of industrial tracks, and revise existing agreements of using industrial tracks, as well as corresponding instructions for using industrial tracks. All property rights and business relations, particularly in determining the responsibility between the carriers, the Railways Infrastructure Ltd. and service users must be accurately and unambiguously defined.

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ZAGREB AIRPORT CARGO CITY PROJECT

ABSTRACT

Air transport of cargo (Cargo) on global scale is not significant in quantity, but its value presents 35% of the total world cargo transport. This amounts to approximately $ 60 billion of financial realization. Directly or indirectly, air cargo transport provides around 32 million workplaces worldwide. All this makes it a significant segment of the global economy. Zagreb Airport (ZLZ) in the long-term realized more than 85% of Croatian air cargo traffic. This means that the responsibility for the development of this segment of air traffic lies at ZLZ. Accordingly, ZLZ determined three strategic development guidelines for developing this segment of business activities: 1) technology development, 2) development of a network of regular air traffic connection from/to Zagreb and 3) infrastructure development. This paper is focused on displaying the possibilities for securing the third strategic guideline, infrastructure development, which is to be solved through Zagreb Airport Cargo City (ZACCP) project implementation.

Key words: *air cargo traffic, intermodality, Zagreb Airport Cargo City*

1. INTRODUCTION

Function of a cargo terminal is to handle and forward cargo and mail on airport (Cargo). Facilities and technology within the storeroom should provide acceptable and expeditious cargo and mail handling and forwarding processes, especially when it comes to the combination of land and air transport, and vice versa. Keeping this fundamental requirement in mind, in project management it is necessary to perceive the financial aspect and expansion capabilities of the terminal without major modifications if the future development of freight traffic requires it.

After entering the full membership of the European Union Croatia should be integrated as part of a unified transport system regulated by the so called White Paper and based on the principles of intermodality and sustainability. Intermodality implies optimization and cost reduction in the transport process, while sustainability implies a rational impact of expanding activities on the environment. Zagreb Airport Cargo City Project (ZACCP) is based on both principles and is compatible with other transport infrastructure projects in the surroundings.

General management objectives of the Zagreb Airport are medium- or long-term development goals. Some of the general objectives are: 1) to develop a network of lines in regular air traffic and to increase traffic to 3 million passengers and 20,000 tones of goods annually by 2015; 2) to develop infrastructure (new passenger terminal construction project) and 3) to build new capacities for cargo handling and forwarding – ZACCP).

2. LOCATION

The implementation of ZACCP is planned at the location of the Zagreb Airport in the triangle bounded by the southern Zagreb ring road, railroad track running through Velika Mlaka and connecting the railway marshalling station to Zagreb- Sisak railroad and existing runway, i.e. its northern boundary. It's a total land area of approximately 350 acres which is reserved for expansion of airport activities by the Spatial Plan for the County of Zagreb district and the city of Velika Gorica. The land is privately owned and there are a lot of small parcels and owners. There are no problems expected with buying off land, since recent legal solutions enable the acceleration of this process through "dispossession" procedures.[1]

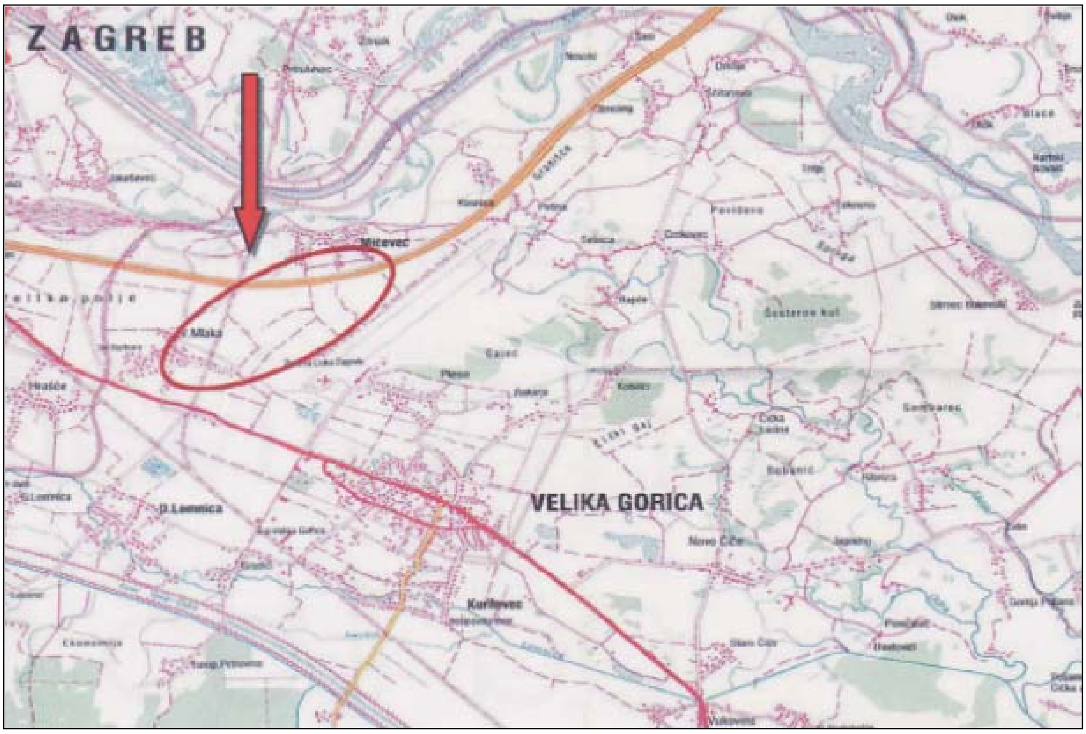

Figure 1 - The area in which Zagreb Airport Cargo City is to be built

Source: Terms of Reference for the conceptual design of Zagreb Airport Cargo City, ZLZ, Zagreb, 2012, p. 19/30.

Investment feasibility study was made and it shows that the return of investments is achievable in a period of 10 years[2]. Subdivision study made by University of Zagreb Faculty of Geodesy clearly determines the number of each cadastral plot through which one can gain insight into the ownership certificate, parcel area etc.[3]

3. PROJECT DESIGN PHASES

ZACCP implementation is planned in three phases. The *first* phase is the most complex because it provides connections to the infrastructure: energetic, utilities, roads and railway tracks. This phase envisages the construction of storage facilities with special spaces of an overall surface area 8300 m² and all necessary equipment, which would suit the needs for the turnover of approximately 60 000 tons of cargo per year. One partner has already expressed a need for 3,000 m² of space. Office space to be used for needs of Zagreb Airport, partners and the civil service; cargo aircraft apron of approximately 20 000 m², which would be enough for two Boeing 747 sized airplane positions or for three to five smaller positions and a taxiway system within which would be a taxiway that could take over a function of a second runway would also be built.

The *second* and *third* phase imply the potential expansion of warehouse, office and parking space.

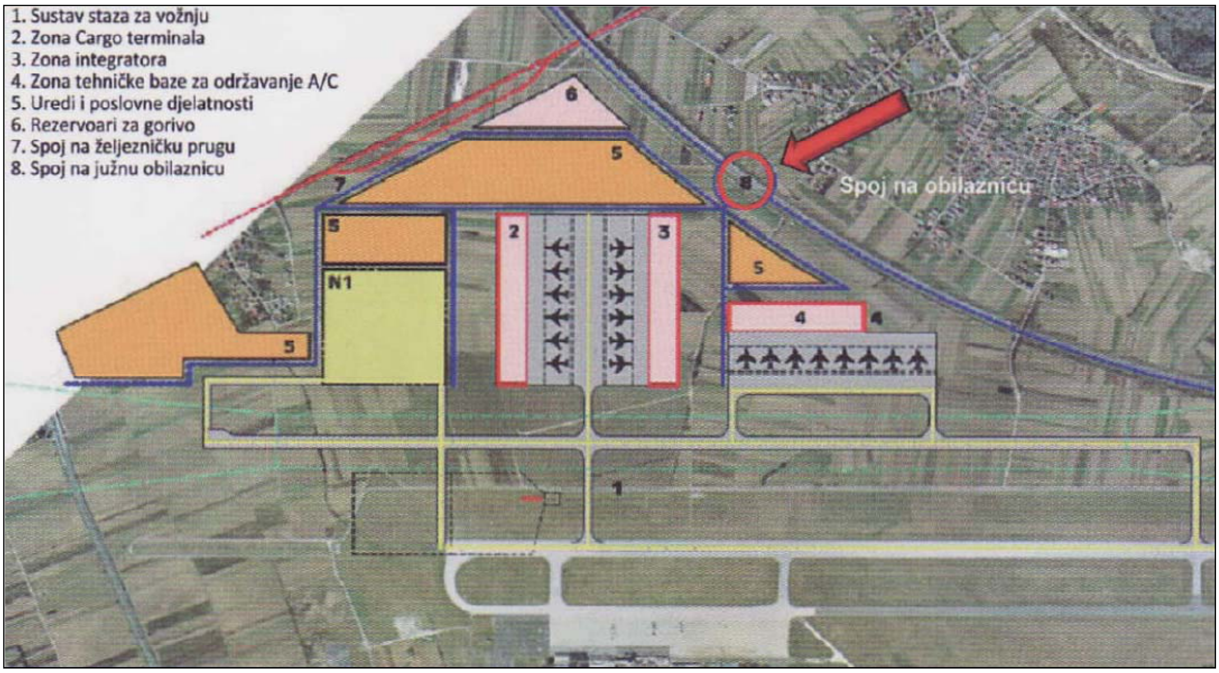

Figure 2 - ZACCP Master plan

Source: Zagreb International Airport, Master plan, 2008.

Potential investors with access to financial resources are expressing interest in this project, because they consider it realistic and feasible. One of the sources of financing this project are EU funds, but for their application the project should have a high level of documentation. That means it is necessary to make the following documents:[4]

- Feasibility study, including variable analysis;
- Cost/Benefit analysis (risk analysis, financial and economical analysis);
- Calculation of missing resources (Calculation of funding gap), indicating the contribution of EU funds;
- Conceptual Design;
- Zoning Permit;
- Information on plot status;
- Future operations and maintenance model description;
- Cost assessment of all project components;
- Financial Plan;
- Procurement Plan;
- Arrangements in implementation and term plan;
- Environmental Impact Study (including public discussions);
- Master project;
- Construction permit;
- Completed application form for the EU funding.

It is also required for the owner, in this case the Republic of Croatia, to make the necessary decisions.

The value of investments will be determined precisely when all input parameters are set. Predictions show that the total cost of the first phase would be between 21 and 23 million euros, which includes documentation, land, construction and equipping facilities.

4. INTERMODAL SURROUNDINGS

When it comes to logistics centres and Cargo traffic there are other projects compatible with ZACC project, beside the project of building a new passenger terminal. These projects are: 1) Croatian Railways logistics centre, HŽ Cargo in Dugo Selo; 2) Rijeka-Zagreb-Budapest railway modernization project; 3) Croatian Post logistics centre construction project; 4) Port of Rijeka container terminal and 5) long-term, project of navigability of the river Sava to Zagreb. These projects are important for including Croatia in the unified EU transport system, based on the principles of intermodality and sustainability, and for positioning Croatia in the European logistics market.

HŽ Cargo logistics centre project in Dugo Selo should increase railroad share of cargo transport and enable it to take over cargo transport from other corridors. This project is being implemented in cooperation with multiple domestic and foreign partners who function as a consortium.

Implementation of Rijeka-Zagreb-Budapest railway modernization project should significantly shorten and speed up cargo traffic, thus increasing capacity of the route which would better position port of Rijeka in terms of its importance for the countries of Central Europe. This project would provide Rijeka with better connections to European corridors. According to expert assessments Croatia could get more than 70% of necessary funds for this project from European Union access funds.[5]

The project of building a new logistics centre for the Croatian Post in the vicinity of ZLZ should allow for better positioning in the market. This is important due to the onset of postal service market liberalization in Croatia in 2013.[6]

Port of Rijeka also strives to have a more significant role in European intermodal transport system. A great advantage of port Rijeka is its position, which makes transport to and from Asia five days shorter than transport from port of Rotterdam, and six days shorter than from port of Hamburg.

Project of navigability of the river Sava to Zagreb is likely to be realized in the future. This way river traffic would be an integral element of intermodal transport in terms of ZACCP, and also of other projects.

Location selected for ZACCP should be considered and evaluated within this context. Its fundamental feature is good transport connectivity, since one of the most important ZACCP goals is integration into a unified transport system of the EU through intermodal transport connectivity with road, rail, water and air transport.

5. STRATEGIC GUDELINES FOR THE DEVELOPMENT OF ZLZ CARGO TRAFFIC

In the period from 1993. to 2006. ZLZ realized an average annual 85.35% of total Croatian air cargo traffic.[7] Consequently, the responsibility for the development of air cargo traffic in Croatia lies at ZLZ. For this purpose, three strategic guidelines for the development of cargo traffic have been determined.

The first phase is *technology development* which implies a complete computerization of business processes, competent staff, quality management, etc. As a part of this, successful participation in IATA global freight projects such as “E-Freight”[8], concerning an increase in efficiency through elimination of paper documentation and the introduction of electronic business, and "Cargo 2000"[9], which is a project of standardization and quality management in the freight transport process, was achieved.

The second strategic guideline is *development of regular connections* from Zagreb. Vision is to establish direct regular traffic from Zagreb to the U.S. and destinations in the Far East, eg China or South Korea. That would be a new offer for customers, and would imply an increase of cargo traffic through Zagreb, because the Asia-Pacific region accounts for more than 44% of global air cargo traffic.[10] Developing a network of regular connections is important because these airplanes beside passengers also carry cargo, unlike so-called low cost carriers and passenger charters.

The third strategic guideline is *construction of modern infrastructure* which is intended to be accomplished through Zagreb Airport Cargo City project.

6. CONCLUSION

Transportation of cargo by air contributes significantly to the global economy and is a key indicator of its efficiency, since the value of the goods transported by air amounts to 35% of the total cargo traffic, which represents an amount of approximately $ 60 billion annually and provides 32 million workplaces worldwide, despite its modest share in physical cargo traffic.[11] Therefore air cargo traffic presents a significant component in the distribution chain.

In the mid 80-ies of 20th century Croatia achieved only about 1 ‰ of global cargo turnover, and by the year 2010. this portion decreased to about 0.1 ‰.[12] During the period from 1996. to 2010. ZLZ generated an average 85.38% of the annual Croatian air cargo traffic.

These shares could increase within the next period, but for that to happen appropriate organizational, technological and infrastructural prerequisites are needed. In order to create infrastructural prerequisites Zagreb Airport Cargo City project has been started, and it applies to the construction of storage facilities and other buildings, access roads, operational surfaces, business and other premises, parking lots for cars and trucks, as well as connections to the highway and railway line. Including ZLZ from the point of cargo traffic in intermodal transportation system, where at the role of other compatible projects is also considered, would create preconditions for the repositioning of ZLZ and Croatia at the Southeast Europe air cargo market. Air Cargo traffic is an essential structural element of every serious intermodal transportation system.

ENDNOTES

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SEAPLANE TRANSPORT MODEL IN ORDER TO IMPROVE TOURIST TRAFFIC TO THE ISLANDS

ABSTRACT

The paper discusses a seaplane transport model as one of the solutions to improve the tourist traffic to the islands. Specifically, transport links of Split Airport, the city of Split and nearby islands, are taken as an example. The second section discusses the existing maritime connections from Split Airport to the islands. In the third section, special attention is given to an alternative transport by seaplanes from the airport directly to the islands. The fourth part is oriented on the main characteristics of seaplanes suitable for the coast. The fifth section deals with four types of seaplanes and their characteristics. In conclusion, there is a suggestion for guidelines of the development and use of seaplanes as one of the options in tourist transport offer.

1. INTRODUCTION

This paper develops a theoretical advantage of seaplane exploitation in respect to other existing forms of transport, especially maritime transport. From the viewpoint of faster and more efficient transport, and additional tourist transport offer, it argues the need for more systematic approach to reviewing the potential use of seaplanes in Croatia, as one of transport options, especially in the tourist offer.

Seaplane transport in Croatia has not been developed although there is a demand for this type of transportation as an option in the tourist industry.

Operators that provide seaplane transport service exist in Norway, and these are Fonnafly AS[1] and ScanAviation AS[2]. Also in Greece there is seaplane transport developed but only for tourism, and there are operators such as AirSea Lines[3] and ArGo Airways[4].

For example, Argo Airways air carrier transports from the city of Volos to the islands and cities which are also most visited tourist destinations in Greece (city of Athens, Thessaloniki, and islands such as Skiathos, Scopeles, Alonissos). ArGo Airways has defined links toward their destinations, in average, one flight twice a week (both directions).

This work has focused on developing models of seaplane transport which would help improving tourist traffic. Thereby, Split Airport and nearby islands such as Drvenik Mali and Veliki, Šolta, Brač, Hvar, Vis, Biševo, etc., are take as an example.

2. SECONDARY EXISTING TRAFFIC LINKS BETWEEN THE SPLIT AIRPORT AND NEARBY ISLANDS

The only way to arrive, for example, to the island of Vis is via ferry or catamaran of Split Jadrolinija Agency, and if one comes from Split, and maybe by car, must use Jadrolinija.

If passenger arrives to Split Airport, there is a bus that transports passengers to the city of Split, and after that thay can go to Split harbor and take ferry to transport them to the island of Vis.

There is a special speedboat that transports passengers directly from Split Airport to the island of Hvar (but only during the season), and then from island Hvar to island Vis. There is no direct connection, for example, to the island of Vis.

Split Airport has regular flights to Zagreb (domestic) and to Stuttgart, Cologne, Munich, Paris (de Gaulle), Frankfurt, Rome and Oslo (international). Split Airport is located near Adriatic coast. It is 20 km away from Split, and 6 km away from Trogir.

As regards of transport, i.e. from Split Airport to Trogir or Split, there is a direct bus line – direct transfer to/from Split was organized in cooperation with Pleso Prijevoz. There is public transport too, bus no. 37 (Split –Trogir; Trogir – Split) and bus no. 38 (Airport – Kaštel Stari – Split; Split – Kaštel Stari – Airport), and there is also a taxi service available during airport hours of operation.

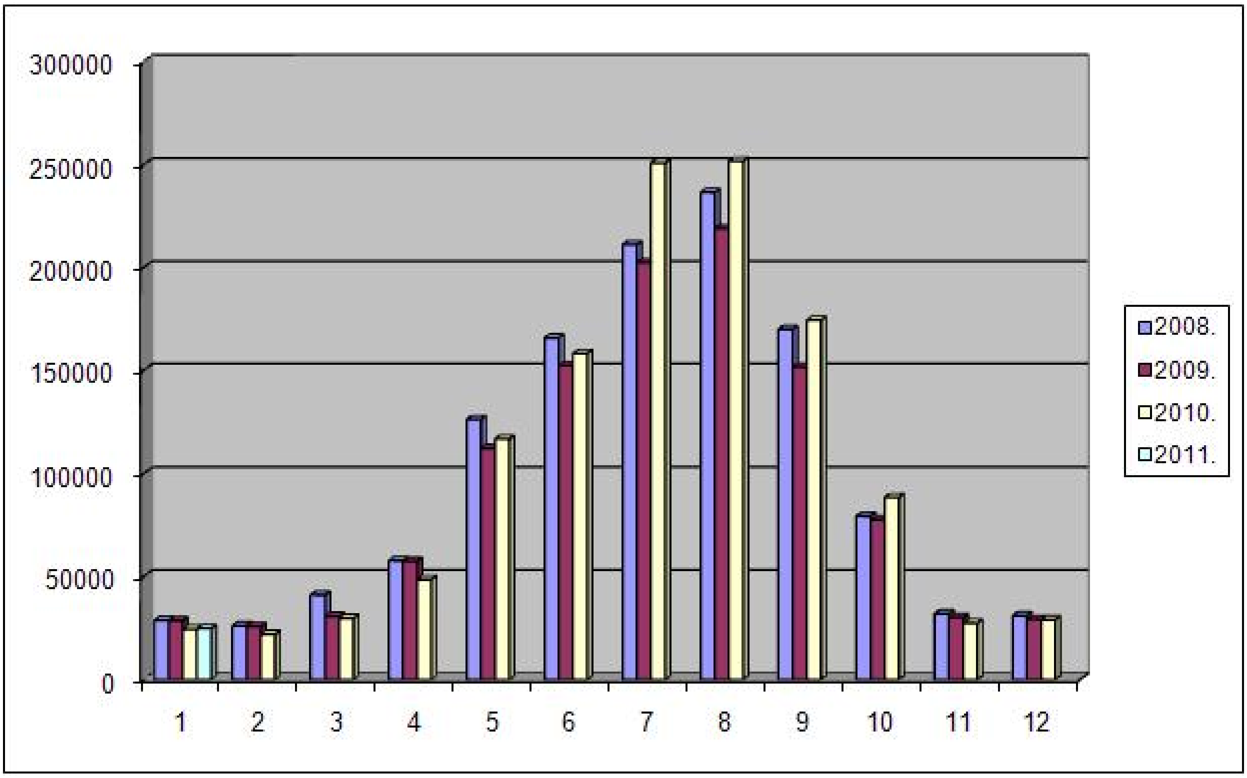
During the season, Split Airport has much higher passenger traffic when compared to other months of the year.

Table 1 - The total number of passengers in the period of 2008. - 2011.

	sij	velj	ožu	tra	svi	lip	**srp**	**kol**	ruj	lis	stu	pro	**total**
2008.	28629	25897	40817	57584	126203	165669	211028	236466	169848	79112	31740	30793	1203786
2009.	28401	25629	30530	57277	112185	152226	202233	218751	151504	77497	29910	28956	1115099
2010.	24250	21799	29585	48344	116748	158029	250755	251618	174280	88328	27178	28827	1219741
2011.	24579	22809	29471	65652	113879	172119	274063	259664	185462	95679	28905	28099	1300381

Source: http://www.split-airport.hr/hr/statistika.html

Table 1. shows the total number of passengers carried in the period since 2008. to 2011. It can be seen that the month of July and August differ according to the number of passengers carried in respect to the number of passengers carried during the other months; from 25 to 40%.



Graph 1 - The total number of passengers in the period since 2008. - 2011. - Per month

Source: http://www.split-airport.hr/hr/statistika.html

In respect to increased transport demand during the season, as it is provided in Table 1. and Graph 1., it is necessary, to provide transport to tourist destinations and offer various alternatives in terms of transportation.

Particularly interesting is the transportation to the islands near the city of Split. As it is already mentioned, there are direct connection only from Split Airport to the island of Hvar – with a speedboat. For all other islands, it is necessary to transport passengers to the city of Split or Trogir, then to seaports where passengers are then transported by ship (ferry) to the island.

Seaplane transport, transport of passengers from the airport or from a place very near airport to the islands, represents one of the fastest and most efficient transportation solutions, and also an expansion of tourism.

3. SEAPLANE TRANSPORT AS AN ALTERNATIVE TRANSPORT OPTION

Seaplanes or aircraft are equipped and capable to take off and land on water, except the fact that for these planes, special infrastructure does not need to be built (surface area for takeoff and landing is a body of water, and maintenance and handling facilities of such aircraft can be provided in existing seaport or airport), and have many other advantages.

Seaplane in the context of this paper can be used to transport passengers/tourists or as an additional transport option in the tourist offer.

Seaplane has a relatively low impact on noise pollution. The highest level of noise is generated during takeoff when high power is required, and even then, the noise level is slightly larger than the noise created from people having a conversation.

Table 2 - Noise Levels

Source of Noise	**dBA**	**Note**
Jet ski	110	e.g. watersports on lake
Chainsaw	100-104	e.g. tree felling
Lawn mower	88-94	e.g. golf course
Tractor	95	e.g. general operations
Speedboat	65-95	e.g. watersports on lake
Seaplane	75	Take off only at 300m from plane for 20 sec
Inside Car at 30mph	68-73	
Normal Conversation	55-65	

Source: Cronin Millar Consulting Engineers: Seaplane Environmental Impact Information Report

Table 2. shows the results of measuring the impact of noise. It is emphasized that the seaplane have a significant low impact on noise pollution in respect to existing sources of noise on the lake or at the sea.

Table 3 - Noise Levels for seaplane operations

Event	**Duration of Audibility**	**Maximum Noise Level**
Seaplane landing	50 s	62 dBA
Seaplane idling towards pontoon	3 min	55 – 61 dBA
Seaplane engines started and departs	9 min	63 – 48 dBA
Seaplane takes-off	10 s	57 dB (350 m)

Source: Koikas Acoustics Pty Ltd: Aircraft noise assessment of seaplane operations at Cottage Point Inn, Ku-ring-gai Chase National Park

Seaplane emission of carbon compounds in respect to boats is negligible. Seaplanes use Jet A1 fuel. This fuel does not contain methyl-tert-butyl ether (MBTE), which is volatile and flammable substance contained in the fuel for boats. Boat engines emit large amounts of exhaust gases into the water, which can lead to general pollution and water pollution with MBTE. Seaplane exhaust gases are expelled directly into the atmosphere so at least they don't pollute the water.

Seaplane is capable of transporting passengers in 20 minutes to the nearby island, which is much less than the journey by boat which takes at least twice as long.

Seaplane landing and taking off only from the water, need infrastructure on the shore of the sea or the lake (or any other water surface), where they are properly handled (together with passengers and luggage), maintained, refuelled and other. Such aircraft can land at any seaport, with the fact that once seaplane lands on water, seaplane is treated as a vessel, and the same laws as for ships and other vessels, are applied.

If new links, for example, were introduced from Split harbor, where seaplane would transport passengers to the islands, flight schedule should be adjusted in respect to public transport from the Split Airport, that way passengers would be able to go from an aircraft to a bus, and then to the harbor and at last to the island of the destination.

Another version would be to introduce a link at the airport so when passengers get off their flights have another flight with amphibian. Amphibian has the option of landing and taking off from the land and water, and it would be an ideal solution for all passengers leaving for the islands because it would be direct line from the airport to the island. It would also be necessary to adjust the flight schedules as well as the space and equipment for such aircraft at the airport.

Figure 1. shows some examples of seaplane (at the right up corner is a seaplane that lands on the hull, on left is a seaplane with floats, and two other pictures show two different types of amphibians).

Figure 1 - Seaplane (a seaplane landing on the hull, a seaplane with floats, amphibian – capable of landing on both land and water)

Source: FAA Seaplane Operation Handbook

4. GENERAL CHARACTERISTICS OF SEAPLANES SUITABLE FOR THE ADRIATIC COAST

Transportation vehicle or aircraft required (optimal solution) must satisfy the conditions such as: aircraft must be „EKO GREEN" (without excessive noise, vibration and pollution of the environment), must be safe and reliable in accordance with ISO standards, should provide a modern and fast travel („door to door"), should be economical, must allow range to at least to the continental part of Croatia or part of European Union and must allow travel in continental part of Croatia within one hour of flight.

The main features:

–aircraft must have the ability to takeoff/land on minimum length runway, with a significant gradient of descent or climb, capable to leave the airport area as fast as possible (to reduce noise), and the minimum takeoff/landing speed,

–carrying capacity for passenger services should be up to 19-23 passengers or 2310 kg, passenger cabin must be spacious, in range with better economy class (for longer trips, tourists),

–it is desirable that the aircraft reaches the desired range with maximum payload,

–optimal airspeed – so the journey takes no longer than 2-4 hours at maximum range,

–good performances at higher temperatures (30-32°C) with maximum payload and maneuverability in winds up to 30 km/h,

–economy of operation and minimum fuel consumption,

–reaching the ceiling with the cancellation of the propulsion system (engine) with maximum payload,

–environmental compliance with „EKO GREEN“ requirement,

–„door to door“ technology,

–it has to meet all internationally accepted standards, has to be safe and reliable in all aspects (collision, sinking, fire, etc.).

Currently, seaplanes are in a compliance with most of the conditions listed above; i.e. seaplanes with the possibility of landing on the water surface and amphibians with the possibility of landing on water and land surface.

In the following text there are descriptions of the features and technical characteristics of aircraft/seaplanes that might meet the requirements.

The first option is a conventional aircraft with the possibility of installing floats (and even with the possibility of installing additional undercarriage for takeoff and landing on runway and water surface), thus obtaining a seaplane or an amphibian. Another option is a seaplane, a third possibility is an amphibian.

The use of seaplanes and their production is still underdeveloped. For the commercial flights in continuous production, there is Cessna Caravan which can have floats fitted on request. Such a seaplane has advantages such as cost (the most economical aircraft, the lowest operating costs), the empty weight of seaplane is less for 13,54% (the reason is the need for strengthening the lower part of the seaplene hull, i.e. water undercarriage, which also must meet certain standards for shock waves and can be divided into watertight chambers), weight ratio of empty and loaded seaplane is almost 50% better than turboprop CTOL aircraft and has lower fuel consumption and greater payload in respect to its own weight. Cruise speed of seaplane is always slower (resistance of the hull), and also requires more power due to weight. When taking off from water, due to a sudden increase in resistance to water, seaplane requires strong operational group or reduction of payload when taking off from the water in respect to the taking off from land runway.

Existing amphibian production, does not produce the optimal aircraft for the complete coast of Croatia. Options are Canadair and Dornier Seastar CD2. Canadair transport category with its payload capacity is too large (32-35 passengers), has a large volume space, and high operating costs. Dornier Seastar CD2 has a payload of 1574 kg/12 passengers –it is a smaller aircraft (up to 5,7t MTOW, 9-20 passengers). The average traffic demand in Croatia is 19-23 passengers (2310 kg).

Amphibian is suitable for civil air traffic to the Croatian islands and meets most of the requirements and specifics of the region. It complies in respect to connecting the Adriatic islands and the continental part of the Croatia and the central part of the EU, and does not require the construction of new infrastructure. It meets requirements for using a shorter runway. It has all the characteristics of the specific CTOL aircraft landing gear – the possibility of landing/taking off from land and sea/water surface.

5. EXAMPLES OF APPLICABLE TYPES OF SEAPLANES AND AMPHIBIANS FOR CROATIAN COAST

Conventional aircraft/seaplane Cessna Caravan (with possibility of installing floats)

Table 4 - Specification

General characteristics
Crew: one
Capacity: nine passengers or 14 with FAR Part 23 waiver
Length: 12.67 m (41 ft 7 in)
Wingspan: 15.88 m (52 ft 1 in)
Height: 4.32 m (14 ft 2 in)
Wing area: 26.0 m^2 (280 sq ft)
Empty weight: 2,073 kg (4,570 lb)
Gross weight: 3,970 kg (8,752 lb)
Powerplant: 1 × Pratt & Whitney PT6A-114A , 505 kW (677 hp)
Propellers: 3-bladed Hartzell variable pitch
Performance
Cruising speed: 317 km/h (197 mph; 171 kt)
Range: 2,000 km (1,243 mi; 1,080 nmi) with max fuel and reserves
Rate of climb: 3.9 m/s (770 ft/min).

Source: http://en.wikipedia.org/wiki/Cessna_208_Caravan#Specifications_.28208B_Super_Cargomaster.29

Figure 2 - Cessna 208B Caravan

Source: http://en.wikipedia.org/wiki/File:Cessna.208b.n208nj.arp.jpg

Figure 3 - Cessna 208B Caravan

Source: http://en.wikipedia.org/wiki/File:Seawings_Cessna_Caravan_208A.JPG

Cessna Caravan Amphibian

Figure 4 - Cessna 208A Caravan
Source: http://www.vectorsite.net/avcvan.html

Figure 5 - Caravan Amphibian
Source: http://www.cessna.com/caravan/amphibian/

Figure 6 - Caravan Amphibian
Source: http://www.cessna.com/caravan/amphibian/amphibian-gallery.html

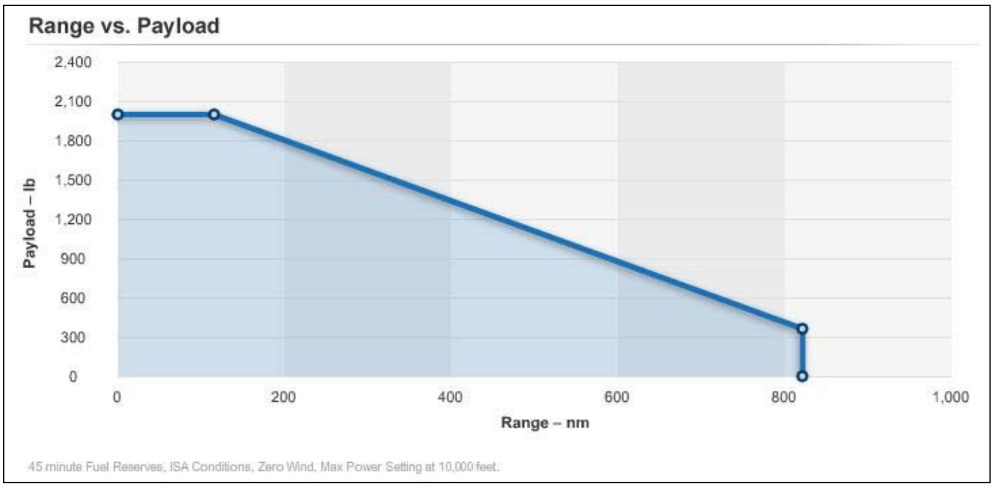
Figure 7 - Characteristics and prices

Source: http://www.cessna.com/caravan/amphibian/amphibian-performance.html

Table 5 - Performance[5]

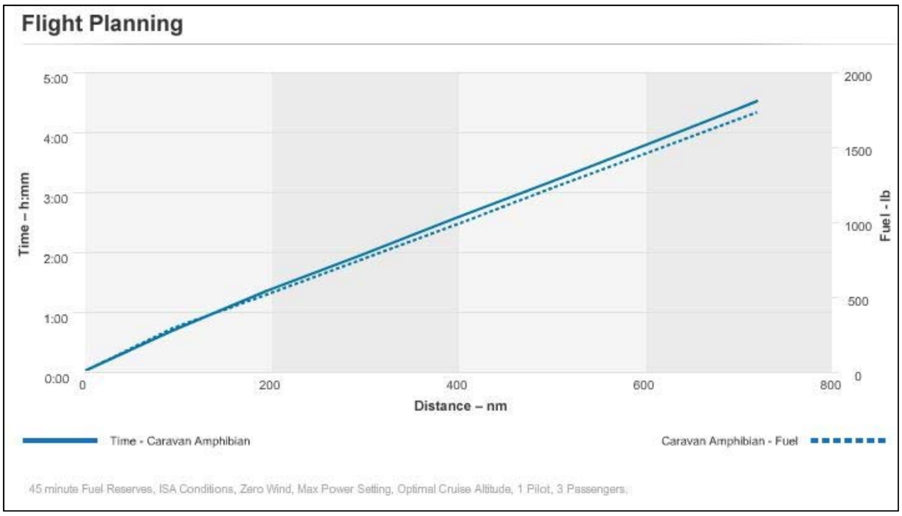
	Caravan Amphibian
Maximum Cruise Speed	162 ktas
Maximum Range [1]	820 nm
Takeoff Distance (S.L., ISA, MTOW) [2]	3,280 ft
Ground Roll	2,025 ft
Landing Distance (S.L., ISA, MLW)	2,045 ft
Ground Roll	1,123 ft
Maximum Operating Altitude	20,000 ft
Maximum Climb Rate (Sea Level)	1,030 fpm
V_{MO}	175 kias
Stall Speed	57 kcas

[1] *45 minute Fuel Reserves, Max Cruise at 10,000 ft, Max Fuel, MTOW.*
[2] *Distance to 50 feet above the runway.*



Graph 2 - Range vs. Payload

Source: http://www.cessna.com/caravan/amphibian/amphibian-performance.html#



Graph 3 - Flight planning

Source: http://www.cessna.com/caravan/amphibian/amphibian-performance.html#

Table 6 - Specification[6] Avionics & Powerplant

	Caravan Amphibian
Avionics	Garmin G1000
Powerplant	
Manufacturer	Pratt & Whitney
Model	(1) PT6A-114A
Power Output	675 shp
Propeller	
Manufacturer	McCauley
Description	3 blade metal, constant speed, full feathering

Weights	
	Caravan Amphibian
Maximum Ramp Weight	8,395 lb
Maximum Takeoff Weight	8,360 lb
Maximum Landing Weight	8,360 lb
Usable Fuel Capacity	
Weight	2,224 lb
Volume	332 gal
Typically-Equipped Empty Weight [1]	5,610 lb
Useful Load	2,785 lb
Maximum Payload	2,750 lb
Full Fuel Payload	561 lb
Baggage Capacity	
Weight	725 lb
Volume	104 cu ft

Dimensions	
	Caravan Amphibian
Exterior	
Length	38 ft 11 in
Height	16 ft 4 in
Wingspan	52 ft 1 in
Wing Area	279 sq ft
Cabin	
Length [2]	12 ft 9 in
Maximum Height	54 in
Maximum Width	64 in
Seating Capacity	8 - 14
Single Pilot Certified	Yes

Pricing/Operating Cost	
	Caravan Amphibian
Base Price [3]	$1,886,548
Typically-Equipped Price [3]	$2,400,000
Estimated Direct Operating Costs [4]	
Cost per Nautical Mile	$3.03
Cost per Hour	$454.40

[1] Empty weight does not include a pilot. Actual empty weight can vary based on installed options.
[2] From back of cockpit seats to rear bulkhead.
[3] Price represents 2012 U.S. dollars.
[4] Represents costs for fuel, parts, airframe maintenance, and powerplant maintenance. Assumes a fuel Cost of $5.50 per gallon and a shop Rate of $85.00 per hour. Actual operating cost will vary according to mission profiles flown, maintenance practices, and utilization.

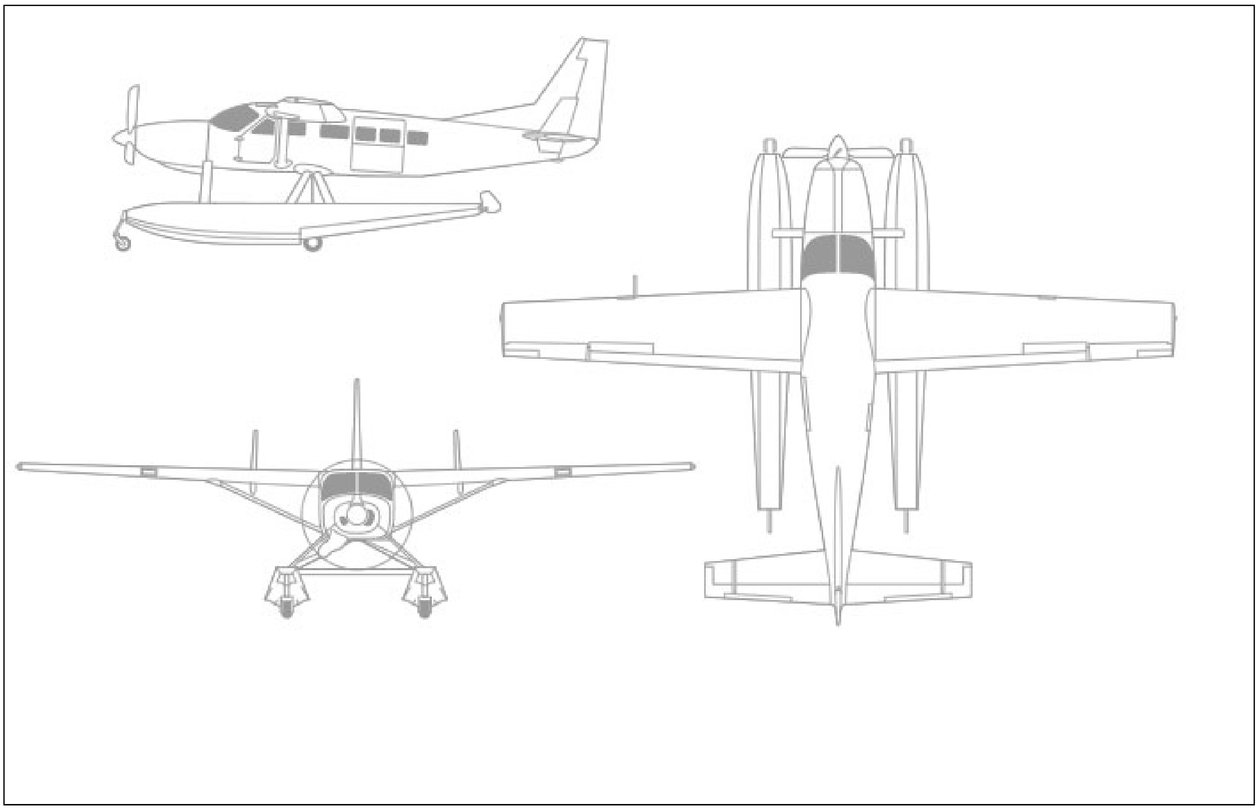


Figure 8 - Caravan Amphibian

Source: http://www.cessna.com/caravan/amphibian/amphibian-performance.html#

Canadair CL-415 Amphibian

The Canadair CL-415 is the latest in Canadair's line of multi-role amphibious aircraft beginning with the CL-215 in the 1960s. The Canadair 415 amphibian is a high-wing, turboprop aircraft that evolved from over 25 years of experience with the CL-215 firefighting amphibious aircraft. It features a four-compartment, four-door water tank system that can hold 6137 litres (1621 US gallons) of water/foam mixture and refills its tanks by skimming the surface of any suitable body of water. The Canadair 415, although externally similar to its predecessor, is quite a new machine. It features Pratt & Whitney Canada turboprops, an air-conditioned glass cockpit, and powered flight controls. Compared to the CL-215, it has increased operating weight and speed yielding improved productivity. Aircraft systems have been updated for easier maintainability. The Canadair 415 amphibian is also well suited to other missions such as maritime surveillance, coastal patrol, search and rescue, utility transport and resource protection.[7]

Table 7 - General

Cost	**Approx. $35 million (Canada)**
Crew	2
Passengers	8 / 30 with tanks removed

Source: http://www.oognok.ca/415/415.shtml

Figure 9 - Canadair CL-415

Source: http://www.airliners.net/photo/Protezione-Civile/Canadair-CL-215-6B11-CL-415/2078767/&sid=9de7d61916e1f2cc741eacc944602934

Figure 10 - Canadair CL-415

Source: http://www.airliners.net/photo/France---Securite/Canadair-CL-215-6B11-CL-415/2078304/&sid=a2ad15d30047248bf220646886b8119d

Figure 11 - Canadair CL-415

Source: *http://www.airliners.net/photo/Croatia---Air/Canadair-CL-215-6B11-CL-415/2077427/&sid=a2ad15d30047248bf220646886b8119d*

Figure 12 - Canadair CL-415

Source: left: http://hr.wikipedia.org/wiki/Datoteka:Canadair_at_Zagreb_airport.JPG; right: http://hr.wikipedia.org/wiki/Datoteka:Canadair_CL-415_Filling.jpg

Dornier Seastar CD2 Amphibian

Seastar[8] is the first new amphibious seaplane introduced in the last 50 years. Seastar is an FAA and EASA certified amphibian capable of landing on runways or water. In salt water or fresh water, the all-composite construction is impervious to corrosion, powered by two reliable Pratt & Whitney pt6 turboprop engines, and speed cruise is 180kt. The in-line design offers an additional measure of safety to its operations. A cabin is the largest in its class (capable of carrying up to 12 passengers in a commuter configuration).

Figure 13 - Dornier Seastar CD2

Source: http://www.dornierseaplane.com/content/image-gallery

Table 8 - Specification[9]

Engines	
Manufacturer	Pratt & Whitney Canada
Model	PT6A-135A
Shaft-Horsepower per Engine	650 (Flat Rated)
Propellers	
Manufacturer	McCauley
Number of Blades	4
External Dimensions	
Wing Span	58 ft. 2 in.
Length	41 ft. 7 in.
Height	15 ft. 9 in.
Wing Area	329.4 ft.
Internal Dimensions	
Cabin Length	13 ft. 1 in.
Cabin Height	4 ft. 6 in.
Cabin Width	5 ft. 4 in.
Cabin Volume	348 ft.^{3}

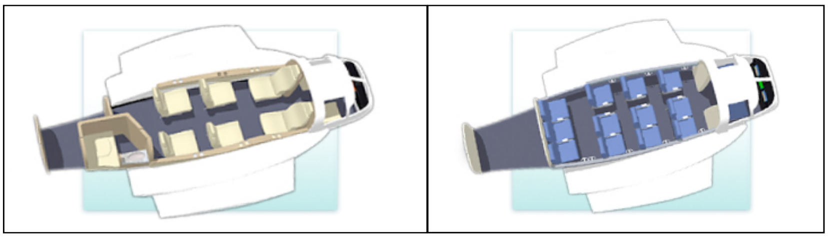


Figure 14 - Dornier Seastar CD2 Interior

Source: http://www.dornierseaplane.com/content/interior

Figure 15 - Dornier Seastar CD2 Cockpit

Source: http://www.dornierseaplane.com/files/imce-shared/pdfs/SeastarBrochure2010V.pdf

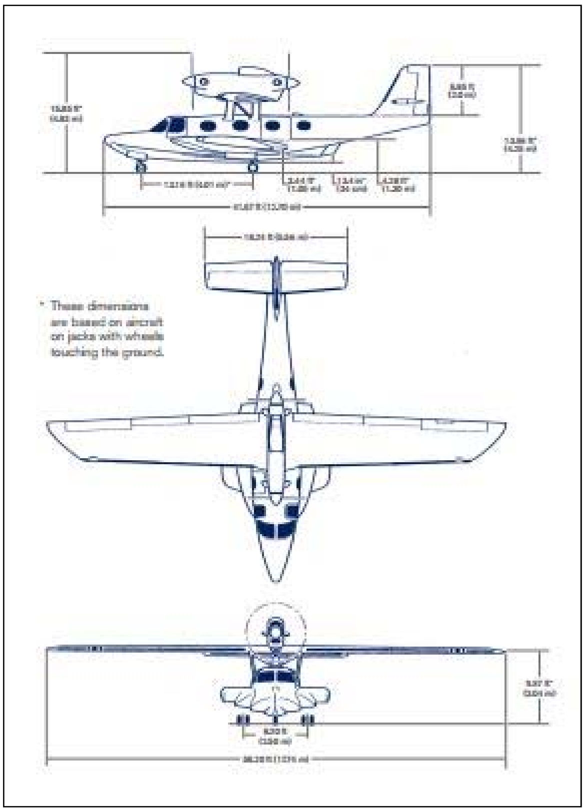


Figure 16 - Dornier Seastar CD2

Source: http://www.dornierseaplane.com/files/imce-shared/pdfs/SeastarBrochure2010V.pdf

6. CONCLUSION

This paper deals with possibilities for the use of seaplanes to transport passengers to the islands, and presents a seaplane transport model with the example of the connecting Split Airport to nearby islands (Vis, Hvar, Brač, etc.).

Conclusion is, and also a fact that the area is suitable for development of seaplane transport in Croatia. Tourism development is closely associated with an increase in tourism demand. Large tourist facilities on the Adriatic islands and coast opened up new possibilities and offers to tourists. This paper proposes an expansion of options in terms of transport connectivity development by seaplenes which are from functional, economical and ecological aspect, suitable and acceptable solution.

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INTERMODAL CORRIDORS AS FACTOR FOR DEVELOPMENT OF TRANSPORT LOGISTICS IN REPUBLIC OF CROATIA

ABSTRACT

Traffic, as very complicated system, presents part of many integrated social activities from which follows a need for adequate transport services which satisfies quality, capacity and integrity of system. Integrated network, which uses advantages of same shape of transport and minimizes effects on environment, presents transport logistics on highest level of services efficient for the last users, for that reason, the Croatian goal is to join as soon as possible to European Intermodal Network. It is important for not losing the last possibility to connect the Middle East with Central Europe with potential of the V. intermodal transit corridor and take a role of the state that will connect Central part of Europe with South – Eastern Europe through the X. intermodal corridor, another intermodal corridor which passes through Croatia, it is the VII., in the other words, Danube corridor, which can become the main link between South – Eastern and Central European, with minimum investment and environmental damage. Transport logistics and intermodal corridors can provide fast and safe transportation of the goods and also reduce the manipulating, transportation and distribution costs as the ultimate goal of any businessman or last customers. The balance of the relation between those two concepts into the single intermodal process, as well as monitoring and adjustment of existing and future political process, is prerequisite for the optimization and interoperability of transport – logistics process.

Key words*: transport logistics, European intermodal network, traffic corridors, interoperability of logistics system*

1. INTRODUCTION

Traffic logistics could be describe as integrity logistics in supply chain, which also presents series of planned and directed activities, processes and methodologies used in the transport process, and the ultimate goal is the optimize supply chain. Intermodal corridors are an integral part of transport logistics, the most important part of the transport system, without which the world economy and globalization could not make progress. The main goal of this research is to analyze the current situation of traffic in intermodal corridors and situation of developing of transport logistics in the Republic of Croatia, exactly from aspect of interoperability traffic services. Although Croatia is on the doorstep of joining the European Union, unfortunately, intermodal transport has been studied, but even if there are possibilities, in practice is not adequately implemented. Therefore, the goal of the Croatia is as soon as possible join to European traffic roads, for not losing the last chance to connect the Middle East to Central

European with our largest sea port Rijeka, and take role of transit country which will connect Central Europe with South - Eastern Europe.

2. INTERMODAL CORRIDORS AND TRANSPORT LOGISTICS

Intermodal corridor are roads directed to development of traffic infrastructure at the highest level of giving services in transport goods and keeping safe environment, and they are the part of dynamic and stochastic intermodal transport system, which allows quick, safe and economical transport between manufacture goods from one country to consumers in another country, or transit through the country, with all associated handlings by using at least two different types of transport and based on one contract of carriage, or one executor of transport. Using this kind of transport is more common and popular than other types of transport because of reduction of the costs, transportation of goods “from door to door” and achieving a short transport time. Also, it should be mention that intermodal transport presents the key facts for using potential of world globalization for accelerated and targeted development specific traffic – economy system, but with condition that the home country should ensure adequate system for managing with available traffic – economy resources. An important part in development of intermodal transport have transport logistics, which – it can be explained with the fact that it performs highly important element of every logistics service and material product. Logistics services are essential in the production of all economic sectors and that products of transport logistics provide transport, transmission, transfer object in all part of economy activity, in one word - supply chain, exactly in progressive modern business activities potentiated large – scale point of production and consumption.

Based on those findings, it can be conclude that the intermodal corridors and transport logistics make the system of integrated and influenced sub-systems, specific logistics knowledge and activities which with some production elements in transport and logistics industry provide manufacture of transport – logistics produce.

3. DEGREE OF DEVELOPMENT IN INTERMODAL TRAFFIC POLICY AND TRANSPORT LOGISTICS IN REBUBLIC OF CROATIA

In terms of geotraffical position, and in the context of the anticipated market expansion due to the Croatian accession to the European Union, Croatia has solid predispositions for attracting international traffic roads, particularly transit. However, economic situation and investment ability on the one hand and desired goals of transport development on the other are dictating principle of intermodal approach to the development concept of transport network that is intermodal corridor V, X, VII, which pass through the Republic of Croatia. Croatia needs to base its development on its advantageous geographical position. Transport cannot be solved separately by its individual branches because each branch represents a subsystem of one unique transport system. For Croatia to be compatible with European and international transport roads, it needs to create development strategies for each transport branch (including development of intermodal transport) so it can be recognized as equal partner in European Union.

By signing previous agreements Republic of Croatia has become an equal participant in the Europe transport market, but with much lower standards of infrastructure than the ones usually required by these agreements, particularly in railway traffic. When it talks about the Croatian transport development it also needs to consider Europe because it is its integral part. One of the essential prerequisites for its successful integration into Europe is the construction of high level transport infrastructure. Entire area of Central Europe is very important because it represents a bridge between western, eastern and southern Europe, and Croatia is located right on that bridge.

By reviving economic activities, opening transport corridors potentiated by European Union and by the constant increasing of intermodal transport in the total share of transport, it is not unrealistic to expect an average increase of 7 – 9 % by 2020. in intermodal transport. To achieve this growth attention in development policy needs to be on planned development, identification of profitable national economy areas and their fast adapting market regularities, and on globalization processes in Europe and around the world. Transport logistics has the main role in this because it ensures smooth flow of goods, services and information that is the foundation of globalization and greater effectiveness and efficiency of society.

Transport logistics can optimally perform its basic tasks only if the environment is based on positive concept and if political relations are positivistic, which is not the case in Croatia. Significant and constant problems of Croatian economy caused the negligence of logistic principles. Therefore it is very important that transport logistics enlivens on Croatian territory so Croatia can retake its position in Europe's most important transport routes, and for it to become apparent again on economic map of the world. This will increase interest for investing in Croatia, as in the logistics and related sector as in general investing in industry and development of high technology.

4. INTEGRATION OF CROATIA IN PAN – EUROPEAN SYSTEM OF TRAFFIC CORRIDORS

Republic of Croatia is quite small European country, but thanks to its location, territorial broadness, marine waters, and being the part of the Danube valley, it is both continental and coastal country. Thanks to those features, it can have wider traffic relations. According to that, Croatia should develop complex, wide developed and coordinated traffic system. Transit meaning of Croatia is confirmed by two main Trans-European traffic routes: transverse (with the north-south direction; it is important for the connection of Northern Europe, Baltic and Scandinavia, with Southern Europe and Mediterranean) and the longitudinal route (with the east-west direction; this route is important for the connection of the Middle East, Eastern Europe and South-Eastern Europe, with the Western and Central Europe),with special emphasis on the Pannonia valley part, where the strong traffic corridors were formed. But Croatian interests are still not represented enough in European plans. Most of the Trans-European roads are avoiding Croatia because of the bad policy; there was never long-term and planned perspective about traffic improvement. That is the main reason why, for example, Slovenia gets the most of the goods from the Middle East, and Croatia finds it hard to adapt completely into the Pan-European traffic system. Unfortunately, train corridor infrastructure and suprastructure of those two directions is on low stage of equipment, and it cannot accept satisfaction capacity of goods transfer. For example, only 9% of the railway system has 2 gauge, 36% of the system is electrified. This brings us to a conclusion – Croatia is very poor in railway traffic and system, unlike the road traffic, there's 27,4 km of the highways on 100 000 residents. New political, juridical and international conditions find development of the new Adriatic longitudinal traffic route very important, thanks to the Adriatic – Ionian initiative (which is established by Strategy and Program for organization of Croatian traffic). This direction is the part of Adriatic – Ionian corridor which passes through the area of the 7 countries with Adriatic and Ionian Sea. This route is 1150 km long and only Croatia owns 570 km of it. By building the right road and railway infrastructure, the traffic corridors would certainly attract international transit of the passengers (especially tourists) and goods. By using the Adriatic-Ionian direction, the problem of the regional development of Croatia would be solved, also it would solve one more problem and it is the development of the intermodal transport across our seaports.

Thanks to the candidacy for European Union, step by step, countries around the Croatia find the traffic position Adriatic-Danube important and interesting. Adriatic-Danube tract is not well connected to Trans-European traffic network.[1] That tract should be prepared for connection with TEN-T, with using the capacity of Adriatic seaports, which can become „the Adriatic door of Europe". It can be done by accepting intermodal transport system (sea-railway-road-inland waterways), and also by using seaport capacities, free zones and terminals which already exist in Croatia and should be adjusted and improved.

5. INTEROPERABILITY OF INTERMODAL CORRIDORS AND TRANSPORT LOGISTIC

The most important condition of making the logistic and intermodal transport is integration of the system components. The important aspect of the system integration is interoperability, which helps the functioning of the system components. Because of the complex systems, huge amount of using the technology and interface, interoperability is the most important characteristic of the transport and logistics systems. Defect of interoperability presents obstacle in connection between intermodal transport and logistics system because that system does not content base proposition of existing, in other words it cannot be integrity of intermodal transport and logistics. This system is called traditional traffic system with many unrelated components, defects and bottleneck.[2]

Generally speaking, progress in traffic is possible in two ways: by reducing of costs and improving services, what users really respect. For example, the introduction of logistics nodes as the central and intermediate locations in transport network which greatly reducing time of transport and storage costs. Also, to reduce the transport costs comes with introduction of the now technology such as transportation system of containers and intermodal transport because there is no transshipment activities and all transport units are standardized and secure.

6. CONCLUSION

The main goal, of Croatia and transition countries of the Middle and South Europe, is merging in one unique European transport system. Meanwhile, it is important that all of the elements of the transport logistic maintain functional, and do not represent obstacles to the merchandise roads, services and information. The efficiency in the transport logistic area will principally depend about duly and reliable vision and planning the development of the traffic system, that will, in curtain moment, be compatible with the processes and the technology that characterize curtain period. The balance and the integration of the traffic branches in unique technology process and keeping track and adjusting to the existing political processes is the prerequisite for optimizing transport process.

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IMPLEMENTATION OF CROATIAN INFORMATION SECURITY LEGISLATIVE WITHIN CLASSIFIED ITS

ABSTRACT

Continuous Development of Technology beside the advantages also reveals possible threats for any modern system, first and foremost those which are information or communication dependent. ITS systems in which classified information is handled may become potential target for modern threats (digital data stealing, Denial of Service, etc.) which are especially recognized in cyber space in last ten years. In order to prevent ITS systems to be compromised and abused, it is necessary to provide detailed examination of those systems and implementation of information security measures and standards in all areas of information security that are temporary known. Such process is very complex and appears to be a big challenge because information security is very wide area, legislation and standards are also very complex, and process needs to be continuous. In the scope of this work, it will be shown the approach and the model of adjustment of ITS system with legislation on information security in Republic of Croatia.

Key words: *Information Security, ITS, Legislation in Republic of Croatia, Security Risk*

1. INTRODUCTION

Constant demands to improve quality of service and growth of requests for various forms of transport have led to development of a new approach to address and resolve traffic problems - Intelligent Transportation Systems (ITS). The development of this approach is particularly noted in the late 20th century, and it has been viewed and analyzed through a number of aspects and analysis. In the scope of mentioned, there are four main benefits of ITS: safety, flow efficiency, Eng. reduction productivity and cost and environment benefits.

Information security is a very broad area that includes a wide range of areas, as well as measures and standards through which is achieved a certain degree of security. Information security is defined as a condition of confidentiality, integrity and availability of data, which is achieved by applying the measures and standards for information security and organizational support for planning, implementation, testing and modifying measures and standards.

2. PREPARATION OF ITS FOR INFORMATION SECURITY MEASUREMENT AND STANDARDS IMPLEMENTATION

In order to prepare ITS for better implementation of information security measures and standards which ITS must meet before classified information of any kind, structured analysis needs to be performed as well as unique model of approach needs to be defined to regulate the ITS in this aspect. Furthermore, as a starting point for implementation of information security for a particular ITS, it is very important to define the highest classification of data which will be handled within ITS.

In development of approach the would arrange ITS within the legal regulations of Republic of Croatia in order to meet measures and standards of information security is important to visualize ITS within the information security with implemented measures that are set by standards (Figure 1).

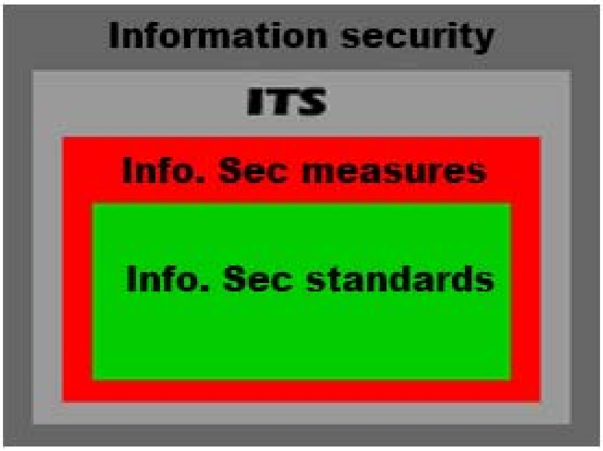

Figure 1 - ITS-a and information security elements

3. LEGISLATION ON INFORMATION SECURITY IN REPUBLIC OF CROATIA

Legal regulations of the Republic of Croatia that regulates information security are developed within the process of Croatia's accession to international associations, namely NATO and the EU. Through this development, first were implemented legal acts related to information security, namely the Data Secrecy Act (NN, No. 79/07) and the Information Security Act (NN, No. 79/07). Under these laws is uniquely defined the term data as a foundation and starting point that defines the information security measures and standards. This stems from the fact that the data is classified or unclassified and its classification assignment (Figure 2).

Figure 2 - Podatak – ishodište za područja, mjere i standarde informacijske sigurnosti

Furthermore, Information Security Act defines five areas of information security for which information security measures and standards needs to be defined: personnel security, physical security, data security, INFOSEC and business co-operation security (Figure 3).

Figure 3 - Areas of information security

Under the Data Secrecy Act, Information Security Act and the governmental Regulation on information security measures (NN, No. 46/08), a central governmental body responsible for establishing and implementing information security measures and standards in government bodies of Republic of Croatia, the Office of the National Security Council (ONSC), issued five ordinances governing the standards defined for all areas of information security: Ordinance on standards of security checks (March 2011 - a new revision of ordinance, ONSC), Ordinance on standards of physical security (March 2011 - a new revision of ordinance, ONSC), Ordinance on standards of data security (May 2011 - a new revision of ordinance, ONSC), Ordinance on standards of organization and management of information systems security (May 2008, ONSC) and Ordinance on standards for industrial/business co-operation security (May 2008, ONSC).

Closing the legal framework for information security has been further developed because the area of security of information systems is very wide area, which combines elements of all five previously mentioned areas of information security. This stems from the generic definition of an information system - an information system is a system that collects, stores, processes, and delivers the necessary information in ways that are accessible to all members of an organization that wants to use them and have the proper authorization . The central government body responsible for conducting the technical areas of information security within government bodies, the Information Systems Security Bureau (ISSB), issued four ordinances: Ordinance on Standards of information systems security (September 2010 - a new revision of ordinance, ISSB), Ordinance on dealing with cryptography and cryptographic equipment for the protection of classified information (August 2008., ISSB), Ordinance on preventing and responding to computer security incidents (August 2008., ISSB) and Ordinance on security accreditation of information systems (August 2008., ISSB).

4. IMPLEMENTATION MODEL FOR INFORMATION SECURITY MEASURES AND STANDARDS IN ITS

These legal and normative acts are necessary for a systematic and complete implementation of information security measures and standards in complex systems such as ITS. Quality implementation of prescribed information security measures and standards within the ITS depends on segmenting ITS in the parts that coincide with areas of information security. It ensures the proper sequence framework for the implementation of information security measures and standards for a particular area, with the aim of the systematic arrangement of ITS in terms of creating compliant system (Figure 4).

The most important limiting factors in the systematic implementation of information security measures and standards are financial and human resources. Meeting the prescribed information security measures and standards for the handling of classified information that has high classification requires a considerable amount of financial resources. Also, there is a great emphasis on staff that that would carry out its functions under such ITS, because it is also complex and time-consuming to implement security checking process which creates additional financial costs and may cause a time gap between planning and human involvement in implementation (lack of access to classified resources without undergoing safety testing and certification of personnel). Subsequently it can be concluded that the hypothesis "security costs" in most cases is a correct statement.

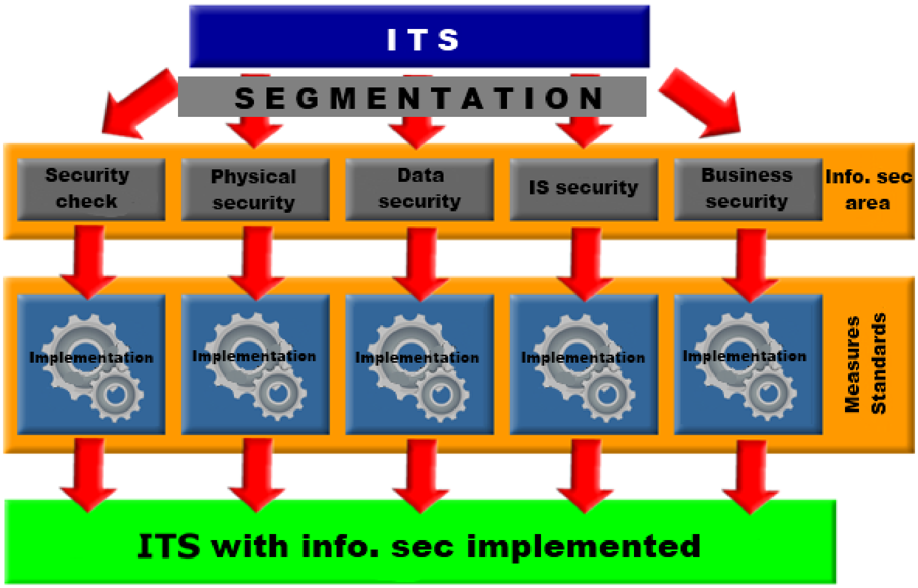

Figure 4 - Model of ITS with implemented information security measures and standards

5. PROCESSES AFTER IMPLEMENTATION OF INFORMATION SECURITY MEASURES AND STANDARDS

To obtain a complete picture of the state of ITS system that went through the process of information security implementation, it is necessary to make the identification and risk assessment after this process. Risk assessment provides a more complete picture and information about the possible solutions to adverse event, despite the implemented information security measures and standards.

Adverse events can affect confidentiality, integrity and availability of information resources in the ITS. Confidentiality refers to the protection of certain content or information from any intentional or inadvertent disclosure to unauthorized persons. Integrity has to ensure consistency of information and prevent any unauthorized changes to the content. Finally, the concept of availability implies that all relevant information in a reasonable time for that period is available to relevant users. Any of these requirements may be compromised in various ways, either intentional or unintentional human error, either because of flaws and failures of equipment and applications, or for other events.

Risk Management (Eng. Risk Management) is a relatively new discipline in the field of ITS system that resulted from the need of standardization and formalization of procedures related to information security management.

The risk management process is identification of those factors that can adversely affect the confidentiality, integrity and availability of information resources, and their analysis in terms of evaluation of individual resources and the cost of their protection. As a final step of the process is taking appropriate protective measures that would identified security risk take to an acceptable level that is within business objective.

Identification of risks in ITS systems requires a good understanding of the environment in which the system works, and on the other hand, it is necessary to identify all the resources that are important to the organization/company.

Special attention in the framework of risk assessment of ITS systems that are treated with classified information must be given to the first segment of information security, a security check, because it is directly related to the human factor. Specifically, in each system the human factor is the most important of all because it is directly interacting with all other areas of information security. From the standpoint of known metrics that could be applied in assessing the security risks, an individual represents unchangeable variable (each person has a different perception and criteria for any area which is caused primarily by direct and indirect influence of the sociological and the timeframe of events that directly affect a person). Ethics is particularly important factor of a person that is interacting with ITS system, because it directly affects the level of safety evaluation of risk in a particular system.

6. CONCLUSION

Process of implementation of information security measures and standards in ITS is very challenging and dynamic process that must be well and systematically implemented in order to have compliant system. Special attention must be given to the organizational part of the implementation of information security measures and standards, because without the establishment of well-organized implementation process cannot be performed well and standards fully implemented in each area. Moreover, in certain areas of information security organization itself does most of the information security measures and standards (the area of security checking). It should be noted for ITS that went through process of implementing information security measures and standards is not finish, but a continuous process that must follow the dynamics of development of the system and its lifecycle.

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GOODS FLOW ANALYSIS AS DEFINING ELEMENT OF LDC LOCATION – CASE STUDY CITY OF ZAGREB

ABSTRACT

Development of logistics and distribution centres (LDC) has a major impact on improving the entire transport chain and promotion of sustainable modes of transport, as well as integrating and linking the national transport system and commodity flows. Integration of LDC network is required to achieve full potential of LDC network in regional development. Location of Zagreb junction is suitable for organizing and attracting domestic and transit cargo flows, because Zagreb connects the Adriatic ports, as a significant generator of transit cargo flows, with the Central and South-East European countries, as a destination or starting point of these flows of goods. Therefore, Zagreb is suitable for building a modern LDC.

Key words: *logistics and distribution centres, freight flows, the city of Zagreb*

1. INTRODUCTION

Development of logistics and distribution centres (LDC) has a major impact on improving the entire transport chain and promotion sustainable modes of transport, as well as integrating and linking the national transport system and commodity flows. Integration of LDC network is required to achieve full potential of LDC network in regional development. Development of new and existing LDC needs to support the integration of different sectors that are important for the development of operational environments of LDC in order to improve the integration of seaports, logistics centres and other entities involved in the entire supply chain. Mode and functions of LDC at a particular location significantly depends on the structure and features of the gravitational flow of goods in the terminal zone. The structure and intensity of commodity flows in a particular area is one of the most important criteria for selecting macro location of the LDC. Location of Zagreb junction is suitable for organizing and attracting domestic and transit cargo flows, because Zagreb connects the Adriatic ports, as a significant generator of transit cargo flows, with the Central and South-East European countries, as a destination or starting point of these flows of goods.

2. CRITERIA AND METHODS FOR SELECTING A LOCATION OF LDC

When forming the LDC, the main criteria and factors that decide the future location of LDC need to define the required number of LDC's in a particular area as well as location.

When making decisions, decisive factors are:

- workforce,
- land prices,

- the degree of development of infrastructure.

These conditions are the basis for deciding which and how many distribution centres is necessary. In practice, there are four different models of distribution centres (Figure 1).

1. The decentralized and uncoordinated type of organization. This type refers to the national distribution centres, where each country has a distribution centre that serves the immediate environment.

2. The centralized type of organization. It refers to one European distribution centre, which is based on the strength of the broader economic environment and the assumed continuity of the employment centre.

3. Type of organization incorporated in the main distribution centre and some regional centres. The main feature of this organization is a joint organization of logistics operations ("call centres", promotion, etc.) that are located in the main distribution centre.

4. Coordinated decentralized type of organization. It is composed of several regional centres. Such centres are usually organized and managed from the parent company and the foundation of relationship is a shared information system.

Figure 1 - Models of logistics and distribution centres

Source: Kesić, B., Jugović, A., Perko, N.: The needs and capabilities of the organization for logistics and distribution centre in the Rijeka region, Annals of Maritime Studies 42 (2004)1, 187-208

The decision on the selection of models for logistics and distribution centres is closely linked with the requirements of users who thoroughly analyze the market. Based on this, a decision is made for the model that best fits the needs of distribution. When making a decision, of particular interests are:

- analysis of target markets,
- capacity and infrastructure,
- movement of cargo flows.

It is necessary to take into account that distribution in the gravitation zone depends on:

- economic power of economic entities (personal income, income, an index of purchasing power, purchasing habits),
- geotraffic location of certain industries,
- demand for certain types of goods.

One of the most important factors that affect the choice of location is certainly the transport infrastructure between the city and its hinterland.

The developed transport systems allow:

- a higher degree of competitiveness,
- the possibility of lowering the price of products,
- an increase in production and productivity,
- an increase in the gravitational zone of particular industries or companies.

Service quality is also an important factor when choosing the location of distribution centres. Service quality is defined by:

- labour productivity,
- the availability of workforce,
- availability of subcontractors and the quality of their services.

When planning management of the distribution centre, it is necessary to observe and follow numerous other factors such as:

- selection of the optimal system for inventory management and related management costs;
- selecting the proper organization of the warehouse (rent, concessions, long-term investment, or a combination);
- accessibility and availability of workforce, the creation of added values and other services as well as organization of competitive logistics warehouses (3PL – Third Party Logistic);
- respect and exploitation of legal determinants (tax and customs benefits).

Distribution centre operations require flexibility and adaptability of the service distribution, as well as price of services and focus on the economy of scale. Following this, an increase in the participation of subcontractors is observed in practice, which allows an easier adaptation to seasonal or economic cycles and achievement of positive economic effects of additional system flexibility.

3. ANALYSIS OF THE CURRENT SITUATION OF GOODS FLOW IN CROATIA AND THE REGION

Operating mode and functions of LDC at a particular location significantly depends on the structure and features of the gravitational flow of goods in the terminal zone. The structure and intensity of commodity flows in a particular area is one of the most important criteria for selecting macro location of the LDC. Selection of the location is based both on the transport organization and transport costs, which are affected by the level of intensity of commodity flows in a particular area or in a particular region. Management of terminal operations, forecasting operations, terminal operation analysis and forecast activities of the terminal can hardly be realized without a review and analysis of movement of goods flows. The analysis of commodity flows is a procedure that is performed independently of the LDC's system based on basic data structures[1]: the type of flow, type of goods and the manifestation types of transportation and transportation funding, the structure of the consignor and consignee of the goods, corridors and routes, servicing areas, the holders of realization transport time of receipt / shipment of goods, size of delivery, number of carriers in a matter of shipping / dispatch, applied technologies, transport chains and terminal requirements to subsystems.

Table 1 - The total amount of goods transported through Croatian territory by transport sectors

	Rail transport		Road transport		Sea and coastal transport	
Year	**Goods carried, Thousand tons.**	**Tons kilometres, mil.**	**Goods carried, Thousand tons.**	**Tons kilometres, mil.**	**Goods carried, Thousand tons.**	**Tons kilometres mil.**
2005.	14 333	2 835	58 886	9 328	29 975	126 064
2006.	15 395	3 305	63 840	10 175	31 423	136 994
2007.	15 764	3 574	66 814	10 502	32 420	137 474
2008.	14 851	3 312	110 812	11 042	30 768	142 972
2009.	11 651	2 641	92 847	9 429	31 371	137 345
2010.	12 203	2 618	74 967	3 284	31 948	87 878

Source: www.dzs.hr

Table 1 shows that the total amount of transported goods (included pipeline transport) in the observed period (2005-2010) had a steady growth until 2008. In 2008 there was a significant increase, while from 2009 a decrease in overall amount of transported goods is observed. Although the negative trends observed in most types of freight transportation, the biggest impact, with respect to a share, had a decrease in the amount of goods transported by road, which recorded a downward trend in the last two years. However, at the same time growth has been recorded in the maritime and coastal transport of goods (the second year in a row) and in the railway transport of goods.

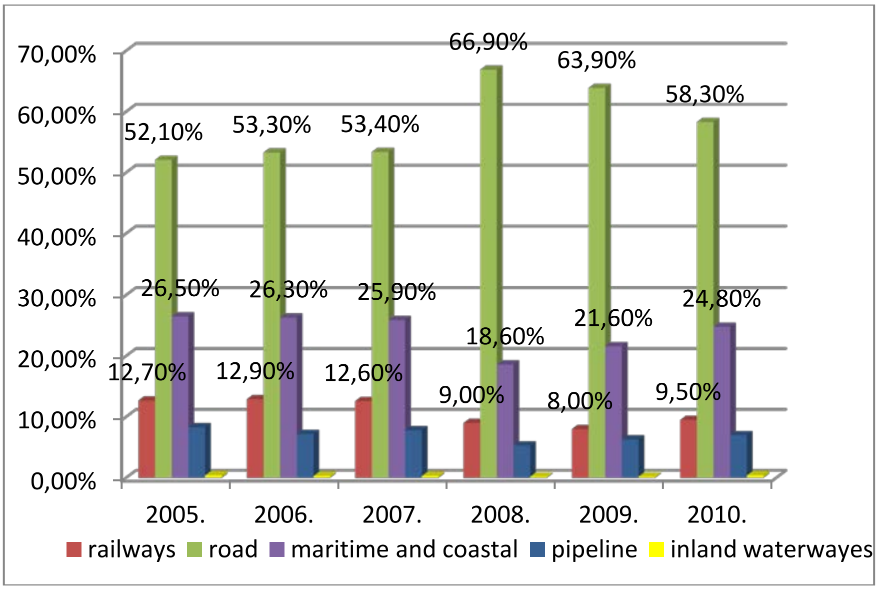


Figure 2 - The share of transport sectors in the total quantity of transported goods

Source: www.dzs.hr

3.1. Analysis of cargo flows in the road transport on the territory of croatia

From the available data of road transport of goods on the Croatian territory (Figure 3) a growing trend in total amount of transported goods can be noticed in the period from 2005-2008, while in 2009 and 2010 goods are transported in the smaller quantities as compared to 2008, but still higher than in the year 2007. In addition, it is evident that the volume of goods in international transportation is holding at about the same level throughout the observation period (Figure 2). Increasing the quantity of transported goods is a reflection of overall economic activity, and consumption levels of the economy and population in the Republic of Croatia during the last ten years. The slowdown of economic activity in Croatia during 2009 and 2010 resulted in a drop of the level of private consumption and a reduction of investments in infrastructure and construction, which affected the drop in activity in the sphere of road transport.

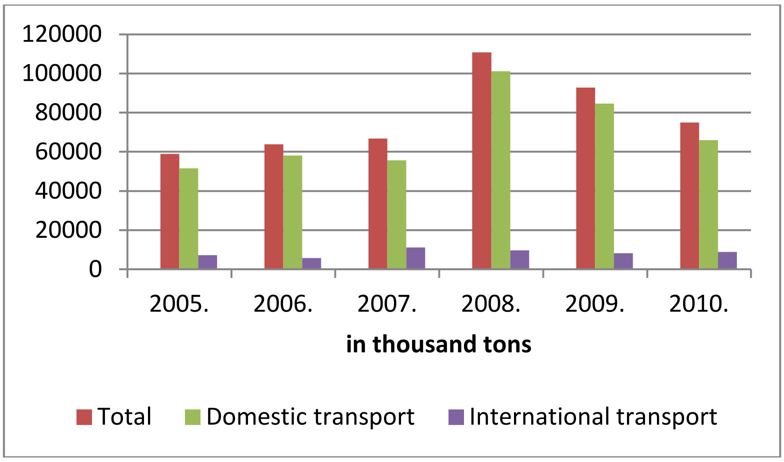


Figure 3 - The volume of goods transported by road transport

Source: www.dzs.hr

3.2. Analysis of cargo flows in the railway transport in croatia

Transport of goods by rail in the Republic of Croatia is not the most common form of goods transportation, which fits in the structure of the transport of goods by industry in European countries. The amount of goods transported by rail in the period 2005-2009 on the territory of Republic of Croatia varies in the range of 14 million tons in 2005 to 12 million tons in 2010. The share of rail transport in the total transport of goods varies from around 13% in the period 2005-2007 to a drop of around 9% in 2010. According to these data, there is a significant downward trend in the share of rail transport in the total amount of transported goods (Table 1, Figure 1), with slight growth in 2010. Simultaneously, the total amount of goods transported in the territory of Republic of Croatia during the observed period has witnessed a steady growth, while in the year 2010 the amount of transported goods is at a lower level as compared to the year 2009 (Chart 1).

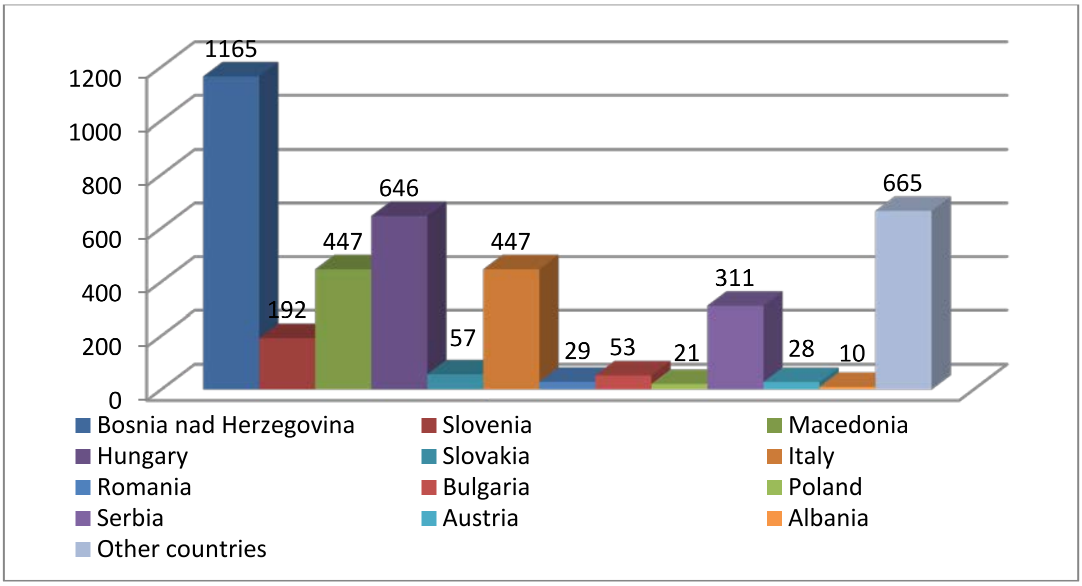


Figure 4 - Exports of goods by rail by country of unloading in 2010.
Source: www.dzs.hr

If we analyze countries to which the goods are exported by rail, it is evident that the rail freight traffic flows are oriented to the fullest extent towards the neighbouring countries: Bosnia and Herzegovina, Hungary, Italy, Austria, Slovenia and Serbia (Figure 4). Such commodity structure of export flows to the fullest extent coincides with the structure of export cargo flows in road transportation. Integration in commodity flows and reception of cargo that can be driven by rail can be an important element in the operations of LDC in Zagreb. This primarily relates to intermodal transportation and trade flows related to food products, various chemicals and hazardous substances, namely with their disposal and storage.

3.3. Analysis of cargo flows in the maritime transport on the territory of croatia

Trade flows in maritime transport are directed through the Adriatic ports, of which Rijeka and Ploče are the most significant Croatian ports for freight traffic. The share of maritime transport in total transportation of goods is at the level of 20 percent. From Table 1 shows that the quantity of goods transported by maritime transport is generally stable, and is around 30 million tons per annum in the period 2005-2010. Maritime transport is relatively cheap, suitable for the transfer of large quantities of goods and environmentally friendly.

3.4. Analysis of cargo flows in intermodal transport on the territory of croatia

Intermodal transport includes several transportation technologies of which the most significant are containerization, Ro-Ro and Huckepack. In Croatia, the majority of the container transport takes place through the port of Rijeka and it is the only one who has a specialized port container terminal. The port of Ploče takes part in a number of trans-shipment container units, but its disadvantage is that there is no built and equipped container terminal. Croatia does not have a built network of inland container terminals, except a railway terminal Vrapče in Zagreb. According to expert estimations, the terminal in Vrapče by its characteristics will not be able to meet the needs of container transport in the near future. Application of the Huckepack technology (trucks, trailers, swap boxes) in Croatia is in its early stages. There is only one Huckepack terminal on the territory of Croatia, in the eastern part of Croatia (Spačva), which is currently not in operation.

3.5. Analysis of cargo flows in container transport

To illustrate trends in container transport, information about traffic at the container terminal Brajdica in the port of Rijeka can be provided. During 2008 about 170,000 container units were reloaded there, of which about 23% shipped by rail. In 2009 there was a significant decline of reloaded container units, which indicates a correlation of economic trends in the world (especially in neighbouring countries) and the level of reloaded containers, while in 2010 an increased number of the reload containers for about 5% was recorded as compared to the year 2009 (Table 2). The percentage of containers transported by rail in 2010 is in the fall, and now is about 15%.[2].

Table 2 - Total turnover on Terminal Brajdica (in TEU)

		Year 2009	Year 2010	2010 vs 2009 (%)
Port Rijeka	**Total**	130.740	137.048	4,82 %
	Truck	100.516	116.491	15,89 %
	Wagon	30.909	20.557	-33,49 %
	Total Wagons %	23,52%	15,00%	-36,22 %

Source: By Author

The highest recorded river port traffic was generated in the year 2007 when approximately 175,000 container units were reloaded. In the same year, the container traffic at the terminal Vrapče reached the highest level of about 17,000 container units. Considering that the forecasts for traffic on the container terminal of the port Rijeka is expected to grow to a level of about 250,000 container units per year in the next medium term, there is a need for construction of background container terminal, with a larger capacity than the existing one in Vrapče. In addition, according to all relevant professional evaluations container terminal in Vrapče is not suitable for further expansion at the existing location. Therefore, the construction of container terminal at the location of the city of Zagreb is justified from a technical and technological point of view.[3]

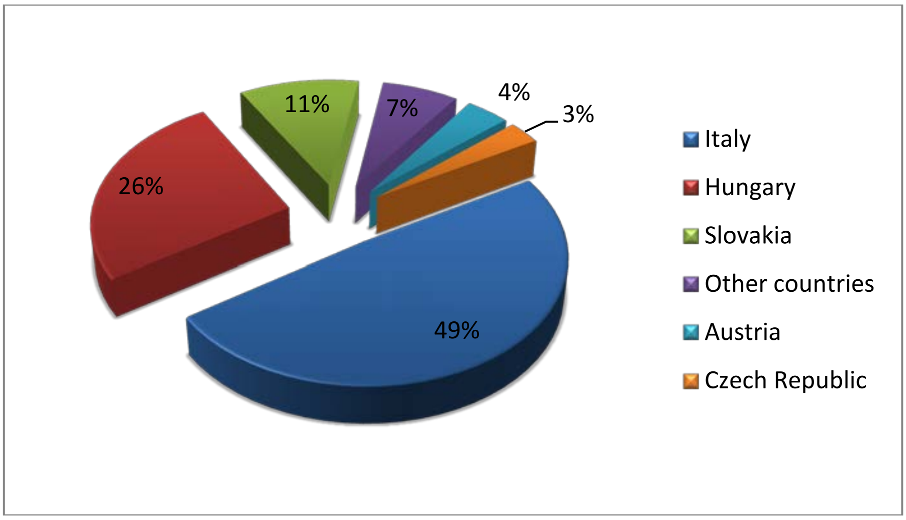


Figure 5 - Transportation of goods in the port of Rijeka transit in 2008 by countries

The most important partner countries of the port of Rijeka are Italy, Hungary, Slovakia, Czech Republic, Austria, Poland, Serbia and Bosnia and Herzegovina (Figure 5). Almost all the mentioned countries are located within the immediate gravitational zone.

4. TRADE FLOWS DIRECTED TO THE CITY OF ZAGREB

The city of Zagreb and Zagreb County are one of the economically most developed regions in Croatia, and also the place with the highest value indicator of distribution in the Republic of Croatia. Trade flows are treated separately for road and rail transport.

Table 3 shows information on the quantity of transported goods by carriers registered in Zagreb. A downward trend of merchandise in 2010 is observed comparing to 2008 and 2009, as a result of reducing the level of economic activity in the whole territory of Croatia. However, there are some differences in the trends of transported goods for the city of Zagreb and the rest of the Croatia. If you compare the figures in Table 3 with Figure 1, it is obvious that for the Zagreb area, transport of goods records statistically different trend than the rest of the Croatia. In fact, while the turnover of goods on the Croatian level decreased in 2009, the city of Zagreb in 2009 recorded an increase in the total amount of transported goods in relation to 2008. According to the data on the quantity of transported goods, it is evident that companies registered in the Zagreb area carry about 35-40% of the total amount of transported goods on the Croatian territory (Table 3). Such a concentration of transport of goods in the Zagreb area implies the need for supporting the construction and placement of storage and logistics and distribution management facilities in the wider area of Zagreb.

Table 3 - The total quantity of goods transported in the city of Zagreb (in thousand tons)

Transported in thousand tons	2008.	2009.	2010.
Total	9366,98	9783,39	7443,22
Domestic transport	8750,96	9085,84	6710,61
International transport	616,02	697,55	732,61
Went to foreign countries	306,08	294,06	307,63
Arrived from foreign countries	232,96	339,38	333,1
Transport to third countries	76,98	64,11	91,88

Source: www.dzs.hr

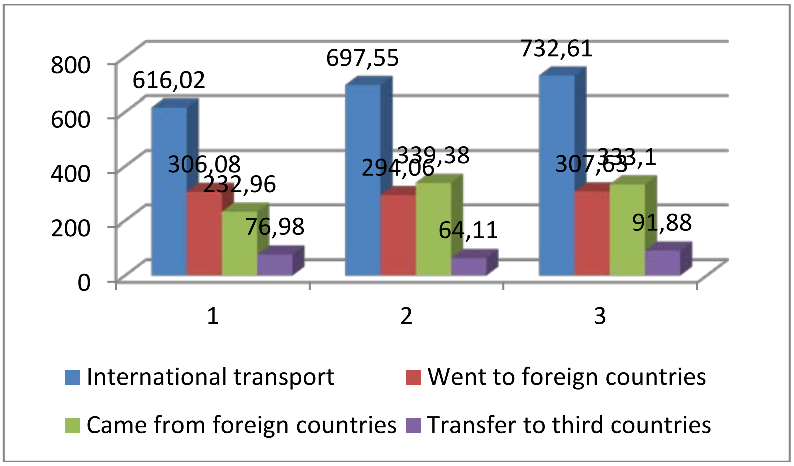


Figure 6 - Flows of goods in international road transport for the Zagreb County

Source: www.dzs.hr

Figure 6 shows the international road transport directed to the Zagreb County. International transportation in the Zagreb county has a continuous upward trend in 2010, for about 3% and 4% as compared to 2009 and 2008, respectively (in 2008 the highest total transport of goods in territory of Croatia was recorded). It also shows an increase in the quantity of goods from foreign countries in 2009, which stayed at approximately same level during 2010.

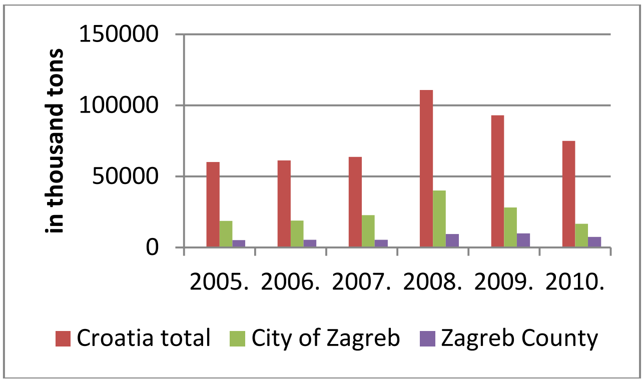


Figure 7 - Road transport of goods for the city of Zagreb and Zagreb County

Source: www.dzs.hr

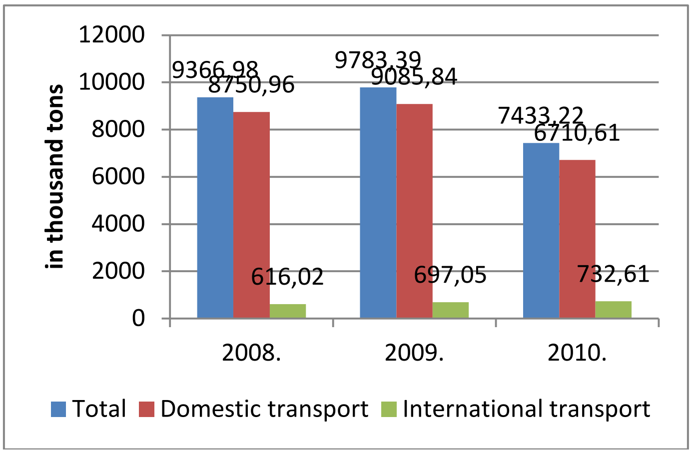


Figure 8 - The ratio of internal and international road transport of goods for the Zagreb County

Source: www.dzs.hr

Overall, in the Zagreb County total quantity of goods transported during 2010 (Figure 7) decreased in comparison with the previous period which coincides with the trends on Croatian territory. It is significant that the quantity of goods transported in 2010 lowered below the 2008 which indicates need for rapid economic revival. Continuation of this trend in the future may reflect on the reduced demand for warehouse space and logistics facilities in general, both in the city of Zagreb and Zagreb County as well as in the Croatian territory.

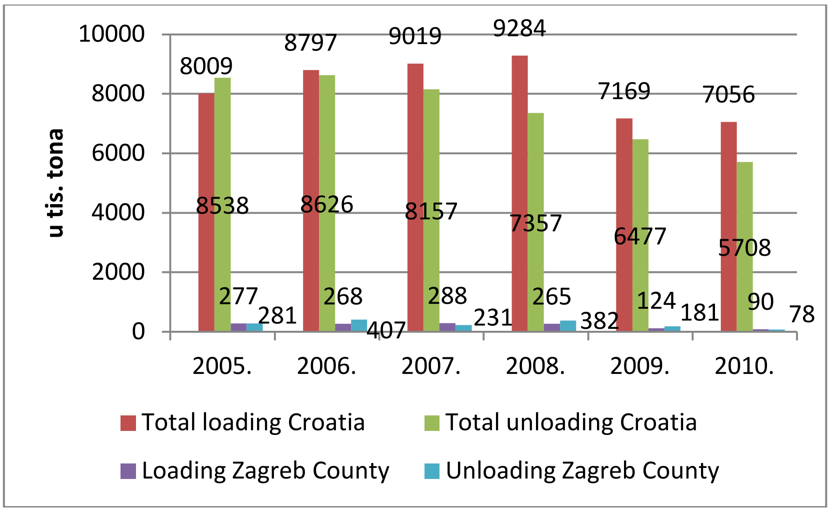


Figure 9 - Transportation of goods by rail for the Zagreb County in relation to the total transport of goods by rail for Croatia (in thousand tons)

Source: www.dzs.hr

Structure analysis of commodity flows, as previously shown, points out a significant proportion of transit transport in commodity flows, especially in road transport. This is a consequence of the Croatian geographical position, where the intertwining of European commodity flows from west to southeast, and flows of goods from overseas to Central and Southeast Europe. This fact indicates that the level of commodity flows that are generated in this way will increase in accordance with the increase of economic activities of countries which are generating these flows, therefore primarily the countries of Central and Southeast Europe.

Location of Zagreb junction is suitable for organizing and attracting domestic and transit cargo flows, because Zagreb connects the Adriatic ports, as a significant generator of transit cargo flows, with the Central and South-East European countries, as a destination or starting point of these flows of goods.

Forecasts and analyzes indicate that container transport can expect a significant increase in the number of reloaded containers in the port of Rijeka in the period of the next ten years. Given the new circumstances (change of owner of the container terminal), these forecasts can be largely taken as relevant. Construction of the LDC in Zagreb can be positioned in this sense as a place of processing and preparation of a number of containers that are directed towards the port of Rijeka. The reality of such a claim is supported by the fact that about 90% of container transport at the container terminal Vrapče is realized through the port of Rijeka. This strategic guidance fits into the concept of a new operator on the Brajdica container terminal.

The presented data show that the intermodal transport sector (excluding container transport) is generally ignored and that the transport of goods is done mainly by road, which is particularly applicable to goods originating from European countries and distribution centres in these countries. Considering the expected increase in the quantity of goods in transit and increase in the number of reloaded containers in the port of Rijeka, the question arises needs for construction of landscaped parking areas for trucks and highway trucks, which can be one of the contents in the future LDC Zagreb.

5. GRAVITATIONAL AREA OF THE CITY OF ZAGREB

Gravitational area of LDC is determined by its geotraffical position, the internal and external flows of goods and economic and political factors. On the basis of existing theoretical settings, the LDC gravitational area width goes up to a thousand kilometres. Narrower gravitational area is considered to be an area of 250 km, the zone of orientation of most goods flows to the terminal up to 500 km, and above this zone of interest in certain kinds of goods, transport modes and destinations. The advantages of geotraffic position according to gravitational field are not used very often because they are affected by both the throughput capacity and construction of transport infrastructure, and economical and political constraints. Considering the above mentioned, gravitational area of Zagreb can be divided into four parts:

- local gravitational area up to 250 km,
- gravitational area up to 500 km,
- gravitational area of special interest up to 750 km,
- gravitational area of periodical interest up to 1000 km.

The main criteria by which the gravitational area of the future LDC Zagreb is defined are distance and travel time. Distance that defines the gravitational zone is determined by the transport type for transport of goods that gravitate to the city of Zagreb. The previous sections show that the most common types of transport are road and rail transport, which in some way can be added to the maritime transport. Therefore, for terrestrial forms of transport and trade flows that are established in this way, for future LDC Zagreb a potentially most interesting area is up to 750 km. This area is covered by the import, export and transit transport flows to the countries of Central and South-Eeast Europe, which are also the most important economic partners of the Republic of Croatia (Austria, Hungary, Czech Republic, Slovakia, in a lesser extent Poland and Germany).

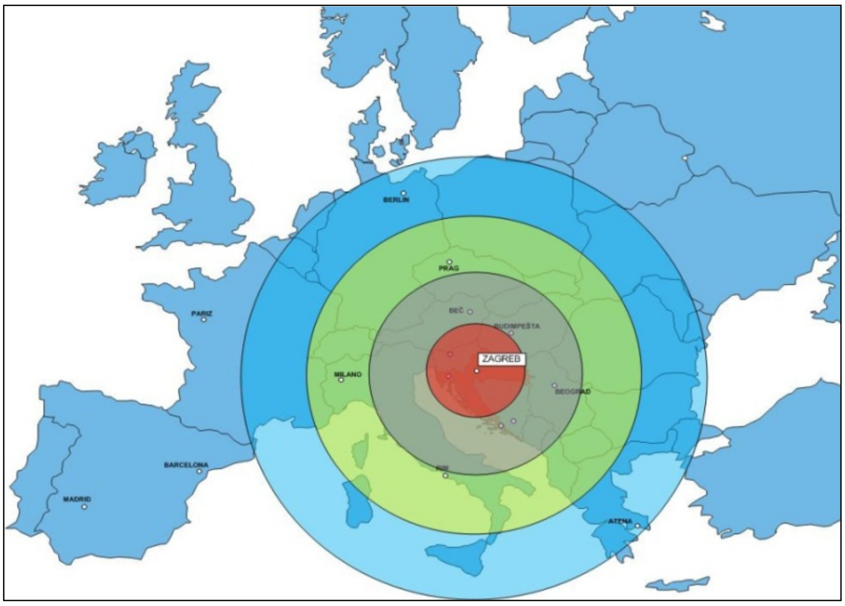
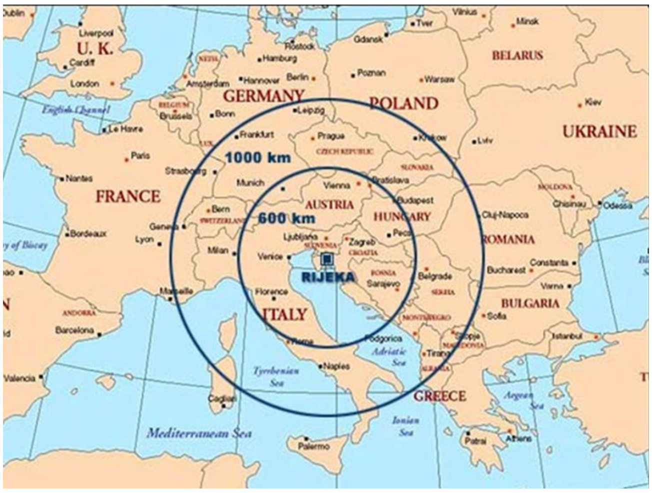


Figure 10 - View of gravitational areas of Zagreb

Source: Adjust and processed by the Authors

If the definition of the gravitational zone of the future LDC Zagreb includes the function of dry-port not only for the port of Rijeka but also for the other Adriatic ports, then its gravitational zone coincides with the gravity zones of the Adriatic ports. Display defined by the gravitational zone is given in Figure 11.



Town	Munich	Praha	Vienna	Bratislava	Budapest	Zagreb
ROAD	560 km	810 km	490 km	550 km	540 km	185 km
RAILWAY	574 km	844 km	572 km	686 km	595 km	229 km

Figure 11 - Gravitational zone of the port of Rijeka and LDC Zagreb as a dry-port

Source: By the Authors

6. COMMODITY FLOWS OF ZAGREB TRAFFIC JUNCTION AS AN ELEMENT FOR SELECTION OF MACRO LOCATION FOR LDC

Defining gravitational zones according to criteria of commodity flows was performed according to the collected and processed data on the movement of goods flows, which are further elaborated in the previous chapters.

According to these data, the Zagreb traffic junction according to the quantity of goods is one of the most powerful generators of flows of goods on the Croatian territory.

Flows of goods in road transport are the most intense towards the countries of Central and South-East Europe, which are also the most important economic partners of Croatia (Austria, Hungary, Czech Republic, Slovakia, in a lesser extent Poland and Germany). According to the structure of commodities this primarily refers to consumer goods, regardless if these are import or export flows. Transit cargo flows have a significant share in road traffic, especially towards the countries of South-East Europe and Asia Minor. In that context, an extended gravitational area of the future LDC Zagreb could be defined, which involves, if we take into account the transit cargo flows, not only a neighbouring countries, but also Turkey, Bulgaria and Romania in South-East Europe, and Germany and Poland on the north. Two of the last countries still marginally touch the gravitational area of the future LDC Zagreb, as their trade flows are primarily adjacent to the western ports (Rotterdam, Hamburg, Antwerp). For the countries of South-East Europe and Asia Minor flows of goods are directly related to the use of road infrastructure of Pan-European Corridor X, in the case of carriage of goods by land. The structure of the existing cargo flows in railway transport can further clarify the importance of the port of Rijeka and the port of Ploče, which are under the direct control of Republic of Croatia and which are significant generators of commodity flows on these corridors.

The traffic data for the port of Rijeka (Figure 5) shows that the narrow gravitational zone of the port of Rijeka generally corresponds to the gravitational zone, which can be defined by the movement of flows of goods by road and railway transport, as described in the previous section. An expansion of the gravitational zone of the port of Rijeka, and thus the gravitational zone of the future LDC Zagreb, can be expected with more intensive traffic of containers towards the countries of Central Europe, Germany and Poland, and with the increasing number of shipping lines to Asia and junction container ports in the Mediterranean.

7. CONCLUSION

The structure and intensity of commodity flows in a particular area is one of the most important criteria for selecting macro location of logistics distribution centre. Location selection was conditioned by organizational method of transport and transport costs which affect the level of intensity of commodity flows in a particular area or in a particular region. Structure analysis of commodity flows shown in this paper shows a significant proportion of transit transport in commodity flows, especially in road transport. This is a consequence of the Croatian geotraffic position, where the intertwining of European commodity flows from west to southeast and flows of goods from overseas to Central and South-East Europe.

Location of Zagreb junction is suitable for organizing and attracting domestic and transit cargo flows, because Zagreb connects the Adriatic ports, as a significant generator of transit cargo flows, with the Central and South-East European countries, as a destination or starting point of these flows of goods. Forecasts and analyzes indicate that container transport is to be expected to have a significant increase in the number of reloaded containers in the port of Rijeka in the period of the next ten years. Given the new circumstances (change of owner of the container terminal), this forecast can be largely taken as relevant. Construction of the future LDC in the area of Zagreb can be positioned as a place of processing and preparation of a number of containers that are directed towards the port of Rijeka.

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STUDY OF IMPLEMENTING AVAILABLE SECURITY CONTROLS OF WIRELESS COMPUTER NETWORKS

ABSTRACT

This article will present an analysis of security levels of wireless home networks based on IEEE 802.11 standard. The analysis of security implementation will be done on the basis of activated security checks available to end users in order to protect their own wireless system to the full. The analysis will encompass average users as regards to their knowledge of network communication systems and implemented security checks. The end result, i.e. a realistic picture of the way end users think about wireless computer network security, which in turn will have an impact on science and society in general, will enhance the awareness of possible ways wireless networks can be abused.

***Key words**: wireless, wlan, wi-fi, security*

1. INTRODUCTION

Recent rapid development and increased usage of wireless networks resemble rapid growth of the Internet usage in the 1990s. Easy implementation, operating flexibility as well as an array of devices used in implementation (network cards, access points) favour the development of wireless networks.

2. ADVANTAGES AND DISADVANTAGES OF WIRELESS NETWORKS

Wireless access computer networks, compared with regular wired systems, have numerous advantages as well as significant drawbacks. Wireless networks are first and foremost easily implemented; they increase user mobility and availability of Internet access as well as enable small increases in capacity, fast installation and possible repairs when needed. Another advantage of wireless networks is the cost of installation which, compared with regular wired computer networks, is less expensive. Finally, when put into practice, these advantages result in higher user productivity which in turn results in increased use of wireless networks in public and private organizations as access points for Internet connection, provided the device sustains the required standard.

Notwithstanding numerous advantages, wireless networks do cause certain problems and threats that are non-existent in standard wired systems. Compared with wired networks, wireless networks are prone to a wide range of potential security threats. The main problem lies in the fact that wireless signal spreads freely in space and can, therefore, be easily accessed by a malicious user who is physically removed from the rightful user. The main disadvantage of wireless networks is therefore security.

3. WIRELESS COMPUTER NETWORK SECURITY

Wireless network security risks arise from the possible occurrence of: unauthorized access to the internal network via wireless networks, theft and malicious spoofing of the rightful user identity, carrying out attacks on wireless networks or devices, staging anonymous attacks on other networks by using wireless networks, planting fake access points and similar.

There are security standards, i.e. measures, which enable regulation of the mentioned security threats as well as raising security to a higher level. Even when all available security measures are activated, the necessary security level may still not be achieved. It is impossible to achieve absolute security as security standards contain many deficiencies and oversights which are spotted and recognized only later. Without the wireless network owner and the administrator ever knowing, the spotted oversights enable a potential attacker unauthorized and uncontrolled access to a wireless computer network, sometimes even without much trouble.

It is important to stress the fact that available security measures are not applied in a great number of cases. Such situations are often the consequence of users not being educated enough and aware of the threats which they invite by failing to apply security measures.

Wireless networks are mainly used at home as a wireless bridge between the user’s computer to the router, which then connects the user to the Internet. When setting up a wireless computer network, users hastily adjust wireless network settings in order to activate their Internet access as soon as possible. The incurring security risks and applied security measures are easily pushed aside.

Inadequate protection of wireless home networks entails consequences of great proportions. In the users’ point of view, Internet traffic theft by unauthorized users and incurred higher costs are regarded as the most serious of consequences. Unfortunately, this point of view is not entirely correct. Attackers whose goal is not only to access the Internet free of charge by using other people’s access points but also to access confidential and personal information and possibly abuse it, present a much more serious problem. By systematically collecting information on a potential victim (by observing who the victim communicates with, what their habits, inclinations, practices, flaws and virtues are, which social networks they use etc.) over a longer period of time, the attacker may create a psychological profile of the victim and use their identity to identify himself in the virtual world. Furthermore, the attacker can make use of an inadequately protected wireless network for illegal activities such as attacks on information systems (e.g. online banking systems), spreading of viruses and similar. It is easy to see that the consequences of such malicious activities may be extremely harmful to the end user.

Results of field research on the usage of available security mechanisms for wireless computer networks.

Wireless computer network security mechanisms as well as the percentage of the surveyed users actively using the mentioned security mechanisms are both stated in the text below. The research encompassed wireless computer network users aged 30 to 40. By using prepared questions, the users were interviewed on their understanding of security risks deriving from inadequately protected networks. Based on the research findings, advice was given and recommendations were made regarding local wireless network implementation and certain security risks, i.e. security measures.

4. ADMINISTRATOR PASSWORD AND ACCESS POINT PASSWORD

The most important element in wireless home networks is the access point, i.e. the router. Router manufacturers very often publish access point installation guides on their web sites so that the equipment owners could enter the information on the network address and the user account. These web tools are protected by a login screen, i.e. the user is required to enter their user name and password, so that only the rightful equipment owner is able to do it. However, logins for any given piece of equipment are simple and hackers are well aware of it. Changing of the default administrator password and user name enhances the security of wireless networks.

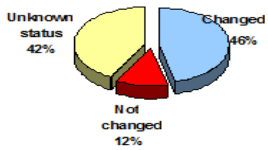

Figure 1 - Changes of passwords due to security reasons

The results of the survey, which are presented in Figure 1, show that 42% of the people surveyed were not aware of the importance and purpose of the administrator and access point passwords when taken from the network system security aspect, explaining that they are not important in every day work. Twenty percent of the survey participants did not change their passwords, stating that changing passwords was irrelevant to the security of their own network infrastructure and that it makes the procedure for possible changes in the settings, which are in line with the access point user manual, more complex.

5. WIRELESS NETWORK TRAFFIC ENCRYPTION METHODS

Wireless network devices uphold several encryption methods. Encryption technology scrambles messages sent through wireless networks so that they cannot be easily read by unauthorized users. Several technologies for wireless network traffic encryption exist today. It is possible to choose one of the available encryption methods (WEP, WPA, WPA/2). In order for these technologies to work properly, all devices on the network need to share the identical encryption settings. Users are, therefore, sometimes forced to choose a simpler encryption method among available encryption methods.

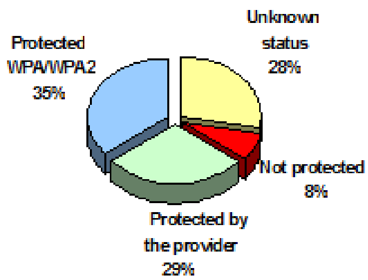

Figure 2 - Encryption method usage

According to the results of the survey, 57% of the survey participants using an encryption security measure say that, from a data security point of view, the manner in which their data traffic is protected is not important to them. Eight per cent of the users use unsecured access and explain that they are aware they share Internet connection with their neighbours and the existing flat rate services of the telecom operator.

6. CHANGING AND/OR HIDING THE ACCESS POINT NAME

*Access points use a wireless network name (Service Set IDentifier; SSID). A wireless access point usually broadcasts its SSID into space. Products containing identical SSID set on all devices are distributed by manufacturers. Provided the network is adequately protected, knowing the SSID will not help a potential attacker in breaking into the network. The message an unchanged default SSID sends to the attacker is that that the network is poorly protected. Furthermore, certain access point device manufacturers (e.g. devices manufactured by Thompson) assign SSID and a default password based on mathematical calculations. In other words, the name of the local network contains data on the network access password. By using almost publicly available tools, a hacker can calculate the password for accessing the network. Additional protection is available by disabling SSID broadcasting and it can be done by activating the option "SSID invisible". To be able to access the wireless network, the user must know the name of the wireless network. Business and publicly available access points (hotspots), where clients are frequently within and outside the network range, contain revealed SSIDs. This characteristic is useless for home networks as its usage only increases the chances of an unknown user to break into the user's home network. Majority of access points enable the network administrator to disable SSID broadcast.

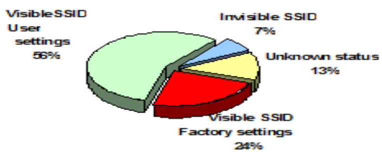

Figure 3 - SSID broadcast

Figure 3 shows that majority of the surveyed users are not acquainted with the way wireless network name is broadcast or regard it irrelevant from a security aspect.

7. STATIC IP ADDRESSING AND MAC FILTERING

Most home networks are set up in such a way that Dynamic Host Controller protocol (DHCP) assigns IP addresses. Unfortunately, this also works to the advantage of attackers who can easily obtain valid IP addresses from the network's DHCP pool. Disconnecting DHCP at the access point or router and setting up static IP addresses within a private IP address range (like 10.0.0.x) will make accessing the computer to malicious users more difficult.

Furthermore, each and every component in a local wireless network contains a unique identifier called physical address or Media Access Control (MAC) address. Access points and routers keep track of MAC addresses of all devices connected to them. Many such products enable the owners of home network devices to key in only to devices listed on the approved MAC address list. It is interesting to note that, even though many may think otherwise, this characteristic will not ensure a high level of security. Hackers, by using publicly available applications, can easily fake MAC addresses of their devices.

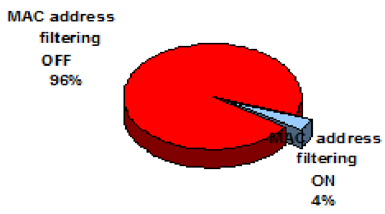

Figure 4 - MAC address filtering

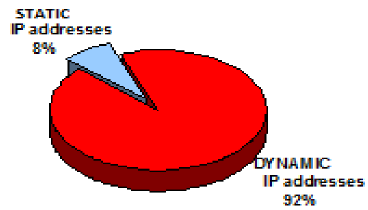

Figure 5 - Assigning IP addresses

When questioned on security checks applied to static IP addressing, as shown in Figure 5, and MAC filtering, Fig 4, most of the participants in the survey stated they were not familiar with the mentioned security methods for protecting their own wireless networks. Most of the participants also had problems understanding the terminology.

8. AUTOMATIC CONNECTION TO OPEN ACCESS POINTS

Automatic connection to open, publicly available wireless networks entails security risks for portable client devices. By connecting to an open network, such as free wireless hotspots, the computer is exposed to security risks. Although not normally enabled, most computers have a setting available allowing connections to open networks to happen automatically without notifying the user.

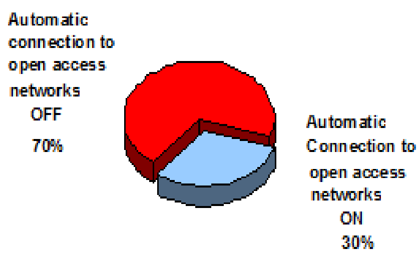

Figure 6 - Automatic connection to open access points enabled

Thirty per cent (30%) of the survey participants using portable devices had their devices set to auto-connect to open access networks so that connecting to the available open networks is be as simple as possible.

9. FIREWALL

Enabled firewall on the network router as well as on any computer contributes to lowering of wireless network security risks. Modern network routers contain a built-in firewall capability, but there is an option to disable them as well. Installing and running personal firewall software on every computer connected to the access point provides additional protection.

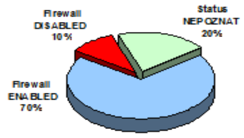

Figure 7 - Firewall usage

Most users, as shown in Figure 7, are aware of the importance of firewall with regard to protecting their own computers from network attacks. Some users were unable to say whether their firewall was enabled or not. During the survey, some the wireless home network users stated that they had disabled firewall in order to achieve easier access to the Internet and certain web sites.

10. ACCESS POINT RANGE

It is normal that wireless network signals go beyond the planned signal perimeter. A small amount of signal leakage outside the perimeter is not a problem, but the further this signal reaches, the easier it is for unknown users to detect it and exploit it. When installing a wireless home network, the location of an access point or router defines the perimeter of the signal. Appropriate positioning of the access point will ensure optimal perimeter.

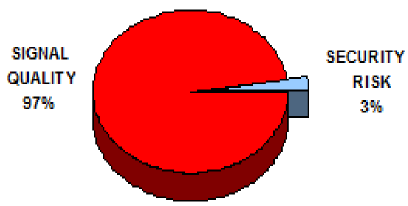

Figure 8 – Reasons for the choice of access point location

When questioning the users on the mentioned security check, it was interesting to note that only 3 per cent of the users had thought about the impact the access point location had on spreading of the signal outside the set perimeter of their home, and in turn exposure of their own network to greater security risks. Most users were more concerned with signal quality within their home than with security.

The ultimate security measure in wireless networking is shutting down of the access point which would almost certainly prevent potential hackers from breaking in. Although it is not very practical to turn devices on and off on a daily basis, it is advisable when access points are not used for a longer period of time. The survey showed that most access points are never turned off as they are part of a daily television system usage.

11. CONCLUSION

Wireless networks on the one hand greatly enhance user mobility and enable easy network access, but on the other hand they present a number of new security risks. In line with the estimated risks occurring during wireless connection, it is necessary to install adequate network protection. There are several wireless access protection mechanisms, although some of them are inadequate and can give users a false sense of security. It is important to note that by even by applying all available wireless network protection systems, computers are never risk free. By keeping up to date with advances in technology and installing the latest security mechanisms as well as providing user education, it is possible to minimize security risks.

The conducted survey on wireless network security proves that a high percentage of wireless networks are inadequately protected. The reasons for such a situation stem primarily from insufficient knowledge about communication systems. Along with the fact that security standards are not infallible and that they can never guarantee absolute security, most security threats come from users themselves, as they are rarely aware of the threats they are exposed to, and, therefore, disregard the need to use available security measures.

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APPLICATION OF THE QUEUEING THEORY IN DETERMINING THE CITY TRAIN CAPACITY OF THE LINE VELIKA GORICA - AIRPORT ZAGREB - - ZAGREB (ZAGREB BUS STATION)

ABSTRACT

The paper illustrates the application of the Queueing theory and Markov chains in the example of determining the city train capacity of the line Velika Gorica-Zagreb Airport-Zagreb. Since the passenger arrivals at the platform occur by a stochastic (random) model which is described in the paper as a Markov chain of type G/G/k and the process of waiting to enter the wagons occurs also according to the random (stochastic) model, which is described as a Markov chain of type M/M/k. To verify the theory and the proposed model of system behaviour all data describing the behaviour of a given system were calculated as well as the capacity of the trains.

Key words: *Queueing theory, Markov chains, determining city train capacity*

1. INTRODUCTION

This paper uses the theory of Markov chains, which is in literature described as a variable model. It is expected that the Markov approach will respond well to the problem since it does not assume any type of distribution upon the request of variations. The probability of variation of the requested values depends on the actual condition of the value and thus it is not a constant anymore and does not depend on previous values before considering the process. [1] The Markov chain is a type of random process. It is said that the Markov chain is a random process with a Markov property. The Markov property means that the future condition depends on the current (actual) condition regardless of the previous conditions. [1]

The city train is an organisational-technical system which operational organization should be adjusted to the times and presence of passenger arrivals at the platforms. Passenger arrivals occur as a general random (Gaussian) variable (stochastic). The very process of entering the wagon also occurs as a random variable generated out of random passenger arrivals at the platform, the waiting time in queues and the capacities of the servers (trains) required for the transport. The passenger arrivals depend mainly on the train schedule, delays and both technical and weather conditions. Such arrivals naturally occur according to the general random (Gaussian) model, in which the G/G/k model from the Queueing theory describes in the best way the mentioned behaviour. The arrival of the (server's) train wagons within the system of such a transportation service occurs also according to the laws of the Queueing theory, according to the exponential random model (Poisson) of the Markov chains of type M/M/k.

By using the Markov chain, i.e. the Queueing theory, to describe the city train service the problem of selecting a model is solved. The obtained results show that, as expected, the approach by means of the Markov chain leads to important knowledges and thus to a better investment policy, i.e., the organisation of a transportation service by a local city train. The model was selected from literature and is in particular acceptable for solving the given problem since it describes well the processes occurring within the system of the city train service.

The selected model of the system behaviour of the city train transportation service is an indefinite M/M/k chain, with a probability distribution of customer arrivals (i.e. of passenger arrivals at the transportation service system) by the G/G/k model. This model is accepted in literature for describing a train transportation service system, i.e. for most heavy traffic.

This paper does not describe the basics of the stochastic process, Markov chains, terms and properties in connection to Markov chains.

This scientific papers aims at confirming or negating the following **causal hypothesis**:

„The Markov chain as a mathematical model may well describe technical and organisational systems, such as the city train transportation service – the example described in this paper – and in addition to credible results, it can solve numerous dilemmas, i.e. problems.“

The **objective** of this paper is that by describing and the mathematical modelling of one of the particular application of Markov chains in practice to explain first the problems and one of the possible ways to solve the problem and thus to give guidelines for the further study of similar and identical systems.

The paper should prove that the Markov chains are a very adequate and fast scientific method for a credible solution of the addressed example and thus it can be applied not only to all similar systems, but also to very different systems, of natural, technical or social behaviour.

The **methodology** for solving the problem of determining the capacity of the city train line was to, by correctly selecting the mathematical model of the description by means of adjusting the Markov chain, make a model and to solve by calculation the given and described problem. The applied methods of the scientific paper were: analysis, mathematical modelling by means of the Markov chain and synthesis of results.

2. SELECTED AND ELABORATED MODEL IN THIS PAPER AS AN EXAMPLE

2.1. Considering the algorithm and the selection of model – model: M/M/k, infinite Markov chain, with probability distribution of the customer number (i.e. passenger arrival at the transportation system) according to the model G/G/k

All available theoretic models of modelling the system for determining the city train capacities are complex. The passenger behaviour, arrivals at the platform, diversity of lines, numerous possibilities to change from line to line, long length of lines with numerous train stations and multimodal transportation complicate the design of the model which includes all that. Therefore, a model including as much and as real as possible all the events during the city train transportation service is still being searched for.

In contrast to other scientific papers, this paper does not iterate many variables and varieties of the system since the paper aims to present the application of the theory of the Markov chain on an example from this paper. This paper uses the programm Excel in which the formulas from the Queueing theory, i.e. Markov chain, were inserted.

2.2. Determining city train capacities

This paper assumes that the Zagreb Airport as the station with the highest passenger traffic (except the first and the last station in both directions), after a foreseeable large investment into its extension, will be enabled for receiving in the first phase three million passengers annually. With regard to the train capacity, various description and calculation models can optimize it. For determining the optimum capacity, i.e. the requried number of standard trains, it is also necessessary to know the passenger number at the entrance into the system and the passenger presence at a specific time. The operation of the city train has to be assumed based on a 24/7 system, i.e. 24 hours a day, seven days a week. However, this will be a two-shift operation since passengers arrive at the train throughout the day and less during the night. Nevertheless, due to the Zagreb Airport operation and other passengers during the night, by all means it will be necessary to operate during the night with some reduced capacity which can be carried out by buses as well.

In doing so, it should be stressed that in order to consider the optimality and financial efficiency of the city train capacity it is particularly necessary to determine the optimal capacity since a too large capacity has too high operating costs and an increased environmental pollution and a too small one causes jams, congestions and stress.

2.3. Description of the model elaborated in this paper

Determining the capacity of the city train transportation service:

This paper sets out with the assumption that a city train on the line Velika Gorica – Airport Zagreb – Zagreb (Zagreb bus station) is taken into consideration.

In addition to it, an optimal number of servers (number of trains) for the predicted passenger number on the line Velika Gorica – Zagreb and for increasing traffic in the Zagreb Airport is being searched for. Currently, the traffic in the Zagreb Airport is up to 1.500.000 passengers annually. Upon ending the investment in the capacity extension, the Zagreb Airport will be able to receive three (later up to five) million passengers. The average passenger number per train of the city train that is accepted is approx. 500 (in theory 522, 189 sitting and 339 standing places – 5 per m^2), which is as well the projected capacity of one composition. The train has 4 inseparable wagons (in the first phase) and the capacity can change only in the number of trains, but not in the number of wagons. The mentioned data can be applied for the trains produced by Gredelj-Končar.

It is supposed that the largest number of passengers always arrives at the first platform, regardless of the direction, and that up to 3000 passengers arrive at intermediate stations. For the Zagreb Airport, as passengers with more luggage will be transported by their own car or taxi and part of Croatia Airlines passengers by the company's buses, it is assumed that 30% of passengers will use the city train services which makes on an annual basis approx. 900.000 passengers and on a daily basis approx. 2.500 passengers. The assumed calculation was also done for working days when the traffic is several times higher than on Saturdays and Sundays.

It is presumed that today on working days approx. 30.000 people, workers, pupils and students commute somehow from Velika Gorica to Zagreb and vice versa. Those using their own cars will continue doing so, and those using bus transports will continue doing so.

The assumption is that the number of passengers using the city train on the above-mentioned line is approx. 15.000 citizens of Velika Gorica per day and mostly between 5 and 23 o'clock. If we add to that the daily passengers on stopovers (3.000 per day) and at the Zagreb Airport (2.500 per day), we get the total number of 20.500 daily passengers.

That means the system is stable if a sufficient number of servers (trains) is determined. The case of the first phase of the airport extension, i.e. the projected traffic of 3.000.000 passengers annually, is included.

The basic idea for solving the problem of determining the capacity of the passenger transportation service was to assume that the number of servers was not known. It was varied for more cases and the optimal number of operators (number of trains) was searched for – in the sense to have the optimal number of trains for the predicted passenger number, but to shorten as much as possible the time the passengers stay on the platforms, meaning with a short as possible waiting period and to harmonise the mean interarrival time of passengers with the mean train arrival time, times which do not have to be identical (and will never be, these are all random variables), but to have the system optimally harmonised with transportation requirements. According to the principle: for the passenger the shortest time spend on waiting and for the server the smallest number of employees and departure of trains which represents a cost and pollutes the environment.

The assumption in this paper is that the transport was considered in one direction only due to an almost identical number of passengers and thus of servers (trains) which equals during the arrival and departure regardless of the first station.

A 24 hours a day operation, mainly in two shifts, and in each the same number of servers (trains), except during the night shift from 23 to 5 o'clock, which can be treated as overtime or handled with a far smaller number of servers (trains) or night transporation could even be ceased. This means, that a specific number of servers (the examples assume 30, 40 and 50 servers – train journeys per day) are operating, covering thus a 24 hour, 7 day a week operation, i.e. a 24/7 system. According to that system, approx. 90% passengers arrive from 5 to 23 o'clock.

Naturally, the transport might be urgent and short-time, for example, after large sport, political or other social events, but such an example was not considered since it has a smaller impact on that problem which was being solved in this paper, simply because of its short-time character and predictability. The unit for measuring times was an hour.

It was considered what kind of implication on the operation and the system behaviour it would have if the number of servers (trains) required for an avareage working day varied.

The results were given in the lower tables.

2.4. Results of the calculation

2.4.1. First example: 30 servers (trains)

Simple Queueing Systems

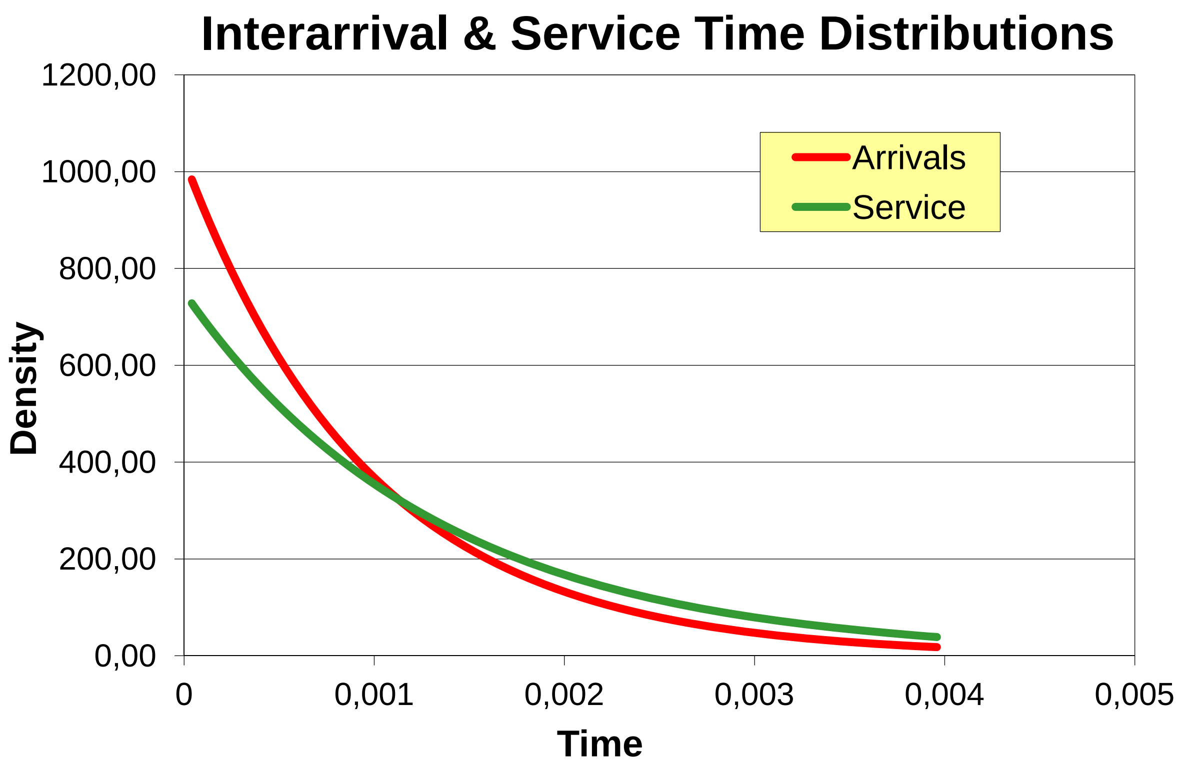
		Mean	Std Dev	CV	
Mean Interarrival Time	$a=1/\lambda$	0,001	0,001	1,00	=ca
Mean Service Time	$p=1/\mu$	0,001	0,001	1,00	=cp
Number of Servers	k	30			
Time Unit	t	hour			
Arrival Rate	$\lambda=1/a$	1025,010	arrivals per	hour	
Service Rate	$\mu=1/p$	750,188	served per	hour	
Server utilization	$\rho=l/k\mu$	4,6%			

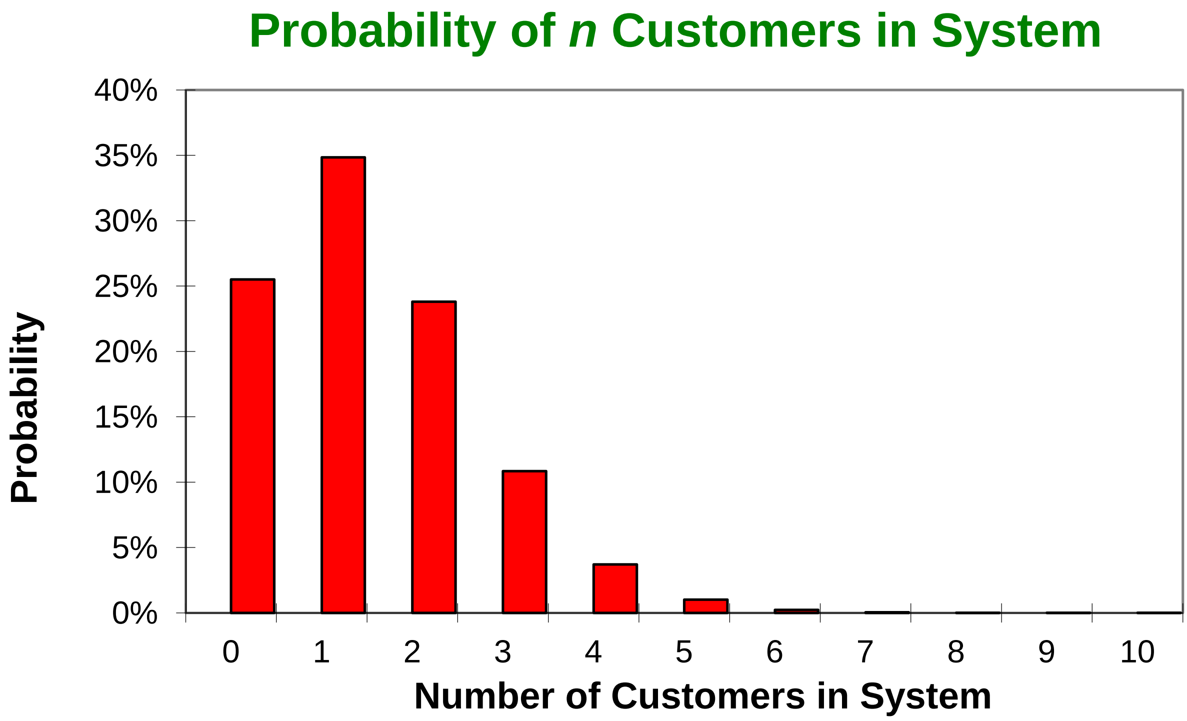
Performance Statistics **(Approx)**

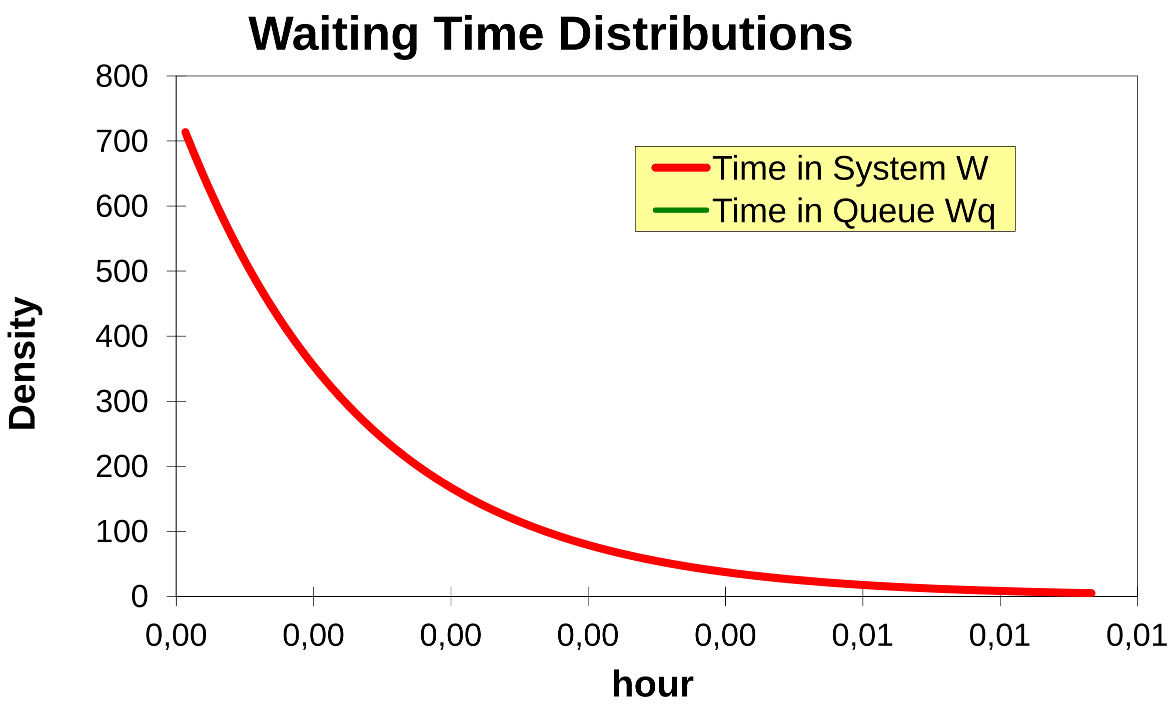
Mean time in queue	***Wq***	**0,00**	hour
Mean time in system	***W***	**0,00**	hour
Mean number in queue	***Lq***	**0,00**	customers
Mean number in system	***L***	**0,05**	customers

Probability of Number in System		**(Approx)**
0	**P0**	**25,50%**
1	**P1**	**34,85%**
2	**P2**	**23,81%**
3	**P3**	**10,84%**
4	**P4**	**3,70%**
5	**P5**	**1,01%**
6	**P6**	**0,23%**
7	**P7**	**0,04%**
8	**P8**	**0,01%**
9	**P9**	**0,00%**
10	**P10**	**0,00%**
		100,00%

Notes: Queue performance statistics based on G/G/k heavy traffic approximation
Probability of number in system based on M/M/k approximation




Probability of *n* Customers in System
Probability
40%
35%
30%
25%
20%
15%
10%
5%
0%
0
1
2
3
4
5
6
7
8
9
10
Number of Customers in System


Waiting Time Distributions
Density
800
700
600
500
400
300
200
100
0
Time in System W
Time in Queue Wq
0,00
0,00
0,00
0,00
0,00
0,01
0,01
0,01
hour

2.4.2. Second example: 40 servers (trains)

Simple Queueing Systems

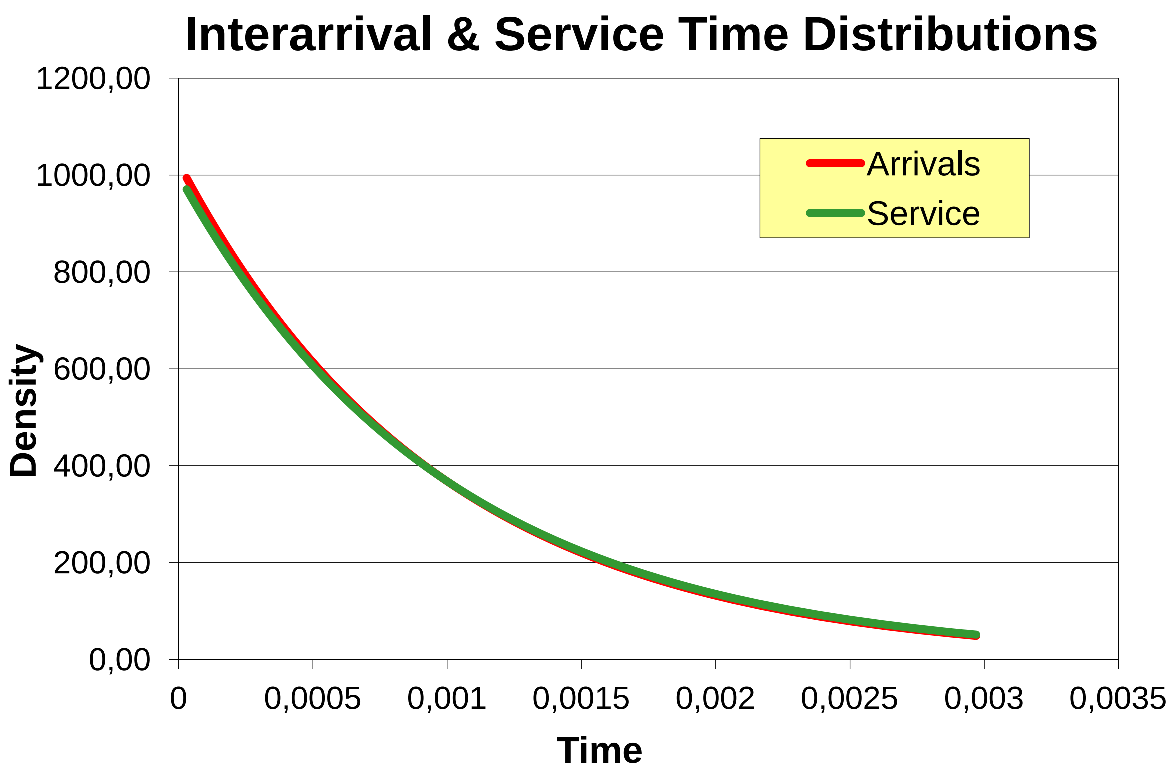
		Mean	Std Dev	CV	
Mean Interarrival Time	$a=1/\lambda$	0,001	0,001	1,00	=ca
Mean Service Time	$p=1/\mu$	0,001	0,001	1,00	=cp
Number of Servers	k	40			
Time Unit	t	hour			

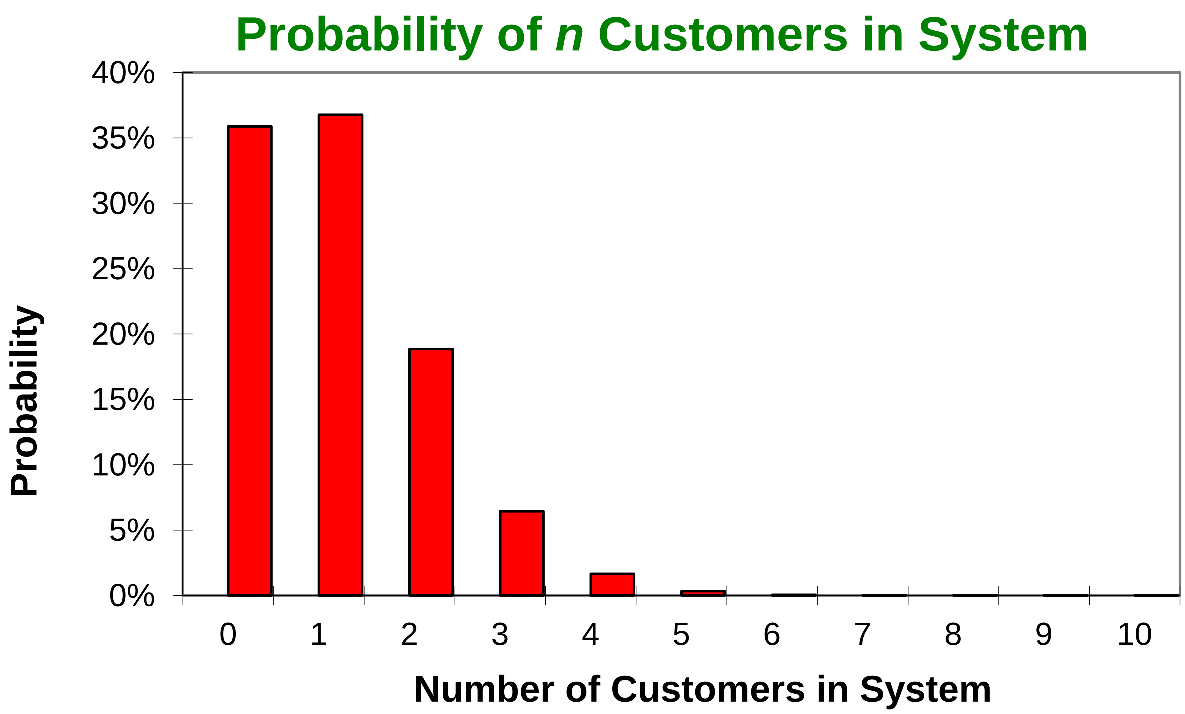
Arrival Rate	$\lambda=1/a$	1025,010	arrivals per	hour
Service Rate	$\mu=1/p$	1000,000	served per	hour
Server utilization	$\rho=l/k\mu$	2,6%		

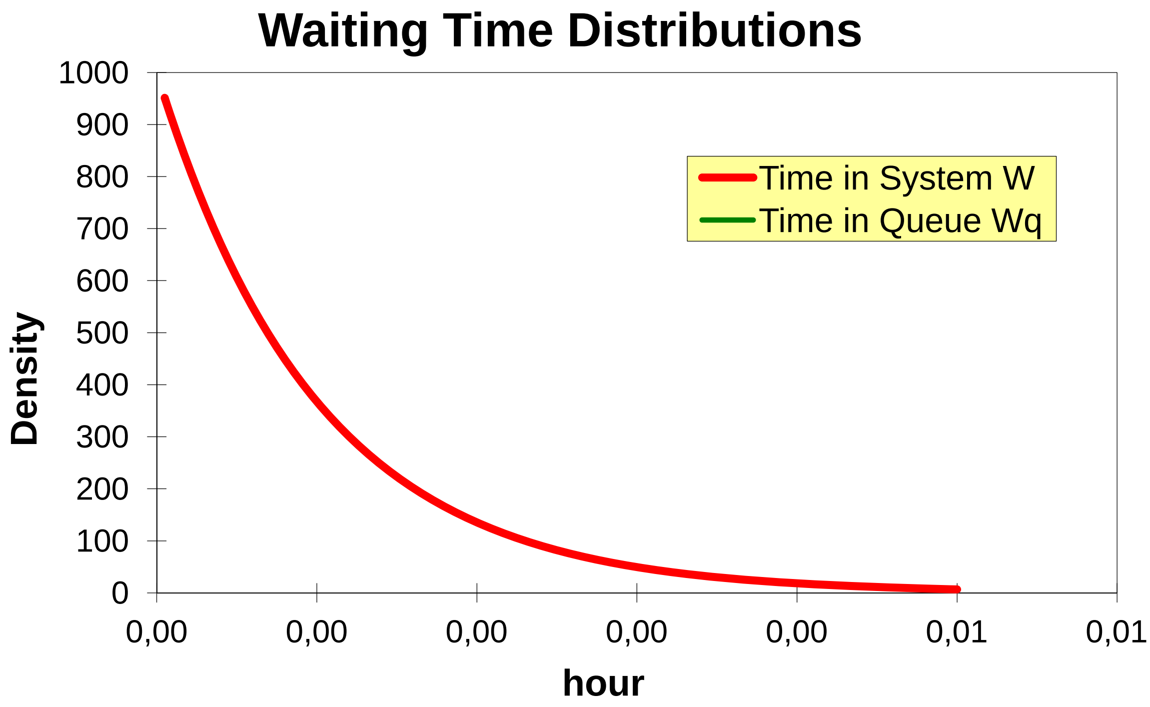
Performance Statistics		(Approx)	
Mean time in queue	*Wq*	0,00	hour
Mean time in system	*W*	0,00	hour
Mean number in queue	*Lq*	0,00	customers
Mean number in system	*L*	0,03	customers

Probability of Number in System		(Approx)
0	P0	35,88%
1	P1	36,78%
2	P2	18,85%
3	P3	6,44%
4	P4	1,65%
5	P5	0,34%
6	P6	0,06%
7	P7	0,01%
8	P8	0,00%
9	P9	0,00%
10	P10	0,00%
		100,00%

Notes: Queue performance statistics based on G/G/k heavy traffic approximation
Probability of number in system based on M/M/k approximation


Interarrival & Service Time Distributions
1200,00
1000,00
800,00
600,00
400,00
200,00
0,00
Density
0
0,0005
0,001
0,0015
0,002
0,0025
0,003
0,0035
Time
Arrivals
Service


Probability of *n* Customers in System
40%
35%
30%
25%
20%
15%
10%
5%
0%
Probability
0
1
2
3
4
5
6
7
8
9
10
Number of Customers in System



2.4.3. Third example: 50 servers (trains)

Simple Queueing Systems

		Mean	Std Dev	CV	
Mean Interarrival Time	**a=1/λ**	0,001	0,001	**1,00**	**=ca**
Mean Service Time	**p=1/μ**	0,001	0,001	**1,00**	**=cp**
Number of Servers	**k**	50			
Time Unit	**t**	hour			

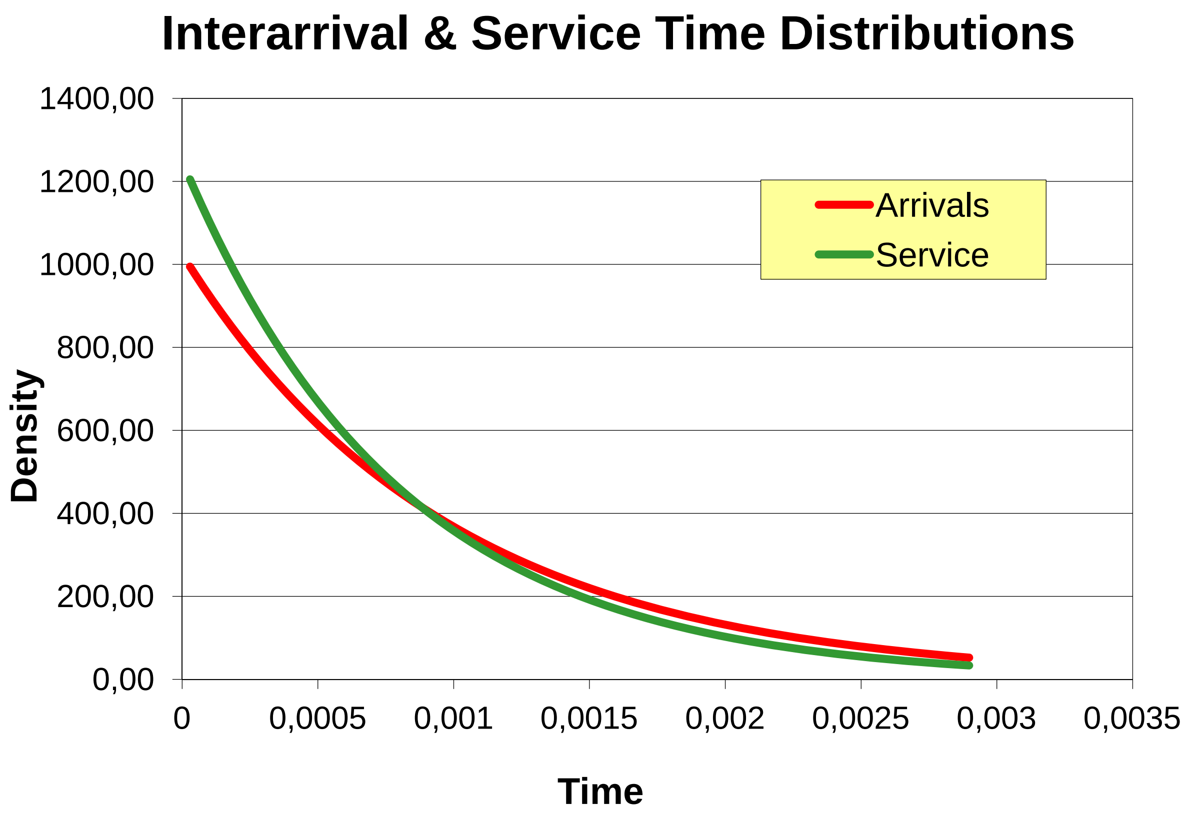
Arrival Rate	**λ=1/a**	1025,010	arrivals per	hour
Service Rate	**μ=1/p**	1250,000	served per	hour
Server utilization	**ρ=l/kμ**	1,6%		

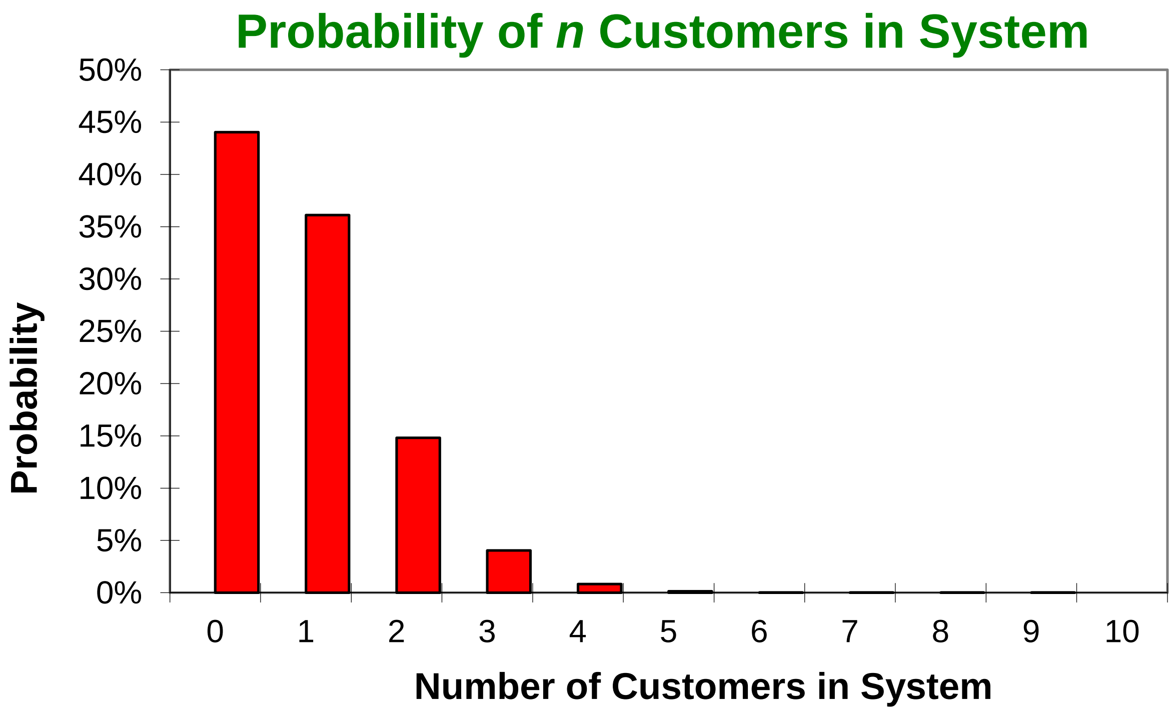
Performance Statistics		**(Approx)**	
Mean time in queue	***Wq***	0,00	hour
Mean time in system	***W***	0,00	hour
Mean number in queue	***Lq***	0,00	customers
Mean number in system	***L***	0,02	customers

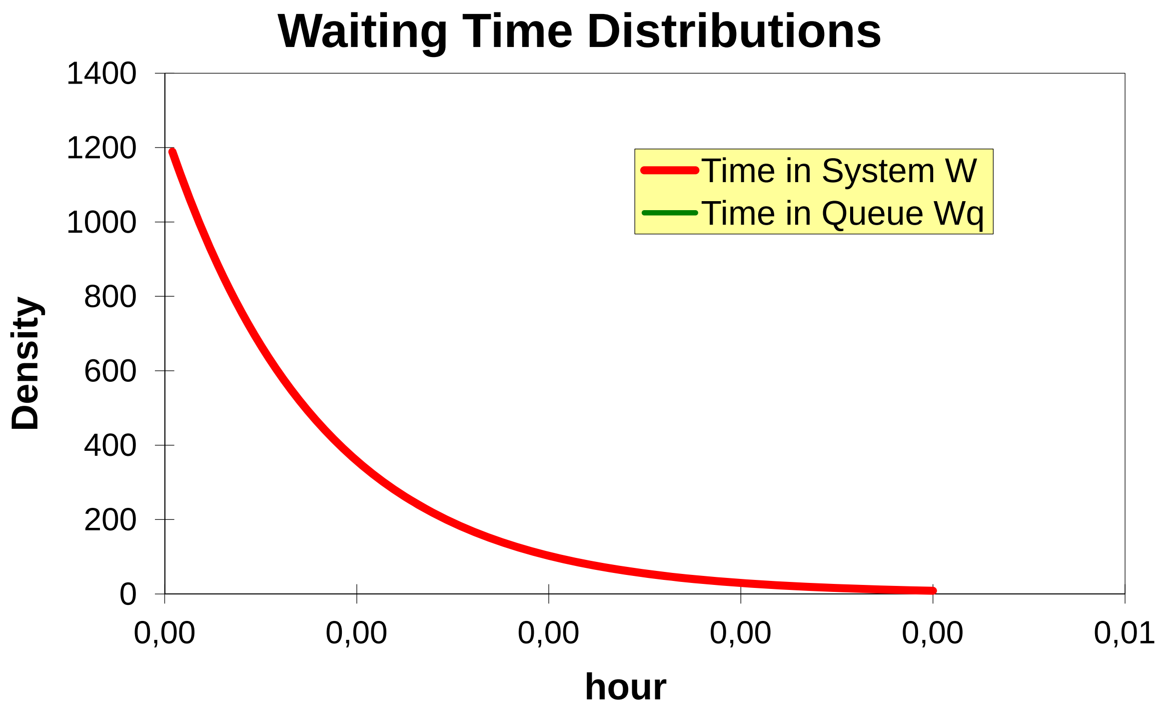
Probability of Number in System		**(Approx)**
0	**P0**	44,04%
1	**P1**	36,12%
2	**P2**	14,81%
3	**P3**	4,05%

4	**P4**	0,83%
5	**P5**	0,14%
6	**P6**	0,02%
7	**P7**	0,00%
8	**P8**	0,00%
9	**P9**	0,00%
10	**P10**	0,00%
		100,00%

Notes: Queue performance statistics based on G/G/k heavy traffic approximation
Probability of number in system based on M/M/k approximation







3. CONCLUSIONS

As it can be seen from the calculations and the attached diagrams, with an increasing number of servers (number of trains departing from the first station) the probability that all passengers will enter the arriving train (from the assumed average 1025 per hour) will be growing. On the other hand, the number of queueing passengers (that did not enter) will decrease, the waiting curve at the entrance will be shorter i.e. the waiting times of the passengers in the system will be shorter. According to the calculations, it is recommended to have 20 trains (servers) departing in one shift, i.e. 40 departures a day. The increasing number of servers (trains) arriving in one hour can thus transport as many passengers as possible (750, 1000, 1250) and the best would be to to have the supply and demand of transportation service harmonised with the number of 40 servers a day.

The number of train departures from the first station, and as we can see the optimal number is 40, from 5 to 23 o'clock means that the departure would be approx. every half an hour which is exactly the assumed time of the entire journey to the bus station with the same return times. This means that a train composition would make a full circle in one hour and for maintaining passenger transport with the predicted parameters, it would require in theory the acquisition of 2 compositions. However, for real reasons (maintenance, crashes etc.) 4 compositions should be acquired. This means the total transport of the predicted passenger number would be sufficient for departures every half an hour. However, in the early morning and the afternoon because of minor jams and better comfort I would suggest every 15 (20) minutes which would require the suggested 4(3) city train compositions.

LITERATURE

[1] Curry-Feldman - Manufacturing Systems Modeling and Analysis Prof. Guy L. Curry & Prof. Richard M. Feldman, Texas A & M University, Dept. Industrial & Systems Engineering 3131 TAMU College Station TX 77843-3131 USA, Springer Verlag Berlin-Heidelberg 2009, ISBN: 978-3-540-88762-1

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APPLICATION OF THE QUEUEING THEORY IN DETERMINING THE CAPACITY OF AIRCRAFT GROUND HANDLING

ABSTRACT

The paper illustrates the application of the Queueing theory and Markov chains in the example of determining the capacity of services for ***aircraft ground handling****. Since the arrival of the aircraft to ground handling occurs by stochastic a (random) model, which is described in the paper as a Markov chain of type G/G/k, and the process of the ground-handling system and waiting in turn occurs also according to the random (stochastic) model, which is described as a Markov chain of type M/M/k. To verify the theory and the proposed model of system behaviour all data describing the behaviour of a given system were calculated as well as the capacity of the service.*

Key words*: Queueing theory, Markov chains, Aircraft ground handling*

1. INTRODUCTION

This paper uses the theory of Markov chains, which is in literature described as a variable model. It is expected that the Markov approach will respond well to the problem since it does not assume any type of distribution upon the request of variations. The probability of variation of the requested values depends on the actual condition of the value and thus it is not a constant anymore and does not depend on previous values before considering the process. [1] The Markov chain is a type of random process. It is said that the Markov chain is a random process with a Markov property. The Markov property means that the future condition depends on the current (actual) condition regardless of the previous conditions. [1]

Aircraft ground handling is an organisational-technical system which operational organization should be adjusted to the times and presence of aircrafts arriving for ground handling. The aircraft arrivals occur as a general random (Gaussian) variable (stochastic). The operational process within the ground handling occurs also as a random variable generated out of random aircraft arrivals to ground handling and the waiting time in queues and the times required for ground handling itself. The aircraft arrivals to the airport depend mainly on the flight schedule, delays and weather conditions. Such arrivals naturally occur according to the general random (Gaussian) model, in which the G/G/k model from the Queueing theory describes in the best way the mentioned behaviour. The arrival of the (server's) ground handling personnel within such a system occurs also according to the laws of the Queueing theory, according to the exponential random model (Poisson) of the Markov chains of type M/M/k.

By using the Markov chain, i.e. the Queueing theory, to describe the capacity of preparing and ground handling the problem of selecting a model is solved. The obtained results show that, as expected, the approach by means of the Markov chain leads to important knowledges and thus to a better investment policy, i.e., aircraft ground-handling. The model was selected from literature and is in particular acceptable for solving the given problem since it describes well the processes occurring within the system of aircraft ground handling. [1]

The selected model of the service operation system is an indefinite M/M/k chain, with a probability distribution of customer arrivals (i.e. aircraft arrivals at the ground-handling system) by the G/G/k model. This model is accepted in literature for describing an aircraft ground-handling system, i.e. for most heavy traffic.

This paper does not describe the basics of the stochastic process, Markov chains, terms and properties in connection to Markov chains.

This scientific papers aims at confirming or negating the following **causal hypothesis:**

„The Markov chain as a mathematical model may well describe technical and organisational systems, such as aircraft ground handling – the example described in this paper – and in addition to credible results, it can solve numerous dilemmas, i.e. problems."

The **objective** of this paper is that by describing and the mathematical modelling of one of the particular application of Markov chains in practice to explain first the problems and one of the possible ways to solve the problem and thus to give guidelines for the further study of similar and identical systems.

The paper should prove that the Markov chains are a very adequate and fast scientific method for a credible solution of the addressed example and thus it can be applied not only to all similar systems, but also to very different systems, of natural, technical or social behaviour.

The **methodology** for solving the problem of determining the capacity of aircraft ground handling was to, by correctly selecting the mathematical model of the description by means of adjusting the Markov chain, make a model and to solve by calculation the given and described problem. The applied methods of the scientific paper were: analysis, mathematical modelling by means of the Markov chain and synthesis of results.

2. SELECTED AND ELABORATED MODEL IN THIS PAPER AS AN EXAMPLE

2.1. Considering the algorithm and the selection of model – model: M/M/k, infinite Markov chain, with probability distribution of the customer number (i.e. aircraft arrivals at the ground handling system) according to the model G/G/k

All available theoretic models of modelling the operation of aircraft ground handling are complex. The present widespread outsourcing of some works and/or ground handling , the involvement of solving the problem of such ground handling already during the phase of aircraft and airport design, various forms of contracts and clauses on aircraft ground-handling between aircraft owners and ground handler server complicate the design of the model which includes all that. Therefore, a model including as much and as real as possible all the events during handling is still being searched for.

In contrast to other scientific papers, this paper does not iterate many variables and varieties of the system since the paper aims to present the application of the theory of the Markov chain on an example from this paper. This paper uses the programm Excel in which the formulas from the Queueing theory, i.e. Markov chain, were inserted.

2.2. Determining service capacities

This paper assumes that the Zagreb Airport as the station with the highest passenger traffic, after a foreseeable large investment into its extension, will be enabled for receiving in the first phase three million passengers annually. With regard to personnel for such an aircraft ground handling, various description and calculation models can optimize it. For determining the optimum of required personnel, it is also necessary to know the volume of ground handling per aircraft and to determine the number of shifts. Naturally, a two-shift operation is desirable since aircrafts arrive at the airport throughout the day, and less during the night.

In doing so, it should be stressed that in order to consider the optimality and financial efficiency of one such ground handling, it is necessary to determine the optimal personnel capacity since it represents the highest cost.

2.3. Description of the model elaborated in this paper

Determining the capacity of the aircraft ground handling:

This paper sets out with the assumption that ground handling is established for the Zagreb Airport.

In addition to it, an optimal number of servers (ground handlers) for the predicted increasing of traffic in the Zagreb Airport is being searched for. Currently, the traffic in the Zagreb Airport is up to 1.500.000 passengers annually. Upon ending the investment in the capacity extension, the Zagreb Airport will be able to receive three (later up to five) million passengers, i.e. if we assume that every aircraft has approx. 250 passengers, it means an reception of up to 12.000 aircrafts annually, and in a later phase up to 20.000.

On that occasion during aircraft ground handling the following should be carried out:

- aircraft cleaning .... 10 minutes
- change of water ....10 minutes
- catering .... 10 minutes
- fuelling .... 25 minutes
- toilet service ....8 minutes
- baggage loading and unloading ....
- making boarding documents ....

Since most of the above-mentioned ground handling works are carried out parallel for one medium-size aircraft (e.g. Airbus A320) in total approx. 30-40 minutes are required.

The assumption is that 100% of all arrived aircrafts, i.e. approx. 12.000 aircrafts annually in the first phase, remain at such ground handling. It is also assumed that 1.000 (and in a later phase up to 1.700) aircrafts should be ground handled and that the ground handling of each aircraft lasts approx. 36 minutes. That means the system is stable if a sufficient number of servers is determined. Primarily the case of the first phase of the airport extension, i.e. the projected traffic of 3.000.000 passengers annually, and the service ground handlers for 12.000 aircrafts annually was elaborated.

The basic idea for solving the problem of determining the capacity of the passenger aircraft ground handling was to assume that the number of servers was not known. It was varied for more cases and the optimal number of servers (employees, service personnel) was searched for – in the sense to have the optimal volume of works, but to shorten as much as possible the time the aircrafts are being ground handled (a request of airlines, assumed up to 36 minutes) and to harmonise the mean interarrival time with the mean ground handling time, times which do not have to be identical (and will never be, these are all random variables), but to have the system optimally harmonised with ground handling requirements. According to the principle: for the airline the smallest cost, i.e. time spend on ground handling if we disregard the price of replaced goods, e.g. catering and fuel and also for the handler (server) in the sense of a small employee number as possible.

A two-shift operation, in each shift up to 10 working hours with the same employee number (servers) was foreseen. This means, that one shift (the examples assume 6, 8 and 10 servers per shift) is always operating, covering thus 20 hours operation per day, 7 days a week operation, i.e. a 16 (up to 20)/7 system. Approx. 90% aircrafts arrive based on that system.

It is also assumed that the average ground handling of one aircraft lasts approx. 36 minutes so that this number was varied in three variants: with 6, 8, and 10 servers in one shift. Naturally, ground handling might be urgent and short-time, but such an example was not considered since it has a smaller impact on that problem which was being solved in this paper. That is, in that case the problem can be simplified so that the annual monthly handling capacity (due to such requirements) is 1.000 x 36 minutes, i.e., it can be calculated that more aircrafts went through ground handling but with minor individual retaining within the system which results in a total operating capacity of 1.000 aircrafts per 36 minutes for each per month, i.e. 36.000 minutes, i.e. 600 hours per month. The unit of time was an hour.

It was considered what kind of implication on the operation and the system behaviour it would have if the number of servers (handlers) of 6, 8, and 10 in one shift varied.

It was also assumed that the smallest number of servers is 5 as due to different operations carried out a smaller number cannot be predicted. Due to the expected increase of traffic and the aircraft number, the system was varied which was mentioned in the varieties with 6, 8 and 10 severs.
The results were given in the tables below.

2.4. Results of the calculation

2.4.1. First example: 6 servers

Simple Queueing Systems

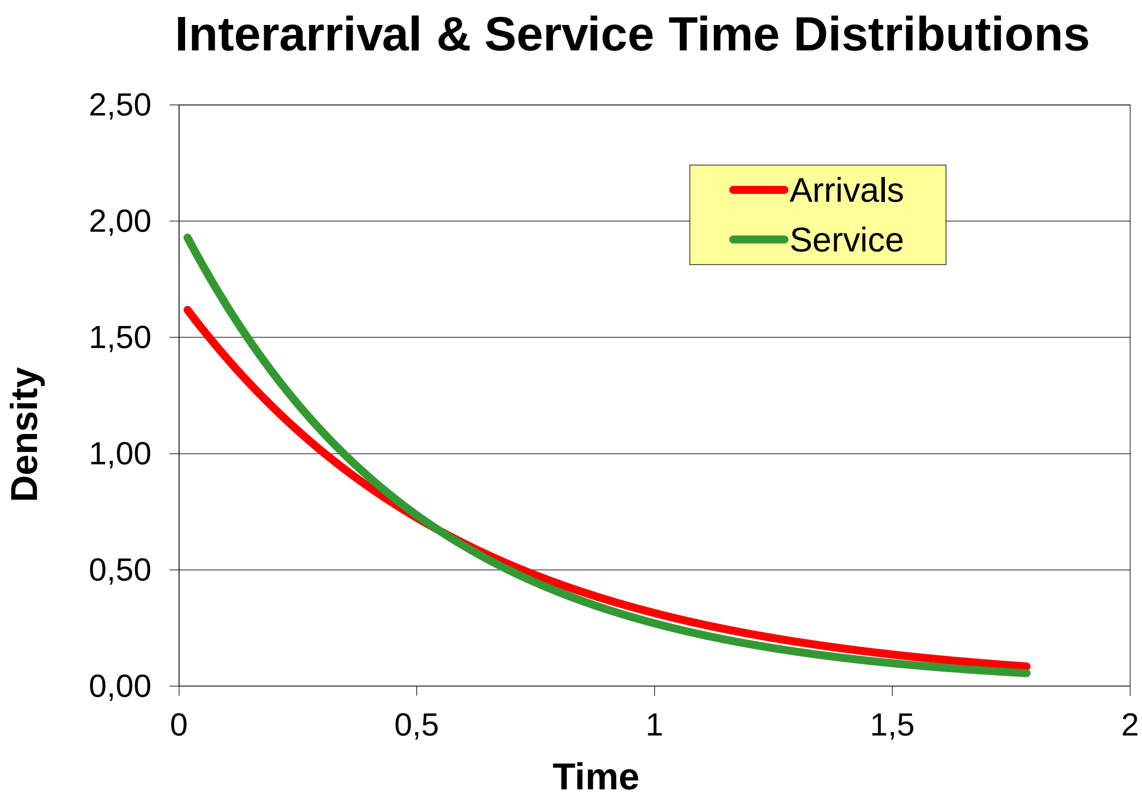
		Mean	Std Dev	CV	
Mean Interarrival Time	$a=1/\lambda$	0,600	0,600	1,00	=ca
Mean Service Time	$p=1/\mu$	0,500	0,500	1,00	=cp
Number of Servers	k	6			
Time Unit	t	hour			
Arrival Rate	$\lambda=1/a$	1,667	arrivals per	hour	
Service Rate	$\mu=1/p$	2,000	served per	hour	
Server utilization	$\rho=l/k\mu$	13,9%			

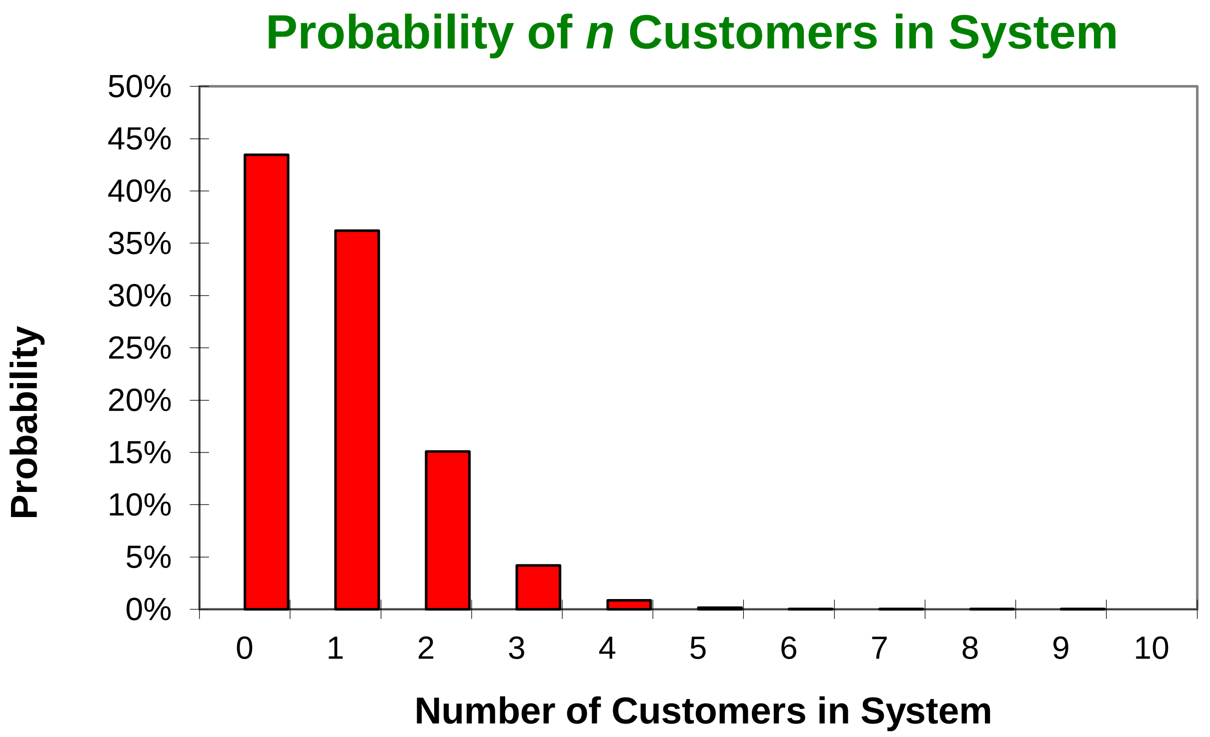
Performance Statistics		(Approx)	
Mean time in queue	*Wq*	0,00	hour
Mean time in system	*W*	0,50	hour
Mean number in queue	*Lq*	0,00	customers
Mean number in system	*L*	0,14	customers

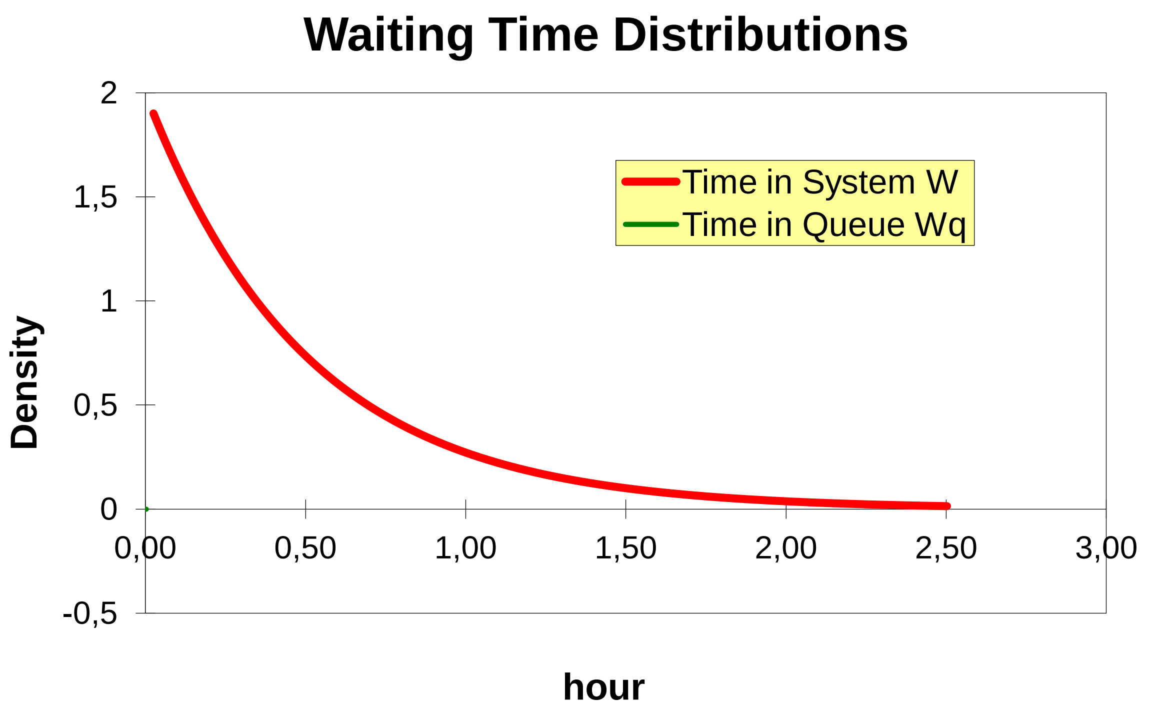
Probability of Number in System		(Approx)
0	P0	43,46%
1	P1	36,22%
2	P2	15,09%
3	P3	4,19%

4	**P4**	**0,87%**
5	**P5**	**0,15%**
6	**P6**	**0,02%**
7	**P7**	**0,00%**
8	**P8**	**0,00%**
9	**P9**	**0,00%**
10	**P10**	**0,00%**
		100,00%

Notes: Queue performance statistics based on G/G/k heavy traffic approximation
Probability of number in system based on M/M/k approximation




Probability of n Customers in System
Probability
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
0
1
2
3
4
5
6
7
8
9
10
Number of Customers in System


Waiting Time Distributions
Density
2
1,5
1
0,5
0
-0,5
0,00
0,50
1,00
1,50
2,00
2,50
3,00
hour
Time in System W
Time in Queue Wq

2.4.2. Second example: 8 servers

Simple Queueing Systems

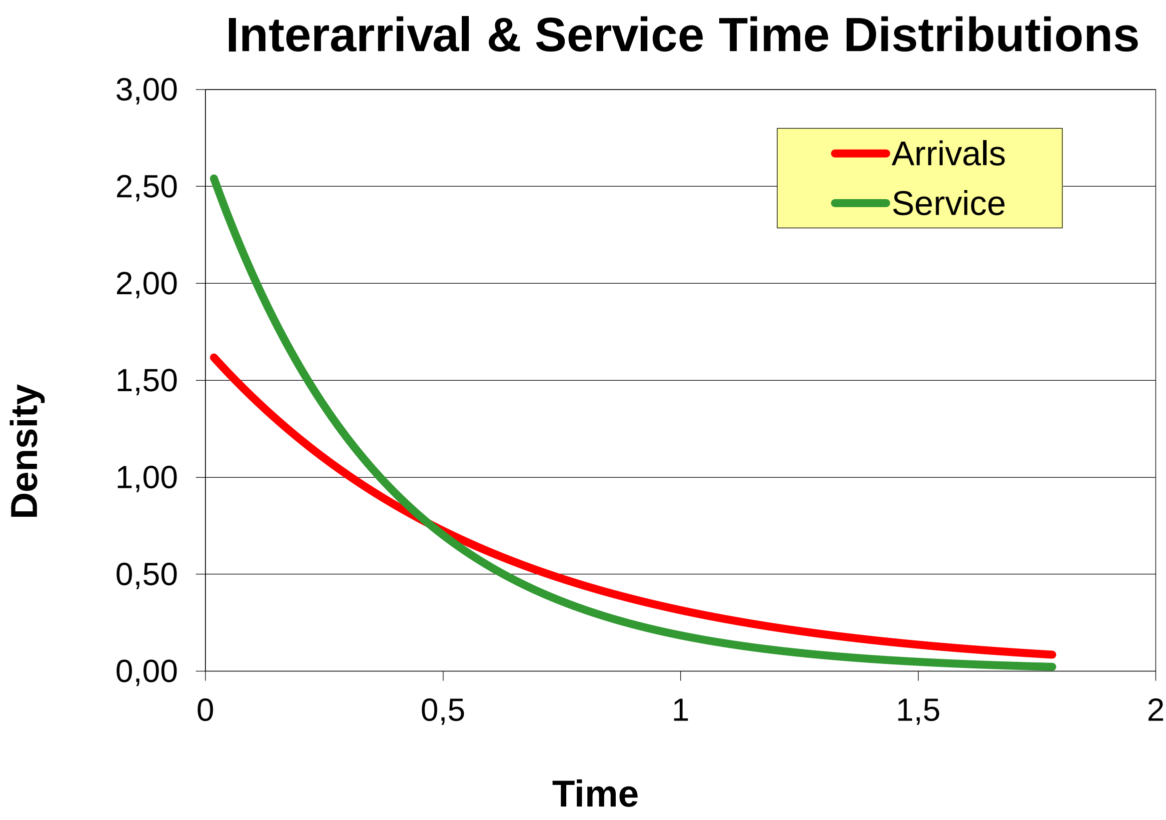
		Mean	Std Dev	CV	
Mean Interarrival Time	$a=1/\lambda$	0,600	0,600	1,00	=ca
Mean Service Time	$p=1/\mu$	0,375	0,375	1,00	=cp
Number of Servers	k	8			
Time Unit	t	hour			

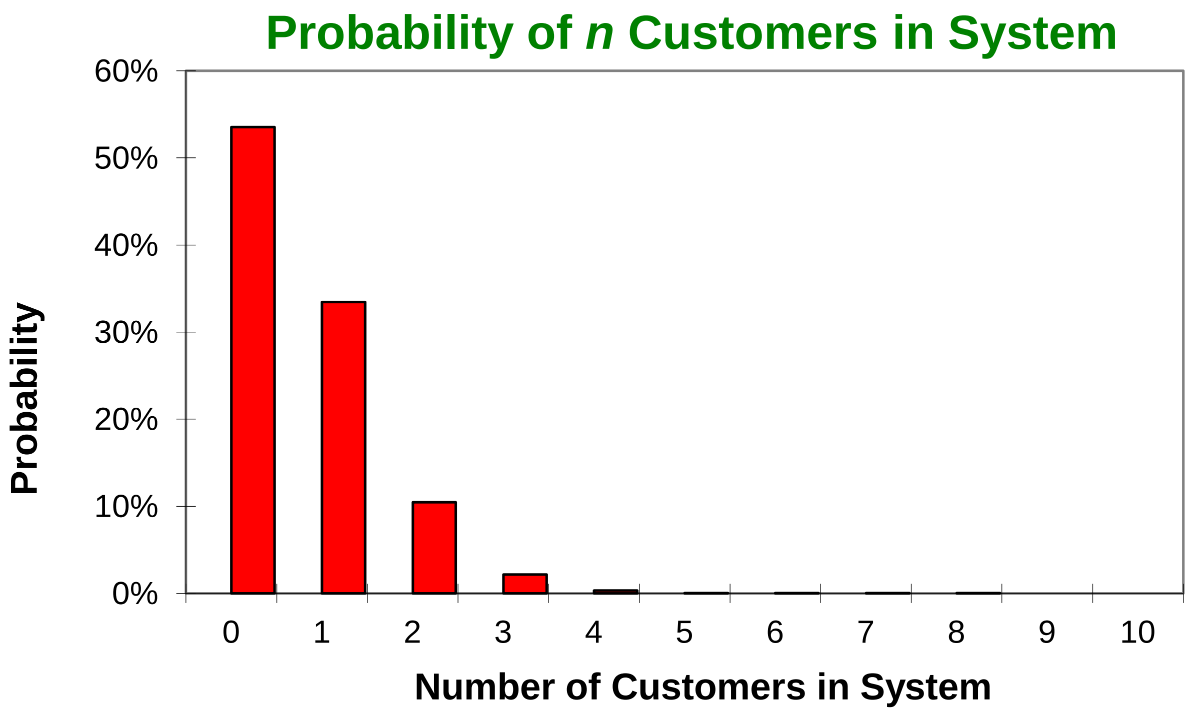
Arrival Rate	$\lambda=1/a$	1,667	arrivals per	hour
Service Rate	$\mu=1/p$	2,667	served per	hour
Server utilization	$\rho=l/k\mu$	7,8%		

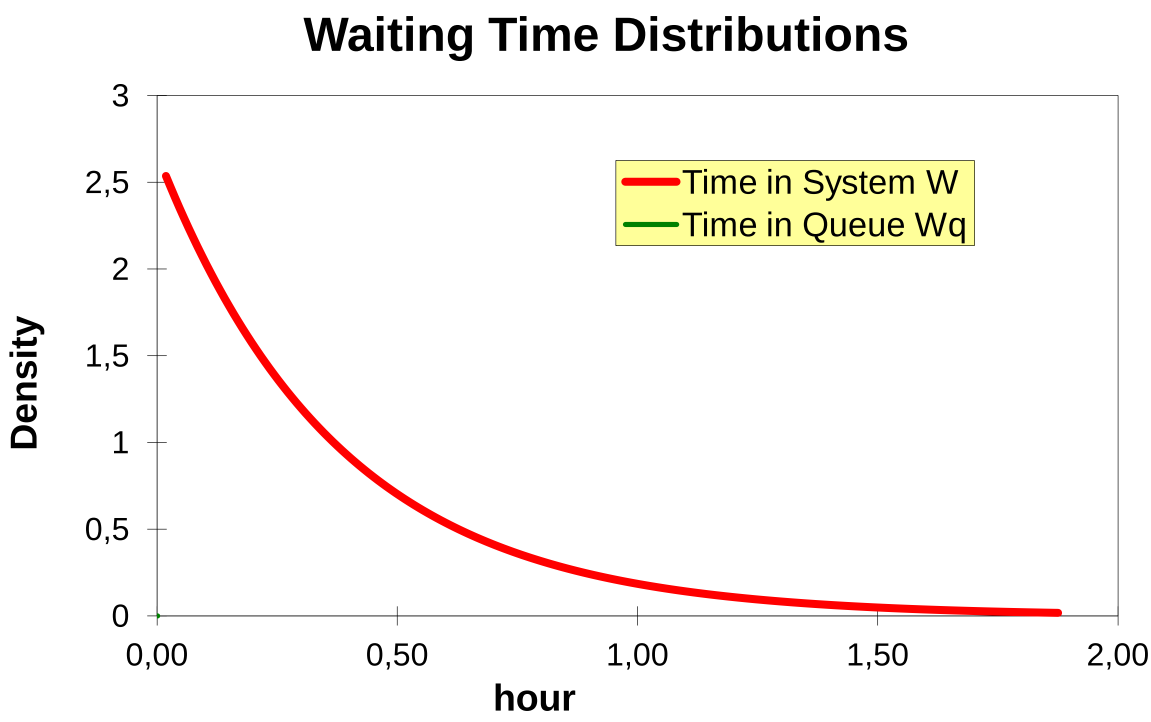
Performance Statistics		(Approx)	
Mean time in queue	*Wq*	0,00	hour
Mean time in system	*W*	0,38	hour
Mean number in queue	*Lq*	0,00	customers
Mean number in system	*L*	0,08	customers

Probability of Number in System		(Approx)
0	P0	53,53%
1	P1	33,45%
2	P2	10,45%
3	P3	2,18%
4	P4	0,34%
5	P5	0,04%
6	P6	0,00%
7	P7	0,00%
8	P8	0,00%
9	P9	0,00%
10	P10	0,00%
		100,00%

Notes: Queue performance statistics based on G/G/k heavy traffic approximation
Probability of number in system based on M/M/k approximation


Interarrival & Service Time Distributions
Arrivals
Service
Density
3,00
2,50
2,00
1,50
1,00
0,50
0,00
0
0,5
1
1,5
2
Time


Probability of n Customers in System
Probability
60%
50%
40%
30%
20%
10%
0%
0
1
2
3
4
5
6
7
8
9
10
Number of Customers in System



2.4.3. Third example: 10 servers

Simple Queueing Systems

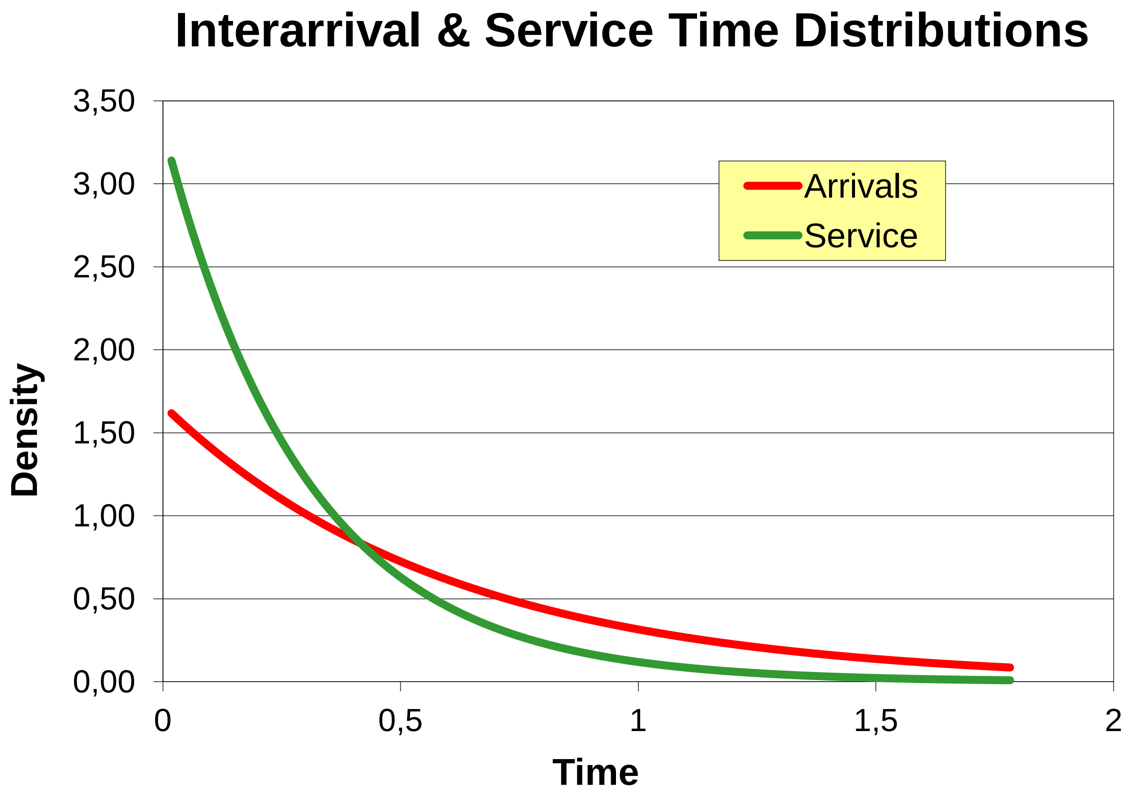
		Mean	Std Dev	CV	
Mean Interarrival Time	a=1/λ	0,600	0,600	1,00	=ca
Mean Service Time	p=1/μ	0,300	0,300	1,00	=cp
Number of Servers	k	10			
Time Unit	t	hour			
Arrival Rate	λ=1/a	1,667	arrivals per	hour	
Service Rate	μ=1/p	3,333	served per	hour	
Server utilization	ρ=l/kμ	5,0%			

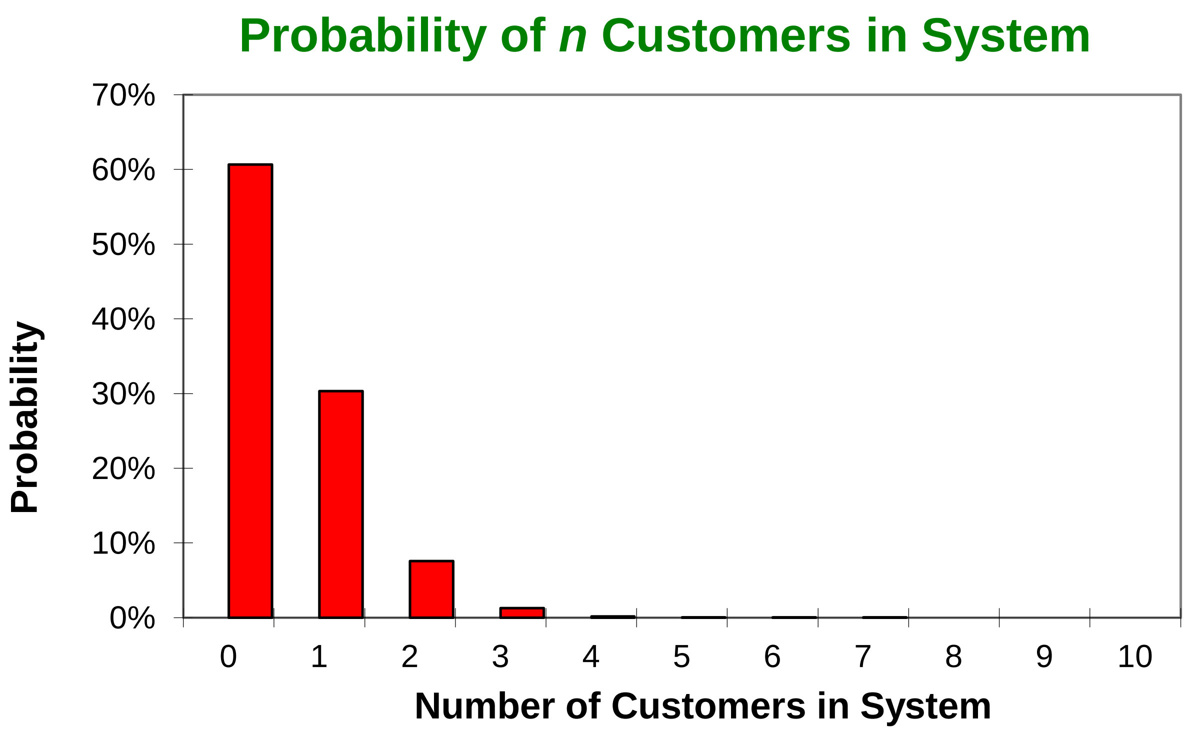
Performance Statistics		**(Approx)**	
Mean time in queue	*Wq*	0,00	hour
Mean time in system	*W*	0,30	hour
Mean number in queue	*Lq*	0,00	customers
Mean number in system	*L*	0,05	customers

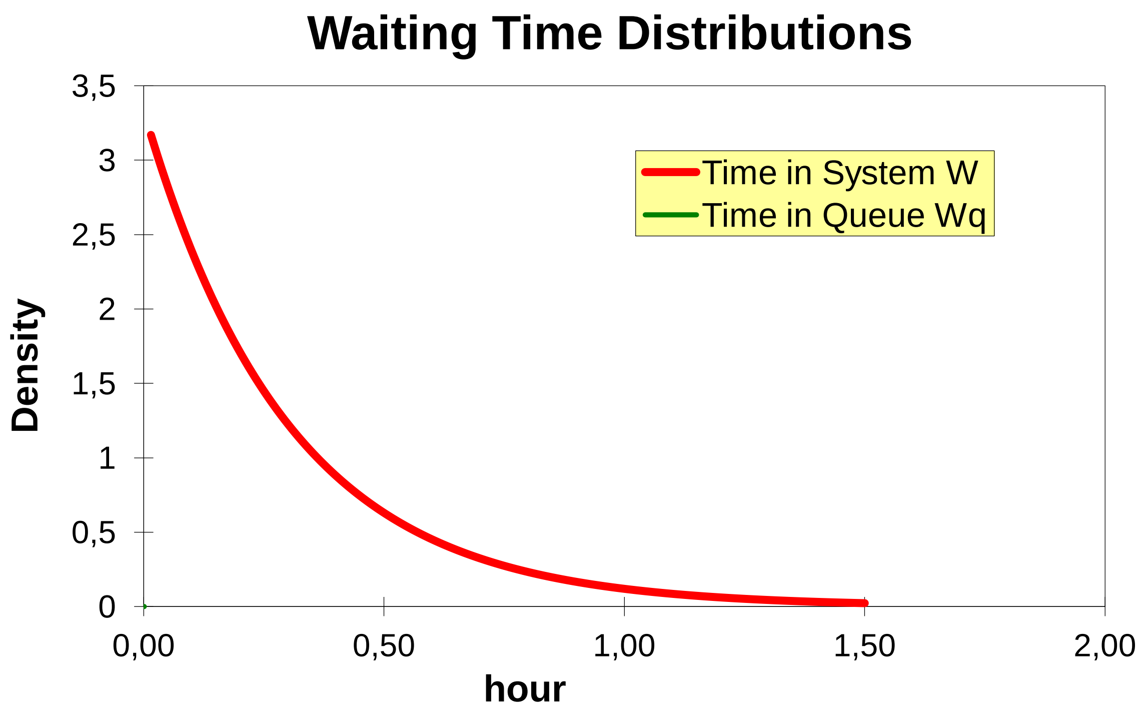
Probability of Number in System	**(Approx)**

0	**P0**	**60,65%**
1	**P1**	**30,33%**
2	**P2**	**7,58%**
3	**P3**	**1,26%**
4	**P4**	**0,16%**
5	**P5**	**0,02%**
6	**P6**	**0,00%**
7	**P7**	**0,00%**
8	**P8**	**0,00%**
9	**P9**	**0,00%**
10	**P10**	**0,00%**
		100,00%

Notes: Queue performance statistics based on G/G/k heavy traffic approximation
Probability of number in system based on M/M/k approximation







3. CONCLUSIONS

As it can be seen from the calculations and the attached diagrams, with an increasing number of servers, the probability that only one aircraft will be in queue will be growing. The ground handling curve will be shorter i.e. the congestions will be smaller and the times of retaining of aircrafts in the system will be shorter. However, since the increasing number of servers means a cost of personnel, it is recommended to employ in one shift (i.e. in each) up to 6 servers, a larger number would lead to finish ground handling faster and a to wait too long for the next aircraft. For minor increases of the volume of work, the institution of over-time can be included. For any larger increase of the volume of work, as it can be seen from the prediction of the traffic increase from three to five million passengers that this will occur, it is recommended to further train and employee new personnel with the indication of an increase of the work volume. However, a large problem of this model is that not all employees can carry out all works and even if this model would predict two employees only, in reality at least 5 should carry out different and incomparable works required by such ground handling. This paper considers 5 various works, therefore a number smaller than six handlers were not considered so that the ground handling time of one aircraft varies from 0,3 to 0,5 minutes, i.e. from 20-30 minutes which is less or within the airline requirement. The mentioned smallest number of servers (5) handles one aircraft for the mentioned starting 36 minutes (0,60 hours).

LITERATURE

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IMPLEMENTATION OF SAFETY MANAGEMENT SYSTEMS IN AIRCRAFT MAINTENANCE ORGANIZATION

ABSTRACT

On 30 July 2010 the Croatian Civil Aviation Agency issued the Air Safety Order (ASO) number ASO-2010-004 which defines the conditions and deadlines for the implementation of the safety management system (SMS) in aircraft maintenance organizations. The ASO defines the implementation of SMS in four phases within a period of two years since the date of the ASO issuing. The basic support for issuing the directive is ICAO Doc 9859; Safety Management Manual (SMM) issued in 2009. The directive describes the general and theoretical model for the implementation of the safety system creating a problem for the aircraft maintenance organization regarding its practical implementation.

The paper presents the practical implementation method of the proactive safety system in aircraft maintenance organization.

***Key words**: Safety Management System, proactive model of safety, practical implementation of safety system*

1. INTRODUCTION

Compared to other transport modes, the accidents and incidents in air transport are fewer in numbers but because of the attractiveness they always attract the attention of the public. This leads to a feeling that aircraft accidents do occur all the time. In order to reduce such a virtual feeling of lack of safety of air transport, and to really increase at the same time the safety of air transport, it was the aircraft technology that was being improved first. By knowing the causes that lead to aircraft accidents an attempt was made to act preventively. The next attempts were directed to the reduction of the influence of the pilots and flight control staff on aircraft accidents. A systemic modification was made in the procedures, flight technology in the organisation of the crew and flight control operation, in order to reduce the human influence in producing an unintentional defect that could lead to aircraft accident.

The improvement of the technology of aircraft manufacture has reached a point where, along with the technological improvement, it is necessary to work on increasing the level of education and raising of awareness of possible failures in the work of direct operational staff in the aircraft maintenance system. It was with this goal in mind that in 1989 the “Human Factor” was introduced as an obligatory subject and which all the technicians have to pass in order to acquire the aircraft maintenance licence.

The evolution in fighting defects in aircraft maintenance the cause of which is human factor may be considered in the following steps:

- Training of people and raising awareness about the possibility of unintentional error in the production as personal error or teamwork error due to poor communication;
- Finding of defect types in production and understanding the causes of their occurrence;
- Finding 12 rules of defect occurrence and understanding as well as implementation of the system for preventing defects in their occurrence;
- Creation of the system of reporting and investigating the cause of defects;
- Increase in the level of education and awareness of every individual;
- Analysis of causes of defects and changes in the system in order to prevent them;
- Introduction of the safety system based on the reactive and proactive study of defects and corrective measures for their removal.

The purpose of this paper is to present a model of proactive action in an aircraft maintenance organization which can be applied in every aircraft maintenance organization. The model is based on the improvement of the existing indicators of the operation of individual organizations and uses the capacities and the data from the reliability program, that are obligatory in monitoring the work of an organization.

2. AIRCRAFT MAINTENANCE AS A PRODUCTION PROCESS

Technical maintenance of aircraft can be presented as a system for the production of operational hours and flying cycles. This means that technical maintenance of aircraft ensures conditional or non-conditional capability of aircraft for safe flying regarding technical safety of the aircraft. The production process is a complex system that starts with the input of the subject of work into the production process system until the creation of new value over the subject of work as result of the production process. By direct action or modifications in the production process all the following processes in the production system are influenced. Figure 1. shows an example of presentation of a production process

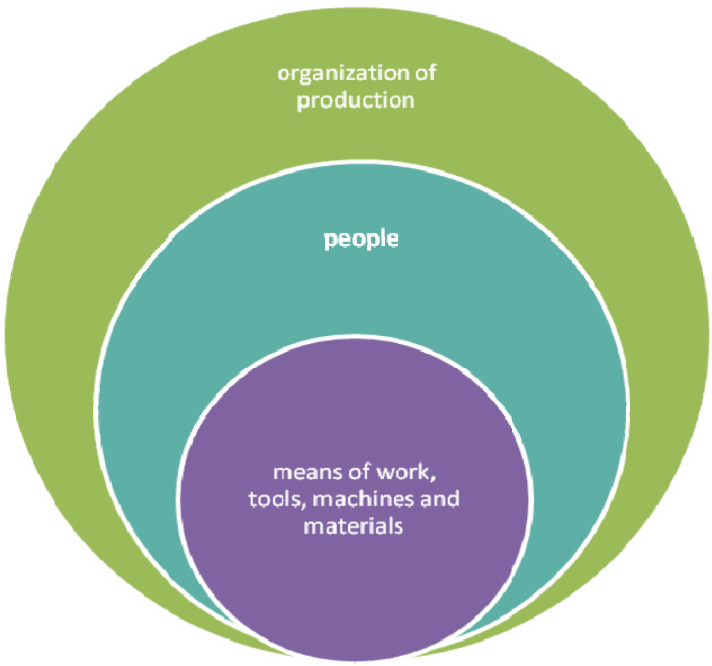

Figure 1 - Presentation of a production process (source: author)

The production process consists of:

- Subject of work: aircraft or aircraft component.
- Means of work: tools, machines and material.
- Humans: active participants of the process who create new value by their work.
- Production organization: organization of work depends on the production technology. The technology of work is determined by the type of aircraft and the volume of work performed on it.

3. APPROACH TO SAFETY MANAGEMENT

Every organization can recognize how much it contributes to the establishment of improved safety based on the following factors:

- Orientation according to SMS represents the relation of the managing structure of organization according to the SMS system. The managers need to provide incentive in the implementation of the principles of risk reduction and ensure a motivating atmosphere for other employees according to SMS.
- The behaviour of all involved in the processes of work has to be oriented to improving the production process and personal contribution in the work in order to reduce the risk of defect occurrence.
- The awareness that behind every work or process there is a probability of defect.
- Adaptation of the work and process in order to reduce the defects, and on the basis of reactive and proactive knowledge where it has occurred or will occur.
- Information about the drawbacks in the production which lead to defects in work and opening of all the communication channels vertically and horizontally in order to report non-compatibility and method of preventing defects.
- The analysis of the events and correction of processes and work in compliance withe the made conclusions.

Relation to the safety system in the aircraft maintenance organization can be assessed on the basis of the tools used by the organization[1] in detecting the cause of defect and which measures are undertaken in order to avoid their recurrence in the future. According to the mentioned assessment, the following forms of the implementation of safety system in aircraft maintenance organization can be identified:

- Declarative, based on the understanding of safety as part of production risk.
- Reactive, which is based exclusively on the knowledge about the causes that had led to the actual accident. The safety policy is based on the identification of the one to blame for the event and penalizing the perpetrator.
- Calculative, based on monitoring the production process and calculation of material loss due to failure and defect in production.
- Proactive, contains elements of management orientation for safety, s well as all the employees. The safety is part of the work culture related to education and work communication.
- Continuous improvements directed to increase in safety which apply the principle that nothing has occurred yet, but the defect is always possible. This approach constantly attempts to prevent defect by preventive actions, and it is based on the knowledge about the possible cause obtained by simulated disturbances.

According to ICAO DOC-9859-SMS there are three types of approaches to identifying the factors that cause defects, and according to the same classification the implementation level of the safety system in the organizations can be ranked.

- *Reactive* – this is a method implemented in investigating the cause of accident. The causes are found which had brought to the accident and based on the knowledge about factors that had led to the defect corrective actions are performed in order to remove the conditions for the creation of these factors.
  The investigation of the causes of such defects is the responsibility of the aviation authorities so that these are received by the aircraft maintenance organization as a finished product, with the defined cause and the corrective action in order to prevent similar events in the future.
- *Proactive* – method which is feasible in the organization itself. The sources for this method are all the methods of reporting and controlling of the production process. It depends on the employees' awareness about the importance of implementing the safety system. The data from the Reliability program can be used as an important source of information. Based on reports and events within the organization that could have affected the reduction of safety the factors that had led to the defect and the corrective actions are studied in order to remove the conditions for the formation of the same factors.
- *Predictive* – a method which is based on the assumption that every change in the system leads to instability that may cause defects. The basis of such a system is systemic monitoring of the changes in the organization, recording of trends that may be the indicators of deterioration and use this as the basis to perform in advance corrective action before the defect occurs. A typical example is to make a good assessment and correction before making a new working procedure, or before changing an important factor in the working system or in decision-making.

All the methods use systems of analyses and data collection. Data collection can be carried out by means of computer systems or directly by means of the employees' reporting system.

The method of reporting is an important part of this method since it yields data from the immediate operational staff who are best informed about the production process. In order to be motivating, apart from being stimulated to report defects and failures in the production the employees must also get feedback on their reports regarding what has been done and what effect is expected from the undertaken measures. The reporting system has to guarantee complete personal anonymity of reporting and guarantee from the management that they will not be penalized or have any negative consequences due to reporting.

The monitoring systems of the work of aircraft, engines and components are part of the aircraft maintenance system and represent technological tools that facilitate preventive repair of a part before it breaks down. Such systems have been set by default so that it is possible to determine corrective actions based on the pre-known trends. The mentioned technical trend also has a working process system component. It is necessary to study the conditions of exploitation and maintenance so that these can be used as the basis to improve work.

The aircraft maintenance organization has to establish a system for controlling the reliability, the so-called reliability program. With this system the organization can control its output product by monitoring the status of individual important production points. The data that are monitored and the analysis and interpretation of data can serve as an important source of information in the safety management system.

4. DETERMINING THE LEVEL OF HAZARD FOR AIRCRAFT SAFETY CAUSED BY DEFECT

4.1. Causes of hazard for aircraft and flying

In order to determine the preventive action that would prevent accidents or harmful events it is necessary to understand what is hazard, i.e. which factor acts on the system so that it results in a defect. A dangerous factor or HAZARD can be defined as conditions or objects that represent potential hazard for the injury of people, damage of the equipment or aircraft, or reduction of the capability for performing the given tasks. An undesired event that has occurred or may occur due to potential hazard is called risk. In forecasting a possible scenario of events an unwanted event is always considered as the most hazardous option.

For example, in aircraft maintenance the staff is exposed to noise which is generated by the work of various aggregates, engines or pressurised air. The noise may damage the hearing partially, or completely. In this example the hazard is the noise, and the risk due to noise is complete loss of hearing. It is not allowed to work with such a risk, and so the risk must be alleviated to an acceptable measure. The preventive action includes carrying ear protectors, determining the distance zone acceptable regarding the noise level for the employees and the duration of noise exposure.

4.2. Hazard factor assessment

Hazard factor can be generally divided into external and internal factors. External factors are related to the general conditions which are influenced by the organization in a minor way. These are the conditions under which the process is occurring and are conditionally external environment of making revenues, and can be recognized as:

- natural factors (weather, disasters, crises..),
- technical (construction, technology, exploitation processes..),
- economic (development, prices of materials, price of work...).

Internal factors are related to the very process of organization and production process. These are the processes which can be efficiently acted upon by the company and the primary interest of the company is systemic insight into the production process in order to identify possible hazards. Each company establishes its control system of the production process but for each the following is characteristic:

- that it has the elements of systemic reporting based on voluntary reporting system. This system is in the interest of the employees themselves, who are crucial in reports, since it improves the conditions of work and the process itself;
- findings of external audits or inspections. The audits in other companies as an important factor in exchange of experience;
- interviews with employees from the production and managing staff;
- inspections and work controls. They may be targeted to a certain field of activity, and may be general for monitoring the working process.
- investigations related to defects in production;
- monitoring the reliability trend in the work or production growth trend;
- feedback after monthly or yearly obligatory education;
- experiences of other companies that are simulated in the organization.

4.3. Risk assessment

Constant hazard is the cause of undesirable event that is called risk, which can but need not occur in all its variants. In risk assessment always the worst scenario in risk assessment is taken.

According to ICAO doc 9859, the risk is divided into five categories which represent:

- A-*Catastrophic* – accident – event that has caused aircraft destruction or a large number of fatalities.
- B-*Hazardous* – A significant reduction in safety margins, a reduction in the ability of the operators to cope with adverse operating conditions as a result of increase in workload, or as a result of conditions impairing their efficiency; Serious injury— Major equipment damag
- C-*Major* – A significant reduction in safety margins, a reduction in the ability of the operators to cope with adverse operating conditions as a result of increase in workload, or as a result of conditions impairing their efficiency; Serious incident— Injury to persons
- D - *Minor*- Nuisance; Operating limitations; Use of emergency procedures; Minor incident
- E – *Negligible* – a negligible event which had negligible effect on safety.

4.4. Determining frequency of event recurrence

Apart from the level of risk one should also forecast or have the data on the frequency of risk recurrence. Minor risk that occurs repeatedly can introduce constant noise into the system which can also be critical in work. Generally ICAO has given recommendation (according to ICAO doc 9859) that the frequency of recurrence is divided into five categories as follows:

- 5 - Frequent – a large number of recurrences. If the frequency is related to flying hours then this is more than one event per 1,000 hours of flying. Regarding time, the recommendation is for one event in three months for individual types of events;
- 4 - Occasional – occasional number of recurrences. If the frequency is related to hours of flying then this is more than one event per 100,000 hours of flying. Regarding time the recommendation is for one event within a year for individual types of events;
- 3 – Remote – small number of recurrences. If the frequency is related to hours of flying then it is more than one event per 10,000,000 hours of flying. Regarding time it is recommended for several events in the lifecycle of the aircraft or system for certain type of event;
- 2 - Improbable – improbable number of events that are repeated. If the frequency is related to hours of flying then it is more than one event per 1,000,000,000 hours of flying. Regarding time it is recommended for one event that will probably not occur during the lifecycle of a device or aircraft operation.
- 1 - Extremely improbable – an impossible event. If the frequency is related to hours of flying then it is at least one event per more than 1,000,000,000 hours of flying. Regarding time it is considered that the event cannot occur.

What should the recurrence frequency be in order to classify an event into a certain category has not been described directly. There are explanations in literature about what number this could be and how this should be determined at the level of flight control and operative aircraft flying. All the events can be classified according to exact data on the number of flying hours or number of flights within a certain period of time upon the occurred event.

For aircraft maintenance organizations the frames of recurrence and their qualification can be related to the production process that does not directly influence the flying safety, but rather only the production process. For instance, injury of an employee during work on an aircraft which is in the maintenance system, has no direct influence on the flying safety but it is an event which has to be prevented in the future. The method of occurrence and the recurrence frequency cannot be related to the direct aircraft operation, i.e. hours of flying, since a part of aircraft maintenance occurs outside operative flying. The consequences do not include hazard to flying safety but are important for the aircraft maintenance process.

Aircraft maintenance also has direct impact on the safety of operative flying if the defect that has been made contributes to or causes accident. Direct connection of the frequency of recurrence does not have to be directly connected to one type of aircraft or with the same company. The maintenance organization can have different operators who have their different types of aircraft maintained there with different maintenance systems. Apart from all this, it is necessary to recognize the cause that leads to a certain defect based on which the possible consequence to the safety is determined along with the assessment of defect recurrence.

In the previous section the sources of information have been mentioned that are used to find the cause of defect. The recurrence frequency is not unambiguous for every method of detecting defect since every assessment method has its own laws of time use.

If the working reliability is used as source for monitoring the system safety, then the frequency of recurrence of events is mathematically clearly defined. The system reliability is measured per thousand hours of flying or defects.

To find the cause by means of other methods of control and investigation it is necessary to simulate such or similar events with the found ones, and based on the known recurrences to identify the current ones. In some cases a method is used which allows calculation of the number of similar operations or operations in a row with the number of defects in order to find the event probability. If one position in the system is changed it is necessary to know what is the share of the possible defect in the process itself, i.e. to calculate mathematically the statistics of the probability that the defect will not be detected at control points that represent the barrier for its influence on the operative flying.

5. SAFETY ASSESSMENT

The Civil Aviation Agency of the Republic of Croatia according to the instructions determined[2] by ICAO Doc 9859, Safety Management Manual (SMM) of 2009 recommends the safety risk assessment matrix for individual cases, according to risk assessments in the frequency of event recurrence that were previously described. Using the risk matrix (Figure 2) the fields are determined which define the level of activity that has to be undertaken in order to remove the defect. The levels of activity are divided into three fields:

- Red field – defect has to be removed immediately since the level of hazard is unacceptable for further flying and further operation;
- Yellow field – the defect is significant and has to be removed but flying is possible and production can be continued but it has to be constantly monitored;
- Green field – the defect is acceptable and does not influence significantly the flying safety nor further production process.

Risk probability		Risk severity				
		Catastrophic A	Hazardous B	Major C	Minor D	Negligible E
Frequent	5	5A	5B	5C	5D	5E
Occasional	4	4A	4B	4C	4D	4E
Remote	3	3A	3B	3C	3D	3E
Improbable	2	2A	2B	2C	2D	2E
Extremely improbable	1	1A	1B	1C	1D	1E

Figure 2 - Safety risk assessment matrix (source: SMS manual ICAO doc 9859)

6. SAFETY ASSESSMENT MODEL BASED ON DATA FROM RELIABILITY MONITORING PROGRAM

As already mentioned earlier in Section 3, according to ICAO-doc 9859, there are three methods i.e. three approaches to safety system in organizations, and these include: reactive, proactive and predictive. Here an example is given for a proactive approach using data from the reliability monitoring program.

The reliability program monitors the following data:

- Number of pilot's complaints within a certain period or on certain work hours – this trend shows the efficiency of the technical system of aircraft maintenance. If the complaints reoccur corrective action has to be undertaken.
- Number of part replacements per systems – if defects per single systems increase, the system should be corrected.
- Number of aircraft delays due to technical reasons – based on the trend the cause can be seen and the operation system corrected;
- Number of tyre changes or brakes removal – this can give insight into the method of flying i.e. landing as well as insight into the maintenance efficiency.

An example of proactive method, a model has been proposed that defines the system of complexity and event recurrence. In the reliability system the behaviour of an event is statistically monitored, in relation to the given goal which is acceptable risk and event recurrence for the operator. The number of recurrences is determined in advance by the limit which is calculated as acceptable for the operator, and defined on the basis of the world average of occurrences.

The deviation from the level of the world average can be categorized as follows:

- Frequent – more than 3 months in a row occurs a trend of increasing defect more than 20% of the world average or more than 20% of the given company goals.
- Occasional – more than 2 months within a period of 3 months occurs a trend of increasing defect more than 20% of the world average or more than 20% of the given company goals.
- Remote – one event within a period of 3 months occurs a trend of increasing defect more than 20% of the world average or more than 20% of the given company goals.
- Unlikely – one event within a period of 12 months occurs a trend of increasing the defect more than 20% of the world average or more than 20% of the given company goals.

- Improbable – one event within a period of 24 months occurs the trend of ubcreasubg defect more than 20% of the world average or more than 20% of the given company goals.
- Extremely improbable – a single event within a period of 36 months occurs the trend of increasing defect more than 20% of the world average or more than 20% of the given company goals.

The risk is defined on the basis of the assessment of influence of a defect on the aircraft safety. These defects and be of the following type:

- C-*Major* – This means a defect in the system about which the crew has been informed as *master warning*. The defects that cause forced landing or repairs before the first flight.
- D-*Minor* – defects that warn the aircraft crew with *master caution* and that have to be repaired before the first flight.
- E-*Negligible* – event of defect with which the aircraft can fly operatively.

Continuous monitoring of the quantity of complaints per single system is an indicator of aircraft system reliability. The reliability is determined on the basis of world average of defects within a certain period that represents reference indicator of work of a single organization. If the organization is worse than the world average it should undertake corrective actions in order to improve the system. At the same time the organization can set its own goals that define the need for action and improvement in the system, which have to be always better than the world average.

Apart from the aircraft system, also individual aircraft components can be controlled. Figure 3 shows an example of monitoring the wear of the tyres according to flight hours and cycles.

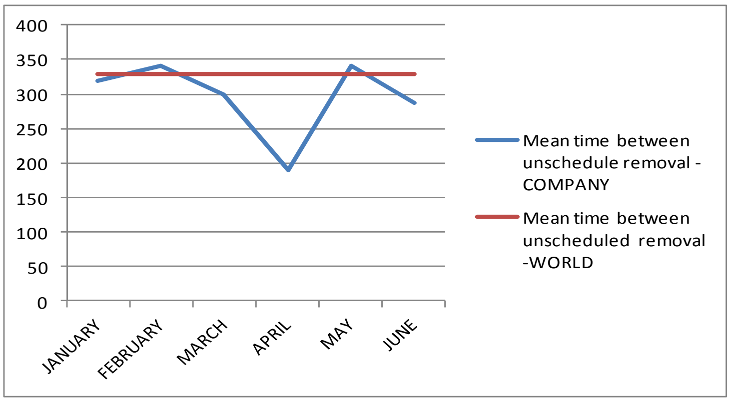

Figure 3 - Brake assy removal rate (source – author)

A sudden jump in increasing the tyre change i.e. reduction of the flight hours between two changes is the trigger that shows that the safety has been disrupted. Here also the world average between two changes is controlled, as well as the jump of sudden increase in the number of changes. In any irregularity an analysis of the event has to be made and corrective actions have to be determined.

After the analysis and interpretation of data about the worn-out tyre, the safety management is started and the risk and incident that can be caused by the worn-out tyre determined using the following logic: continuous hazard is the cause of undesirable event that is called risk, which can but needn't occur in all its variants. It usually occurs in one of the possible scenarios. In risk assessment one always takes the worst scenario in risk assessment.

An example for determining the possible risk due to the worn-out tyre on the aircraft is given in the BOW-TIE[3] presentation in Figure 4.

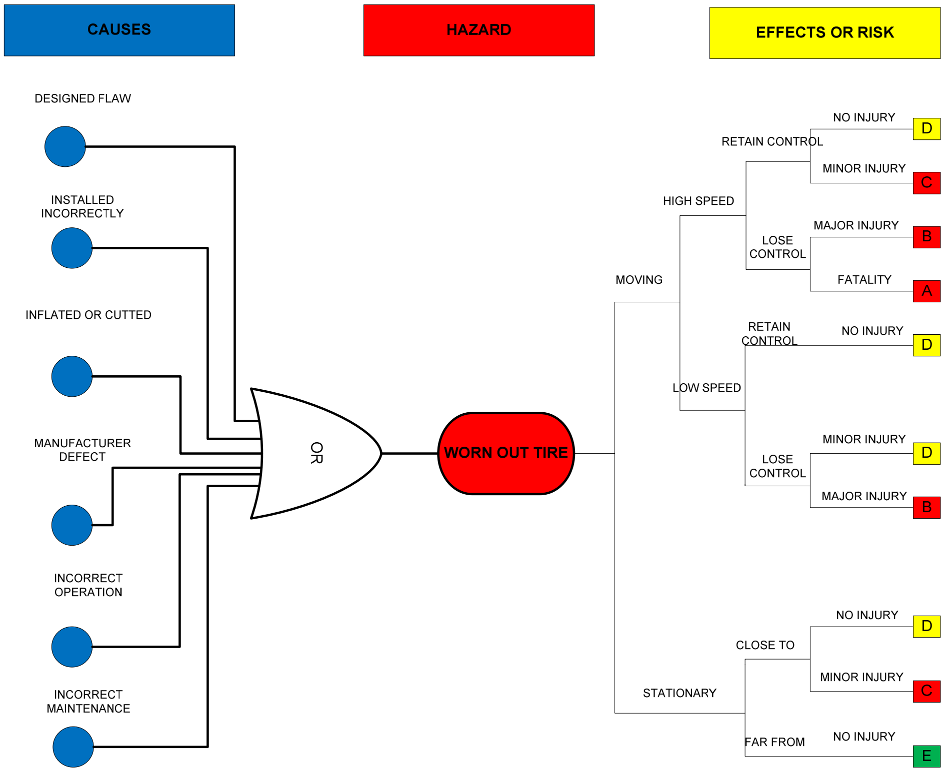

Figure 4 - Bow-tie diagram –risk assessment based on the worn-out tyre (source author)

The worn-out tyre is considered as an undesired event which can lead to puncture and as such have certain effects on the risk. The samples have been analyzed that lead to the worn out of tyre, and then, in compliance with the risk assessment matrix the effects on risk are determined.

7. CONCLUSION

By introducing the safety system into the organization for aircraft maintenance a quality shift is introduced into the production process. The centre of attention is the human who is the main factor in identifying defects within the process itself in which the human is part of the production process. The system assumes constant analyses and feedback about the work improvement effect, and at the same time also monitoring of the current processes.

Every organization has to adapt the improvement models and the system surveillance models to its operation and to determine the transparent indicators for every process measurement. The measurements and the points of warnings should not be within limits to endanger the safety; they are given in the principle frames as the average of the world level which does not mean that they may not be implemented in a stricter way by every organization.

The impact of individual deliberate changes in the system is always stressful for an organization and it is here that the organization has to set its own goal taking into consideration its specific characteristics for the work quality of involved people. It is important that within the organization the parameter measurements are clear and that the procedure of implemented actions is systematically solved and understandable to everyone.

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DEVELOPMENT OF GREEN LOGISTICS CENTRES

ABSTRACT

Logistics and distribution centres represent very significant infrastructure elements of the macro-logistic system. The creation of the logistics and distribution centres and their connection into a wide (global) network have resulted in the creation of conditions for an adequate distribution of labour and significant increase in the productivity of all the logistics elements and processes, noting that the logistics and distribution centres in this concept have a superregional significance.

This paper represents the idea how the term "green" has been developed and applied to the transportation industry and how to develop "green" logistics centers and other logistics facility's. Due to that it will be defined a checklist of initiatives that should be considered for any modern logistics center, looking at sustainable best practices for both efficiency savings.

A sustainable logistics center should be judged by how it fits into a finely tuned supply chain. While reducing environmental impacts caused by operations, improving inbound and outbound transportation of goods, and mitigating the effects of any harmful processes, bottom line benefits also accrue. But real leadership looks beyond the building to the big picture and to those operational questions that are critical to achieving large-scale, holistic sustainability.

***Key words**: logistics and distribution centers, green logistics, enviroment*

1. INTRODUCTION

Logistics are called one of the main accelerators of spreading globalization process around the world. Logistics are at the heart of modern transport systems. The term implies a degree organization and control over freight movements that only modern technology could have brought into being. It has become one of the most important developments in the transportation industry.

'Greenness' has become a code-word for a range of environmental concerns, and is usually considered positively. It is employed to suggest compatibility with the environment, and thus, like 'logistics' is something that is beneficial. When put together the two words suggest an environmentally-friendly and efficient transport and distribution system. The term has wide appeal, and is seen by many as eminently desirable. However, the concept and its applications in greater detail, a great many paradoxes and inconsistencies arise, which suggest that its application may be more difficult than what might have been expected on a first encounter.

In this article we consider how the term has been developed and applied to the transportation industry and how to develop “green” logistics centers and other logistics facility’s. In this article we will defined a checklist of initiatives that should be considered for any modern logistics center, looking at sustainable best practices for both efficiency savings.

2. THEORETICAL ASSUMPTIONS OF LOGISTIC CENTERS

Logistics and distribution centres represent a very significant infrastructural element of the macro-logistics system. As a transport node within a certain geographic area the centre represents an instrument of cargo concentration and cooperation of all elements of the logistics system. It is well known that the transport is characterized by: lack of homogeneity, spatial and time separation, which resulted in the need for concentration as the basic measure of rationalization. The basic objective of concentration is to achieve as much as possible: the uniformity, durability i.e. continuity of cargo flows and best possible usage of traffic infrastructure and transport means. Good usage of traffic infrastructure and transport means is of vital significance for rational realization of logistics functions, since good usage per time and capacity is the basic assumption to reduce the fixed costs that are, as well known, extremely high in transport.

The establishment of the logistics and distribution centres and their connection into a wide-spread (global) network have created the conditions for adequate division of labour and significant increase of productivity of all the logistics elements and processes, noting that the logistics and distribution centres in this concept have supra-regional significance. The network effect is reflected in the fact that between individual logistics and distribution centres, i.e. on single network sections the application of high capacity transport means with good usage is now possible, as well as higher traffic density i.e. more frequent delivery, simpler change of transport means of different transport modes (multimodality) i.e. optimal division of labour, reduction of empty rides and adequate directing of transport means in the catchment area of the centres, as well as realisation of positive effects even in the very logistics and distribution centres through realisation of an entire series of the accompanying functions (multifunctionality) reloading, storage, commissioning, packaging, additional processing, maintaining, etc., with achieving high flexibility. [1]

In the development concept evolution, the logistics and distribution centre is not treated only as a place at which the connection between the distance and local transport is realized in an adequate manner, but rather also as an element which should ensure a whole series of economic and other objectives: improvement of regional economic structure, disburdening of traffic routes, improvement of environmental conditions, etc.

Owing to high rationalization potential in the reduction of costs, improving of the marketing position of all the related economic subjects, improvement of the economic structure of the subjects from their environment, the logistics and distribution centres act very motivationally in the economic sense. Their planning and exploitation is a very complex task due to their complex structure and ambivalent system of objectives. The subjects that participate in the realisation of the objectives are heterogeneous: logistics service providers (logistics operators), employees, industrial and commercial companies, citizens and local government. Some subjects, as their primary objective, have different sub-objectives such as improvement of the economic structure, traffic mitigation, improvement of environmental conditions, etc. which clearly indicates the conflicting issues in the mentioned objectives.

Continuously increasing traffic requires the introduction of innovative as well as often interactive concepts. The logistics and distribution centres are centres that represent the basis for solving the problems in the logistics industry. They successfully connect the cargo flows of global, regional, national and local significance, different transport service providers, reduce transport and environmental impact, and have significant influence in overcoming the market resistance. The planning of logistics and distribution centres is a complex task since it is not an isolated segment of the system but rather a component of a very complex network, so that the design methods of logistics and distribution centres are also subject to continuous research and improvement. [1]

3. LOGISTICS GOING GREEN

Over the past 10-15 years, against a background of increasing public and government concern for the environment, companies have come under mounting pressure to reduce the environmental impact of their logistics operations. This impact is diverse, in terms of the range of externalities and the distances over which their adverse effects are experienced. The distribution of goods impairs local air quality, generates noise and vibration, causes accidents and makes a significant contribution to global warming. The impact of logistics on climate change has attracted increasing attention in recent years, partly because tightening controls on pollution and road safety improvements have alleviated the other environmental problems, but also because new scientific research has revealed that global warming presents a much greater and more immediate threat than previously thought. [3] Figure 1. presents the main principles of logistics going green. [2]

DISTRIBUTION	INCREASE CO_2 EFFICIENCY (10% by 2012, 30% by 2020)	MANUFACTURING	EXTRACTION OF RAW MATERIALS/ SOURCING	PRODUCT RECOVERY
• Combined transport • Alternative modes of transport (rail, waterway, ocean…) • Reverse logistics	• Develop, pilot and implement abatement levels • Integrate CO_2 into subcontractor management	• Reducing energy consumption • Use of clean technologies • Reducing production waste	• Sustainable purchase • Use of less polluting materials	• Recycling • Reusing used products

Figure 1 - Main principles of logistics going green

Source: Čepinskis, J., Masteika, Ig.: Impacts of Globalization on Green Logistics Centers in Lituania, Enviromental Research, Engineering and Management, 2011. No. 1(55), p. 34-42

It is estimated that freight transport accounts for roughly 8 per cent of energy related CO_2 emissions worldwide. The inclusion of warehousing and goods handling is likely to add around 2-3 per cent to this total. In the road sector, the amount of energy consumed by cars and buses, and, in the EU, may overtake it by the early 2020s. It is hardly surprising therefore that governments and inter-governmental organizations are developing carbon abatement policies for the freight transport sector. [2]

Making logistics sustainable in the longer term will involve more than cutting carbon emissions. Despite recent improvements, the potential still exists to cut the other environmental costs of logistics by a significant margin. Furthermore, sustainability does not only have an environmental dimension. Sustainable development was originally portrayed as the reconciliation of environmental, economic and social objectives.

4. DEVELOPMENT OF GREEN LOGISTICS CENTRES

Many supply chain leaders devoted to environmental sustainability practice what they preach by designing those values into their industrial facilities. The importance of sustainability in developing and operating distribution centers and plants has become a popular logistics topic. So has LEED, the Leadership in Energy and Environmental Design (LEED) certification program. LEED, created by the U.S. Green Building Council (USGBC), offers a checklist of various building improvements and operational standards that, when implemented, provides a blueprint for achieving a "green" facility. The program has helped elevate the importance of sustainability in the real estate development community. [9]

LEED reflects the development process, design technique and systems installation during construction, but does not take into account the operational purpose of the property, its long-term performance and its effects on the surrounding environment. In fact, according to a 2007 report on green building in the warehouse sector from Gazeley, a leader in Europe's sustainable building movement and a wholly-owned subsidiary of Wal-Mart Stores Inc., a mere eight percent of a building's impact on the environment occurs during construction. The majority, at 92 percent, occurs during a building's operational life. For the industrial developer pursuing LEED certification based on current criteria, the actions taken to satisfy a checklist have been limited in scope—like installing a bike rack to earn a point on that checklist. That actually provides little real impact for a warehouse facility, and may not even have the longterm benefits that other actions taken on a broader scale might have in achieving large-scale sustainability.

Therefore, to "lead" in adopting sustainable and green best practices in the industrial sector requires more than just pursuing "LEED" certification. While adopting its current criteria can be beneficial, LEED certification is only one part of large-scale supply chain sustainability and should not serve as a substitute. To its credit, the USGBC has been studying ways to make the LEED rating system more applicable to the industrial real estate sector. However, it costs money to register and pursue certification, and viable sustainable developments in the industrial sector are understandably reluctant to take on that additional cost when certification is not necessarily a true measure of their sustainability. [10]

Here is a checklist of initiatives that should be considered for any modern logistics center, looking at sustainable best practices for both efficiency savings:

- **Consider Existing Transportation Infrastructure** - By locating a facility near an existing transportation infrastructure, a strategically located industrial facility can achieve streamlined inbound/ outbound goods movement, reduce fuel costs, and simultaneously reduce related emissions from destination travel.

- **Route Outside of Urban Congestion** - By moving inbound/outbound logistics patterns outside of the congested urban core, operators can conserve fuel and reduce emissions from excessive idling of diesel-fueled trucks.

- **Site Outside of Residential Environments** - By strategically placing a development at a location with no adjacent residential development, but one that has existing transportation infrastructure for regional employees and efficient inbound/ outbound goods movement, operators can reduce impacts on regional quality of life.

• **Design for Energy Efficiency** -The use of modern, high efficiency Energy Star-rated systems will reduce energy consumption at a significant level. But industrial buildings have the additional advantage of using extensive skylights to provide natural light, and large footprint roofs perfect for adding solar panels as a carbon neutral energy source.

• **Conserve Water** - By investing in drought tolerant landscape and recycling waste water and runoff onsite for use in irrigation, industrial facilities can significantly reduce water consumption.

• **Re-Visit Facility Design** - Black Roof/White Roof technologies can help conserve energy by heating/cooling (respectively) a facility more effectively, thereby reducing dependence on energy intensive HVAC systems.

• **Re-Design Truck Courts** - By ensuring ample room dedicated to the truck courts at a modern warehouse or industrial facility, improved circulation and ample trailer storage space will reduce emissions from excessive idling and trailer repositioning.

• **Re-Examine Materials Procurement** - By securing construction materials produced within a 500 mile radius of the project site, a development can significantly reduce the carbon emissions created by transporting materials to the facility site.

5. EXAMPLE OF GREEN LOGISTICS CENTER IN JIASHAN, CHINA

July 11, 2011, China – Tesco China today opened its first freehold ‘green’ logistics center in Jiashan, Zhejiang province. Featuring a comprehensive range of leading edge environmentally friendly technologies, the Jiashan Logistics Center elevates the retail industry’s environmental standards, and further strengthens Tesco China’s distribution network in the market. [7]

Featuring an integrated energy-efficient design, the 55,000 sq m facility with a site area of 240,000 sq m incorporates an extensive range of ‘green’ technologies that utilizes renewable energy while reducing energy and water usage. They include ground source heat pumps for central heating, solar PV panels, solar PV street lamps, solar water heating, improved roof insulation, PIR wall insulation, T5 lighting for higher efficiency, high efficiency heat exchangers, photo sensors to control lighting, a grey water recycling system and aerodynamic devices for green vehicles, among others.

The center is expected to use 45 % less energy, 40 % less water and emit 35 % less carbon than traditional logistics warehouses in China. With energy use representing around 80 per cent of Tesco China’s total carbon footprint, this will be an important contribution towards fulfilling Tesco’s global commitment to become a zero-carbon company by 2050. The center will also further optimize Tesco’s distribution network by reinforcing Tesco’s centralized distribution system. It will distribute grocery and non-food products to 53 hypermarkets and 12 Express stores in East China and also deliver Tesco-brand products to four other regional distribution centres, making them available at all Tesco stores in China. Centralized distribution is more efficient than having individual suppliers make deliveries to various stores as it can ensure better control of product quality, while significantly reducing the number of deliveries and the resulting carbon emissions produced by transportation. [7]

In China, Tesco has acted on its global commitment to the environment and society by reducing its own direct carbon footprint through opening energy-saving stores and green logistics centers. It also works with suppliers and partners to lower emissions through environmentally-friendly operations such as centralised distribution, primary distribution and reduced packaging. Customers are given more ‘green’ choices and encouraged to lead a low-carbon lifestyle. [7]

6. CONCLUSION

True sustainability for logistics centers and industrial operations is significantly more than the current checklist offered by the USGBC. It begins at the macro level, master planning a location that could have major positive impacts on emissions reduction through improved inbound and outbound movements while avoiding impacts on adjacent or nearby residential communities. From there it advances to the micro level of design, energy efficiency, water conservation, and systems improvements at the individual facility. By focusing on a facility's sustainability impacts throughout the supply chain, higher levels of sustainable and environmentally- conscious operations can be achieved than what is called for by the current checklist.

A sustainable logistics center should be judged by how it fits into a finely tuned supply chain. While reducing environmental impacts caused by operations, improving inbound and outbound transportation of goods, and mitigating the effects of any harmful processes, bottom line benefits also accrue. But real leadership looks beyond the building to the big picture and to those operational questions that are critical to achieving large-scale, holistic sustainability.

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ANALYSIS OF RETROREFLECTIVITY OF PAINT AND PLASTIC ROAD MARKINGS ON CROATIAN STATE ROAD D1

ABSTRACT

With the urbanization process constantly accelerating, road traffic safety becomes one of the biggest problems facing the society. Road traffic safety depends on the efforts of the entire society, through increased investment in road safety and traffic development of culture of all road users. Driving in the night and wet conditions reduces drivers' visual perception which as a result has decreased road traffic safety. The most common ways of performing road markings are by using paint or plastic materials. This paper will analyze how two types of road markings on one section of the road can influence traffic safety. Research has been done in the period of 2 years with dynamic retroreflectometer on Croatian state road D1 on section Junction Zaprešić (A2) and shopping mall ''West Gate''.

1. INTRODUCTION

Road traffic safety aims to reduce the harms (deaths, injuries, and property damage) resulting from crashes of road vehicles traveling on public roads. Main goal of road traffic safety is protection and security of all those who travel on roads. Major factors that contribute to the road traffic safety can be grouped in three categories[1]:

- roads
- vehicles
- drivers' behavior.

In this paper focus will be on the road markings as one of key elements of roads. Road markings can be defined as a set of longitudinal and transversal lines, signs and symbols which combined form the surface transportation infrastructure. They represent part of the overall traffic signals and cannot be replaced by other signs or regulations. Road markings have the same legal value as the traffic signs and traffic light signals and can be set independently or in combination with them.

The main tasks of the road markings are:

- warning drivers about the situation in the area in front of vehicles that require special attention and caution for the continuation of safe driving
- guiding the drivers to their targets by identifying safe travel path
- inform drivers about the legal restrictions
- help in regulating traffic in an optimal way.

In night and in wet conditions, road markings play important role in road traffic safety and because of that different types on road marking have been developed to insure safety.

2. TYPES OF MATERIALS FOR ROAD MARKINGS

There are several types of basic materials for making road markings which differ according to the method of application, longevity, cost, and structural features. Existing road markings are made as follows:

- paint markings
- markings made of plastic materials
- tape markings

Selecting the right material for road markings depends on the situation of the road where the material is applied, which is the result of:

- the frequency of bad weather
- flow of vehicles
- diverting vehicles from other roads
- the frequency of application of asphalt layer
- duration of winter conditions.

2.1. Paint markings

Paint markings are thin film materials in a liquid state for making marks on the pavement. They consist of pigments, binders, fillers, and solvents. Can be a single component and immediately ready for installation or binary. Depending on the composition they are applied with hot or cold process. The thickness of layer is usually between 0.2 mm and 0.5 mm. Retroreflectivity of paint markings is achieved by installing retroreflective elements – glass beads. Glass beads can be incorporated in the color or add later during installation. Although widespread (especially in Croatia) represents the worst material for road markings and are mostly suitable for roads with low traffic intensity. Their main advantage over other materials for making markings on the pavement is a small price.

2.2. Markings made of plastic materials

Plastic materials are multicomponent and consist generally of synthetic binders, natural and synthetic resins, pigments, fillers, and glass beads. They belong to a group of thick road markings with thickness of layer between 1 and 3 mm. Road markings made of plastic materials can be placed on cold pavement or at elevated temperatures, and in this regard can be divided into two basic groups:

- cold plastic
- thermoplastic.

a) Cold plastic

Cold plastic is the material of the liquid state to which are added various additives and thickening mass. After initial densification, they are applied to the roadway where after twenty minutes they harden and can be driven over. Depending on the manufacturer can be embedded with glass beads or they can be added at the end of installation process. Their lifespan is relatively long, between 2 and 4 years. Cold plastic markings can be derived in various forms and regarding their form can be unprofiled and profiled.

b) Thermoplastic

Thermoplastic materials for road markings must be prior to the application heated to a 180 °C temperature. Ten minutes after the application mass hardens and over the marking can be normally driven. One of the advantages of thermoplastic materials is that the application is less sensitive to external temperature and pavement temperature in relation to the paint markings, which provides a longer period of time in a year when it can be applied. Road markings are made from this material are characterized by a very good visibility in all weather conditions, as well in the night and other conditions of reduced visibility during the whole year. Their lifespan is between 2 and 5 years.

3. ANALYSIS OF RETROREFLECTIVITY OF PAINT AND PLASTIC ROAD MARKINGS ON SECTION OF CROATIAN STATE ROAD D1

Dynamic method for testing retroreflection of road markings involves the measurement of night visibility with dynamic measuring device throughout its length. Measurements analyzed in this paper were performed with Zehntner ZDR 6020 dynamic retroreflectometer which measures night visibility R_L in the day and night conditions.

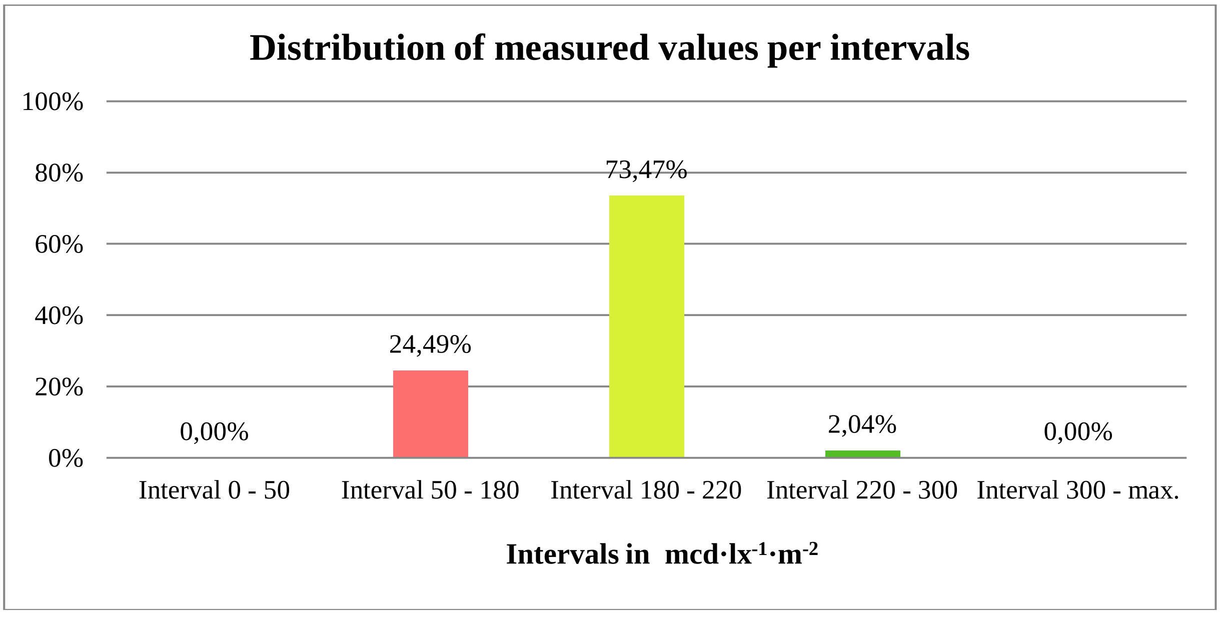
Zehntner ZDR 6020 measures retroreflection in accordance with EN 1436 which defines measuring methods and conditions. In the standard measuring condition, the directions of measurement and illumination define a plane perpendicular to the plane of the field, the observation angle is 2.29° and the illumination angle is 1.24°[2]. Observation distance is 30 m for short lights. Measuring was taken on state road D1 on section Junction Zaprešić (A2) and shopping mall ''West Gate''. All measurements were taken on middle line of listed state road.

3.1. Analysis of paint road markings

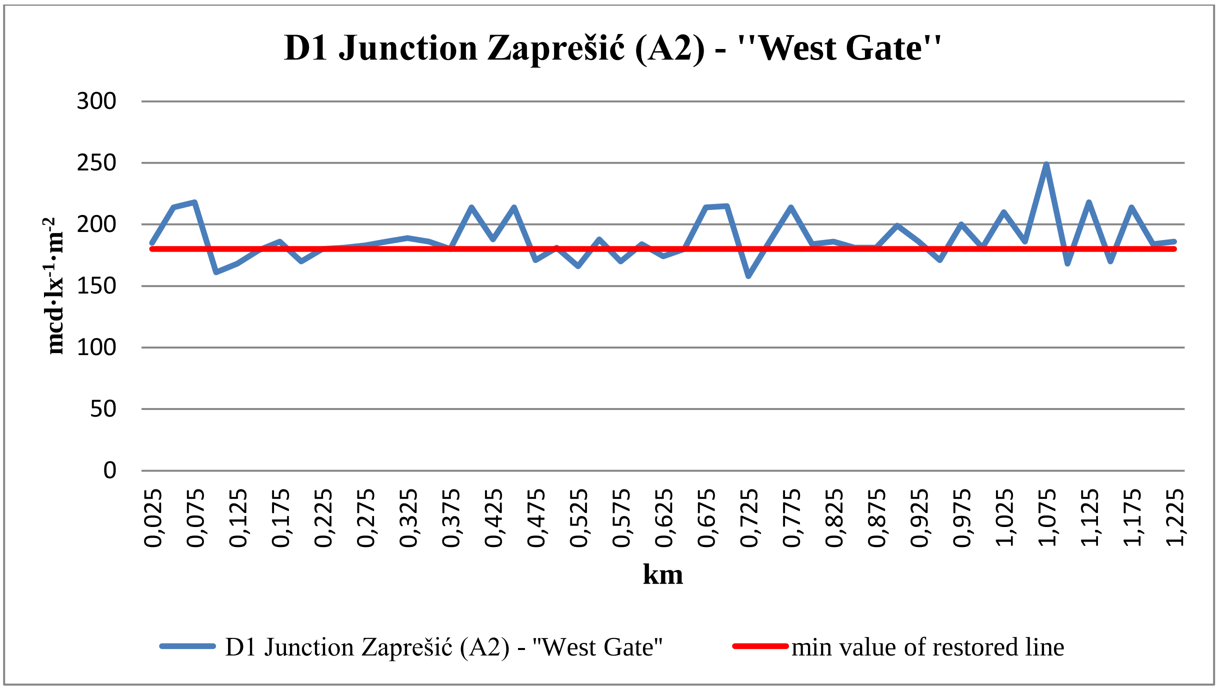
The paint road markings on a section of state road D1 – Junction Zaprešic (A2) – ''West Gate'' were applied in June 2010. Paint that was use is Hempel KSS KW 567 based on chlorinated rubber and synthetic alkyd specially designed for use directly on asphalt or concrete. When applying road markings approximately 0.70 dg/m² of paint and 0.30 dg/m² of glass beads (280-800 T14) were used.

First measurement was taken in October 2010. Graph 1. presents distribution of measured values per intervals and it shows that 73.47% of measured values are between 180 – 200 $mcd{\cdot}lx^{-1}{\cdot}m^{-2}$. Minimal value for restored lines for Croatian state roads is 180 $mcd{\cdot}lx^{-1}{\cdot}m^{-2}$. 24.49% of measured values are below minimal which can be justified with entrance/exits from road and roundabouts. Graph 2. shows values of retroreflectivity per kilometer and minimal value of retroreflectivity for Croatian state roads. Graph 3. shows arithmetic mean of measured values per intervals. Arithmetic mean of measured values below minimal value is 169 $mcd{\cdot}lx^{-1}{\cdot}m^{-2}$ which is near the minimal value. Overall arithmetic values of all measured values is 188.51 $mcd{\cdot}lx^{-1}{\cdot}m^{-2}$.

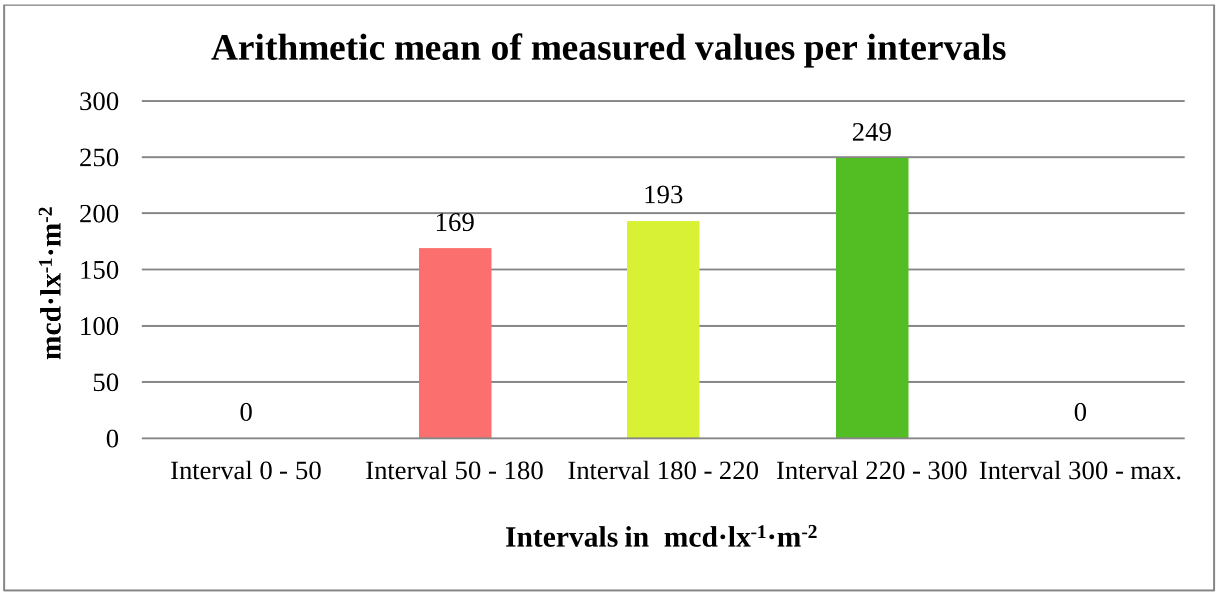
Graph 1 - Distribution of measured values per intervals for restored line



Graph 2 - Values of retroreflectivity for restored line

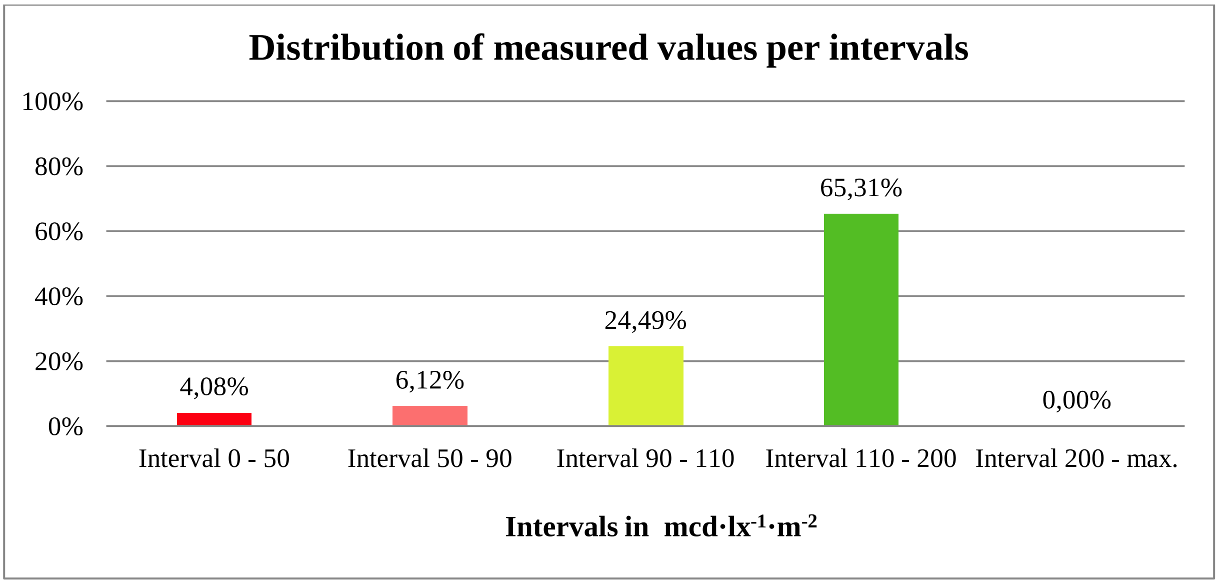


Graph 3 - Arithmetic mean of measured values per intervals for restored line

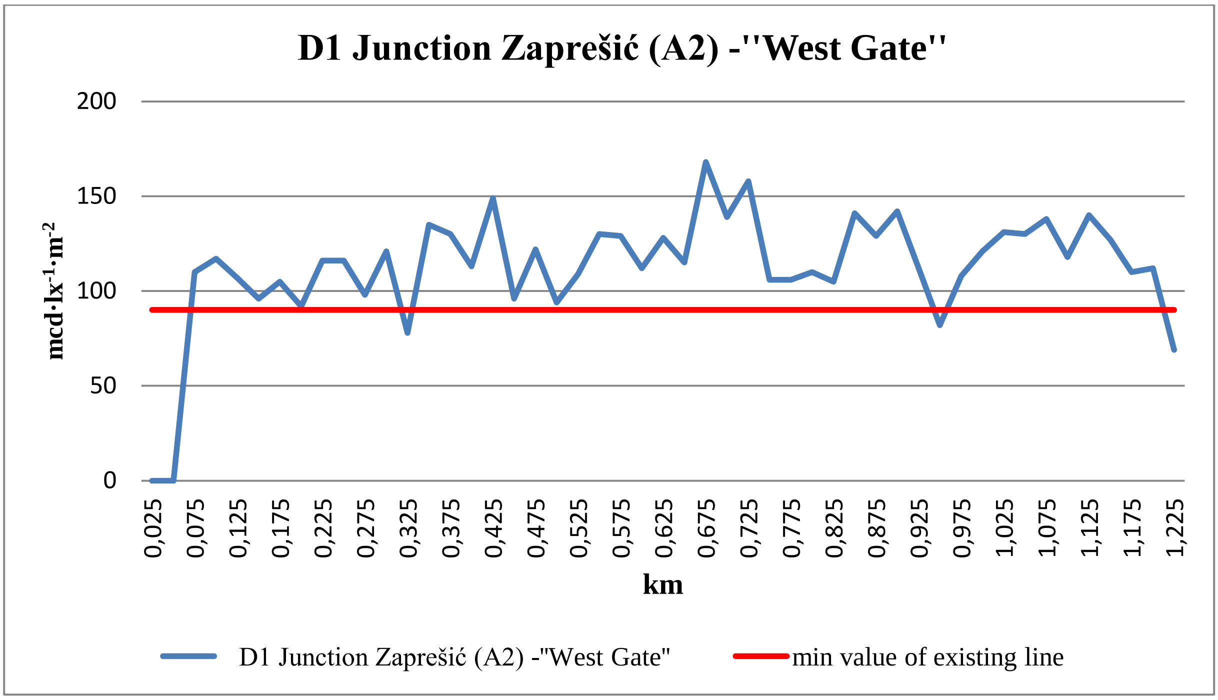


Second measuring was taken in April 2011. Measurement shows that 89.8% of measured values are over the minimal value (90 $mcd \cdot lx^{-1} \cdot m^{-2}$) for existing lines on Croatian state roads. 10.2% of measured values are below the minimal value. Graph 5. shows values of retroreflectivity per kilometer and minimal value of retroreflectivity for Croatian state roads. Graph 6. shows arithmetic mean of measured values per intervals. Overall arithmetic values of all measured values is 112.65 $mcd \cdot lx^{-1} \cdot m^{-2}$.

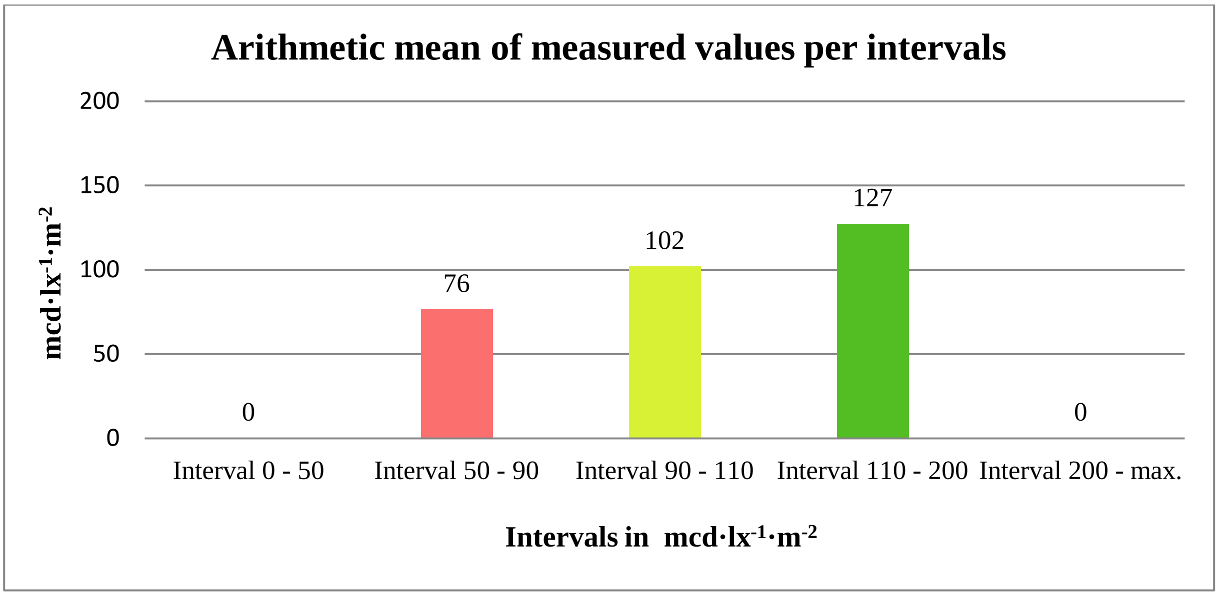
Graph 4 - Distribution of measured values per intervals for existing line



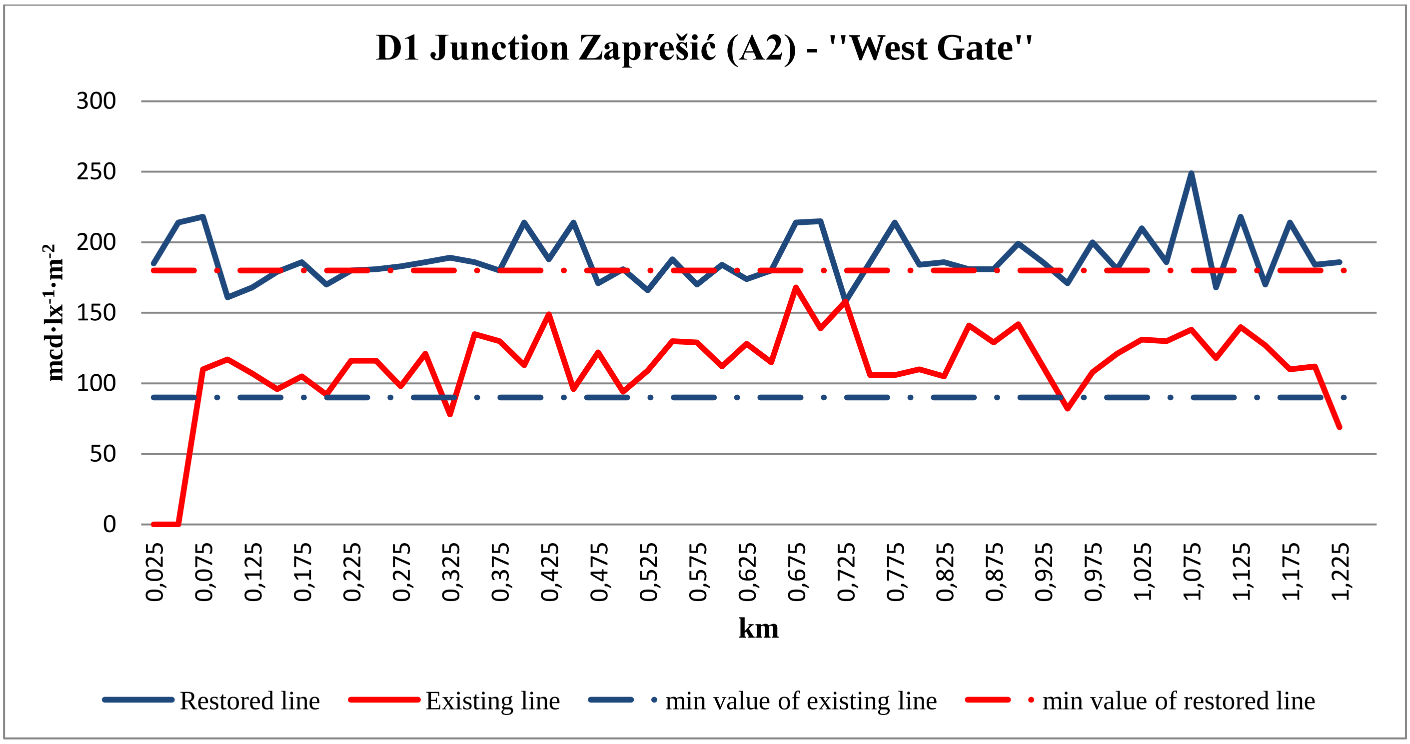
Graph 5 - Values of retroreflectivity for existing line



Graph 6 - Arithmetic mean of measured values per intervals for existing line



Graph 7 - Comparison of measured values of restored and existing line



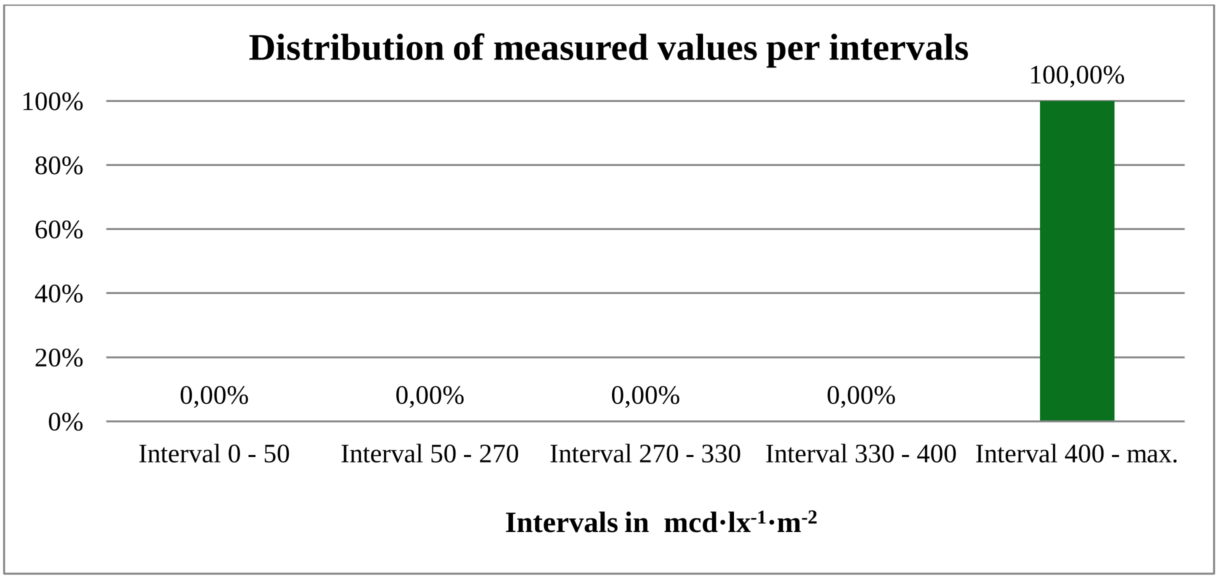
Graph 7. Shows comparison of measured values of restored and existing line. Dividing the mean of the two measurements it was concluded that the values of existing lanes fell by 40.25% in comparison to restored line. This result shows significant decrease of values in period of eight months.

3.2. Analysis of plastic road markings

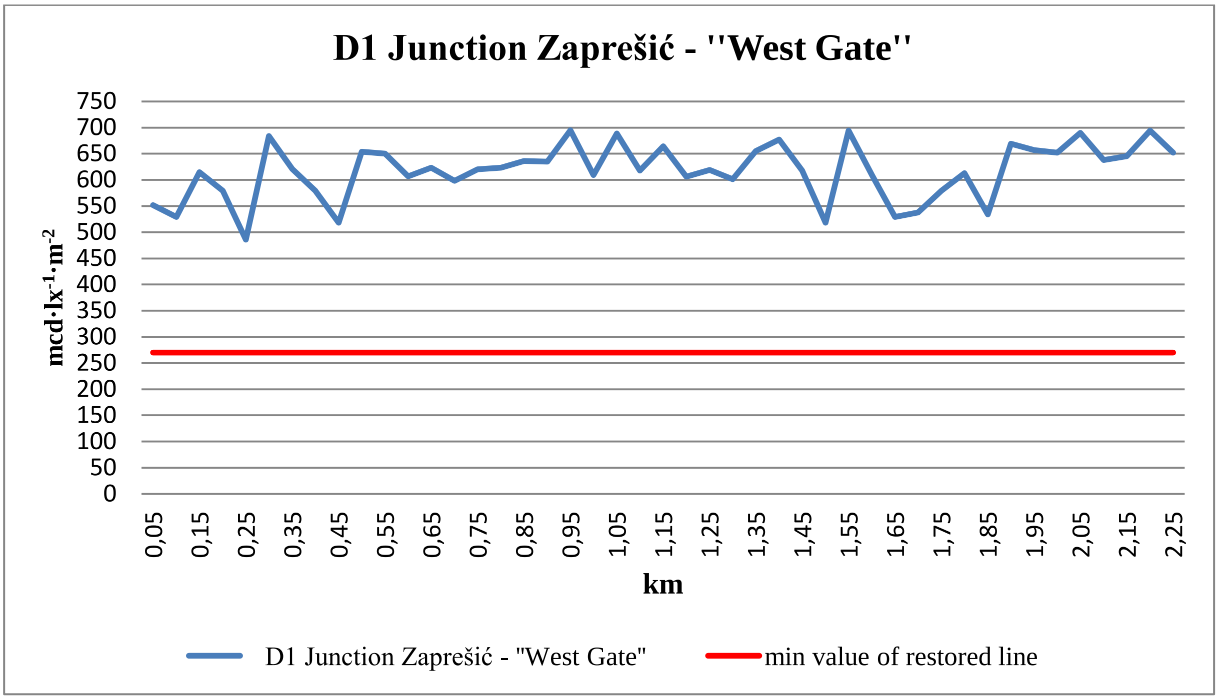
In early June 2011. on the part of state road D1 – Junction Zaprešic (A2) – ‘’West Gate’’ road marking were applied in agglomerate cold plastic TIP II. When applying road marking, 4 kg/m² of agglomerate cold plastic and 0.45 dg/m2 of glass beads (SOLIDPLUS 30 100-800 T18) were used.

First measurement was taken in July 2011. Measured values show excellent results, 100% of values are over the minimal value (270 $mcd \cdot lx^{-1} \cdot m^{-2}$) for restored TIP II lines for Croatian state roads and in interval 400 - max with overall arithmetic mean reaching 617 $mcd \cdot lx^{-1} \cdot m^{-2}$ which is 40.29% higher than minimal value.

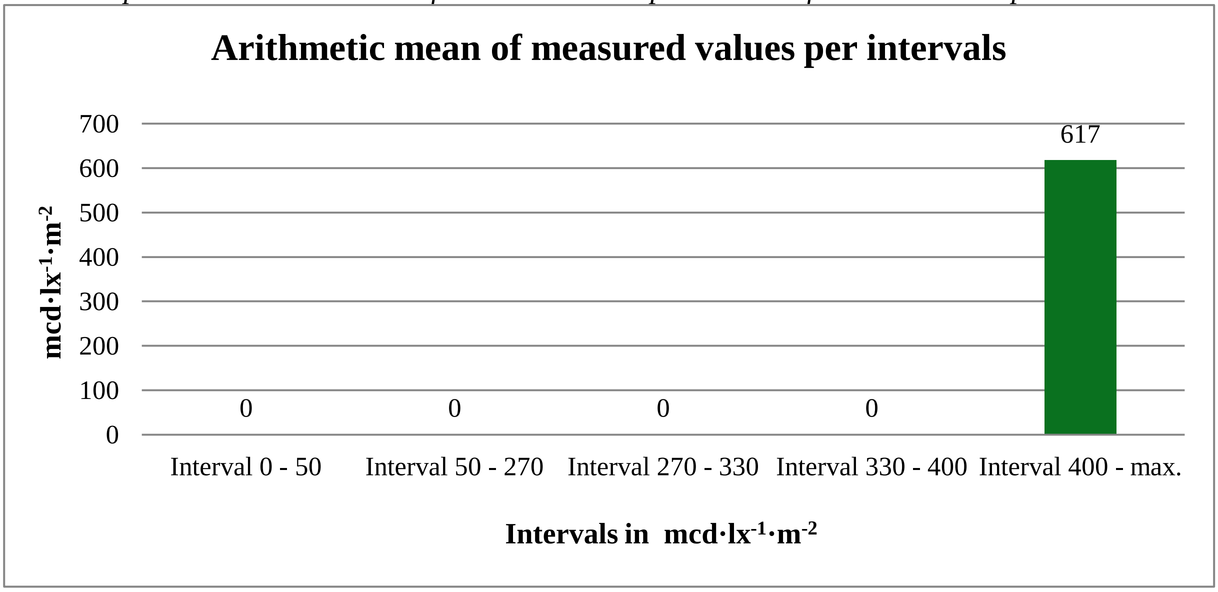
Graph 8 - Distribution of measured values per intervals for restored cold plastic line



Graph 9 - Values of retroreflectivity for restored cold plastic line

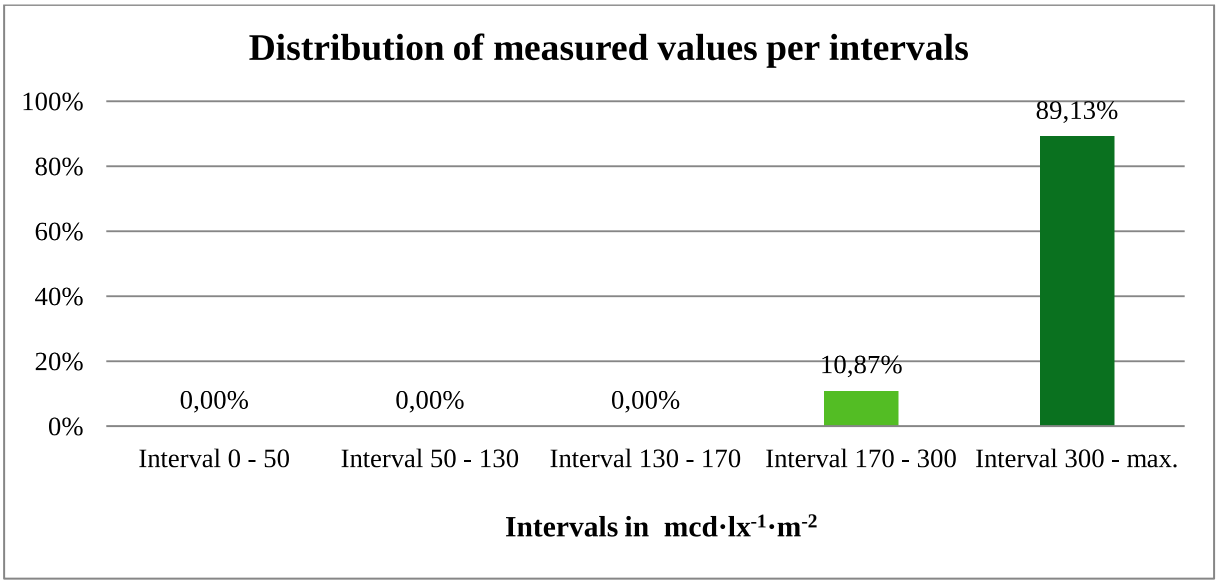


Graph 10 - Arithmetic mean of measured values per intervals for restored cold plastic line

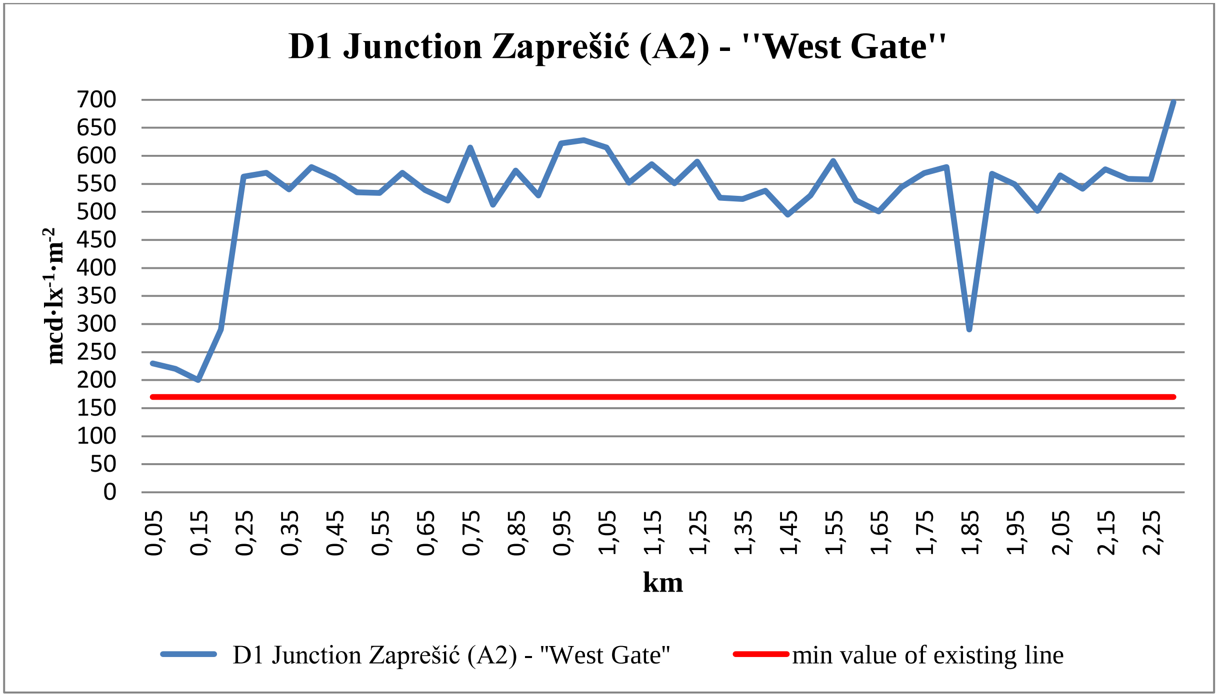


Second measuring was taken in November 2011. Measurement shows that all of measured values are over the minimal value (170 mcd·lx^{-1}·m^{-2}) for existing lines on Croatian state roads. Overall arithmetic values of all measured values is 524.93 mcd·lx^{-1}·m^{-2}.

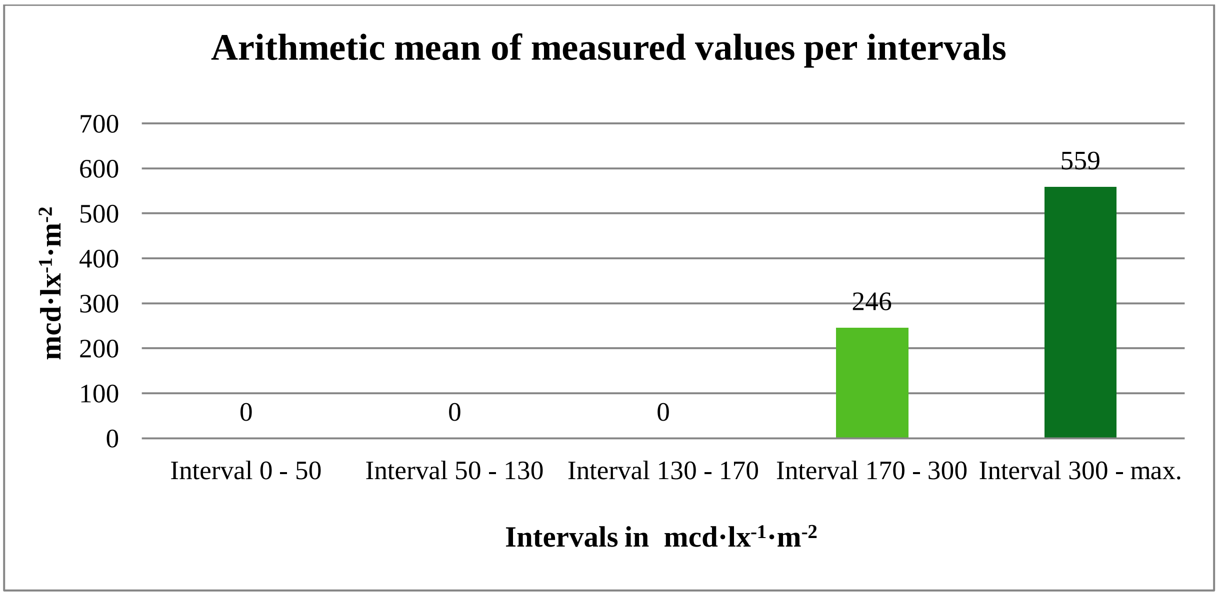
Graph 11 - Distribution of measured values per intervals for existing cold plastic line



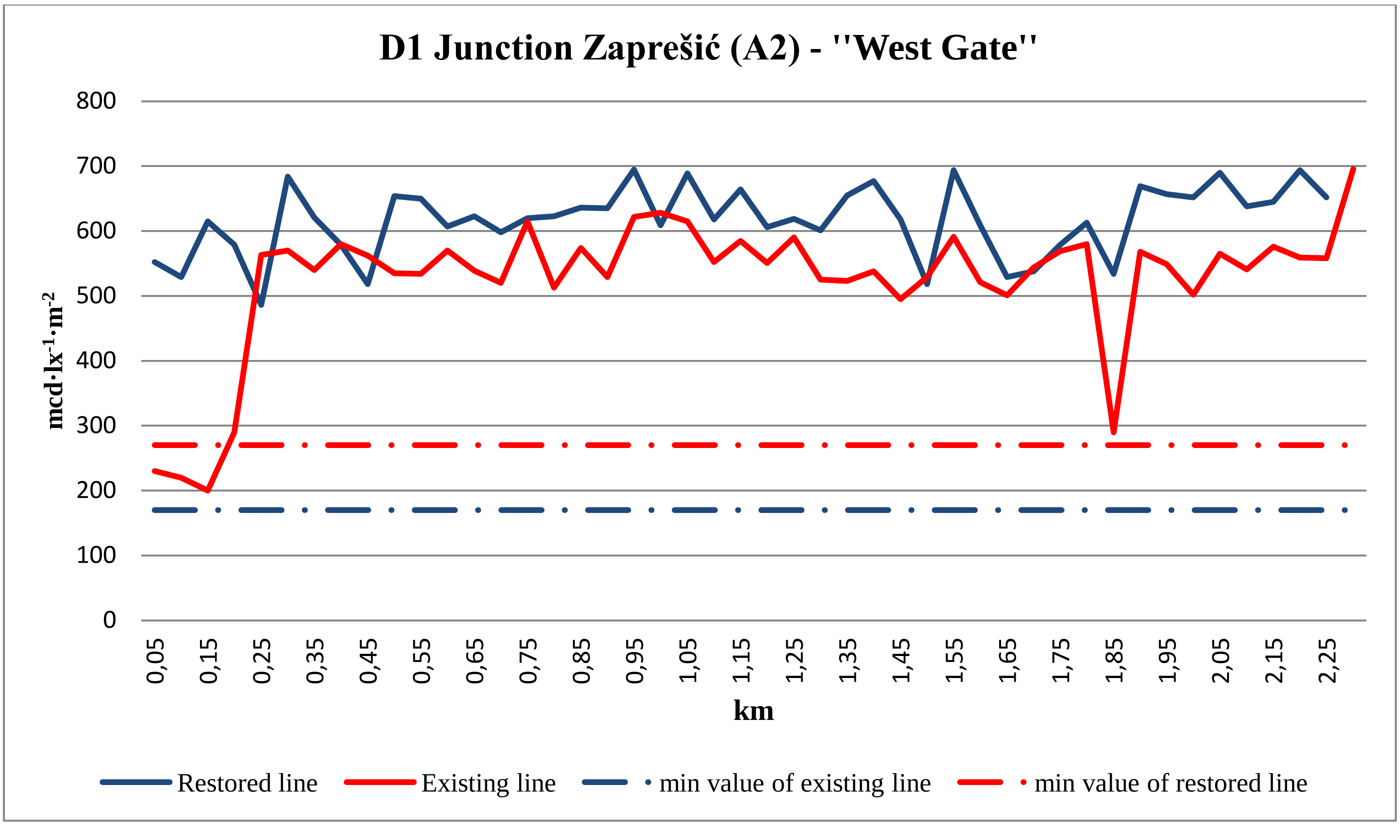
Graph 12 - Values of retroreflectivity for existing cold plastic line



Graph 13 - Arithmetic mean of measured values per intervals for existing cold plastic line



Graph 14 - Comparison of measured values of restored and existing cold plastic line



With the same principal as earlier with paint road markings, comparison of restored and existing cold plastic lines show that values of existing line had decreased for 14.93% in four months.

4. CONCUSION

Measurements taken in period of one year with different road marking materials show that decrease of plastic materials in four months was 14.93% and decrease of paint road markings in eight months was 40.25%. These numbers show that decrease of plastic materials is slower than decrease of paint road markings. Difference between those two decrease percentages is 25.32%. Although period between two measurements for paint road markings were four months longer than plastic road markings, values of retroreflectivity and lifespan for plastic road markings are significantly higher. Also, traffic on measured section after implementation of plastic road markings was higher than before due to opening of shopping mall ‘’West Gate’’ which has great influence on lifespan of road markings because of wear and tear during traffic.

Aldo, plastic road markings are at start more expensive and require complicated applying process, they provide greater retroreflectivity values in day, night and wet conditions and because of that significantly improve road safety.

ENDNOTES

[1] Dawson, J.: Part 1 - The EuroRAP Programme - an overview
[2] EN 1436

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AERODROME AREAS ANALYSIS IN FUNCTION OF AIRCRAFT OPERATION SAFETY

ABSTRACT

Aerodrome surfaces are defined in Annex 14 to the Convention on International Civil Aviation. The implementation of turbojets and intensive development of air traffic in the second half of the 20th century had resulted in increasing the number of accidents. It turned out that a large number of accidents occurs outside the prescribed area by the International Civil Aviation Organization. The developed countries of the world in airport regulations provide additional surfaces to mitigate the consequences of potential aircraft accidents. The paper will study some of the publicly available rules and give analysis and comparison of publicly available airport regulations.

Key words: *aerodromes, aerodrome areas, aircraft operation safety*

1. INTRODUCTION

Aerodrome is defined by International Civil Aviation Organization (ICAO) as: “a defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.”

Runway is defined as: “a rectangular area on a land aerodrome prepared for the landing and take-off of airplane.”

Beside the runway there are several adjacent areas, according to ICAO, associated with runway which are directly related to airplane operation safety:

- runway shoulders,
- runway strip,
- runway end safety area.

The developed countries introduced certain areas under a common name Public Safety Zone in front and beyond the runway strip on extended runway centreline. The reason was the increase in aircraft accidents before the threshold and after takeoff.

2. RUNWAY

ICAO has prescribed aerodrome reference code according to airplane reference field length, wing span and outer main gear wheel span (Table 1) as well as runway width as recommendations (Table 2). The most significant factors affecting runway width are cross-wind condition and runway surface contamination (water, snow, slush, icing...) [1].

The developed countries of the world have incorporated ICAO recommendations in their airport regulations, depending on their own weather conditions of the specific location.

After the introduction of aircraft A380 and the highest reference code for a runway, some of the aerodromes in the developed countries do not comply with the recommended runway width of 60 meters.

Table 1 - Aerodrome reference code

Code element 1		Code element 2		
Code number (1)	Aeroplane reference field length (2)	Code letter (3)	Wing span (4)	Outer main gear wheel span[a] (5)
1	Less than 800 m	A	Up to but not including 15 m	Up to but not including 4.5 m
2	800 m up to but not including 1 200 m	B	15 m up to but not including 24 m	4.5 m up to but not including 6 m
3	1 200 m up to but not including 1 800 m	C	24 m up to but not including 36 m	6 m up to but not including 9 m
4	1 800 m and over	D	36 m up to but not including 52 m	9 m up to but not including 14 m
		E	52 m up to but not including 65 m	9 m up to but not including 14 m
		F	65 m up to but not including 80 m	14 m up to but not including 16 m

a. Distance between the outside edges of the main gear wheels.

Aviation authorities of those countries have accepted that the increased widths of the outer main gear wheel span of 14.3 metres (Table 1 - Aerodrome reference code) and local weather conditions do not require wider runways. Approximately half of the runways used today by A380 still have a width of 45 metres.

Table 2 - Recommended width of runways

Code number	Code letter					
	A	B	C	D	E	F
1	18m	18m	23m	–	–	–
2	23m	23m	30m	–	–	–
3	30m	30m	30m	45m	–	–
4	–	–	45m	45m	45m	60m

Runway length is determined in accordance with the characteristics of aircraft for which an aerodrome is intended and corrected according to aerodrome altitude, temperature and longitudinal slope.

3. AREAS ASSOCIATED WITH RUNWAY

The areas associated with runway which are directly related to the landing and take-off safety of an airplane are runway shoulders, runway strip and runway end safety area.

3.1. Aerodrome Shoulders

ICAO Annex 14 defines a runway shoulder as: “An area adjacent to the edge of a pavement so prepared as to provide a transition between the pavement and the adjacent surface.” Runway shoulders should be provided for runways with code letter D or E and the runway width is less than 60m, as well as for runways with code letter F. Runway shoulders should extend symmetrically on each side of the runway so that overall width of the runway and its shoulders is not less than 60m where the code letter is D or E, and 75m where the code letter is F. A runway shoulder should be prepared or constructed so as to be capable of supporting an airplane without inducing structural damage to the airplane and supporting ground vehicles which may operate on the shoulder.

In 2010 Aerodrome Regulation were published, where among other elements of aerodrome it deals with runway shoulders. Aerodrome regulation of the Republic of Croatia [2] is more rigorous than ICAO Annex 14 because all of the ICAO recommendations have been converted into the standard.

Licensing of Aerodromes Manual [3], published by the United Kingdom Civil Aviation Authority, highlights the problem of jet blast erosion of the surface adjacent to the runway which can cause dust and possible ingestion of the debris by engines. In order to avoid such problems Licensing of Aerodromes prescribes runway shoulders for runway where the code letter is D or E, so that overall width of runway and its shoulders is not less than 60m, and for a runway where the code letter is F, so that the overall width of the runway and its shoulders is not less than 75 m. Shoulders for runways where code letter is E or F should be paved.

There are circumstances where a smaller paved width may be acceptable for runways where code letter is F (in case an aerodrome is nominated as alternate or frequency of operations is very low). In case where smaller paved width is allowed, the minimum paved width shall be 60m and the outer unpaved area of 7.5m should be stabilized, a program of inspections of the shoulders and runway should be implemented, if the number of code letter F airplane increases the need for full paved shoulders should be assessed, and the strength of shoulders (paved or unpaved) should comply with prescribed requirements.

The airport design Advisory Circular [4], published by the United States of America Federal Aviation Administration, differs from other regulations because it prescribes shoulders as a standard for all runway categories. Runway shoulder width varies from 3m to 12m depending on the runway category.

The Manual of standards – Aerodromes [5], published by the Australian Government Civil Aviation Authority, prescribes runway shoulders as a standard for runways with code letters D, E and F. For runway with code letter D or E the overall width of runway and its shoulders must not be less than 60m, and for runway with code F the overall width of runway and its shoulders must not be less than 75m. The characteristics of runway shoulders are almost the same as in other regulations. The Manual prescribes that further width of 7m outside each shoulder must be prepared to resist engine blast erosion for an airplane with engines which may overhang the shoulders. This Manual also gives special attention to runways with code letter E used for A380 operations prescribing that the runway shoulders must be provided and must consist of inner shoulder (7.5m in width to eider side of runway, that are able to support unintended aircraft runoff) and outer shoulder (7.5 metres in width on either side of the runway, that are resistant to engine blast erosion and are able to support vehicles which may operate on the shoulder).

3.2. Runway Strip

Runway strip is a defined area including the runway (and stopway if provided) intended to reduce the risk of damage to aircraft running off a runway and to protect aircraft flying over it during take-off or landing operations [1]. ICAO prescribes that runway strip extends before the threshold and beyond the end of the runway (or stopway if provided) at least 60m for code numbers 2, 3, 4 and 1 instrument runway; and 30m for code 1 non-instrument runway. The prescribed width of runway strip, wherever practicable, extending laterally on each side of the centreline of the runway is at least 150m where the code number is 3 or 4, and 75m where the code number is 1 or 2. A runway strip must be cleared, free of fixed objects, other than visual or non-visual aids used for the guidance of aircraft or vehicles. Objects must be on fragile supports.

In Croatia several airports do not comply with ICAO and Croatian regulations. In the world it is not so often that the runway widths do not comply with ICAO regulations.

3.3. Runway End Safety Area

Runway end safety area (RESA) is an area symmetrical about the extended runway centreline and adjacent to the end of the strip primarily intended to reduce the risk of damage to an airplane undershooting or overrunning the runway [1]. ICAO prescribes that runway end safety area extends at least 90m from the end of the runway strip and that the width of it is at least twice that of associated runway and recommends 240m for runway code numbers 3 or 4. Runway end safety area is constructed to reduce the risk of structural damage to an airplane, to enhance airplane deceleration and facilitate the movement of rescue vehicles.

In Croatia no airports have RESA. In the world only certain airports have no RESA.

4. PUBLIC SAFETY ZONES

Expansions of air traffic in the 70s lead to an increase in air traffic accidents and incidents during take-off and landing. Based on the collected data a statistical distribution of accidents at the airport and its surroundings (Figure 1) was created.

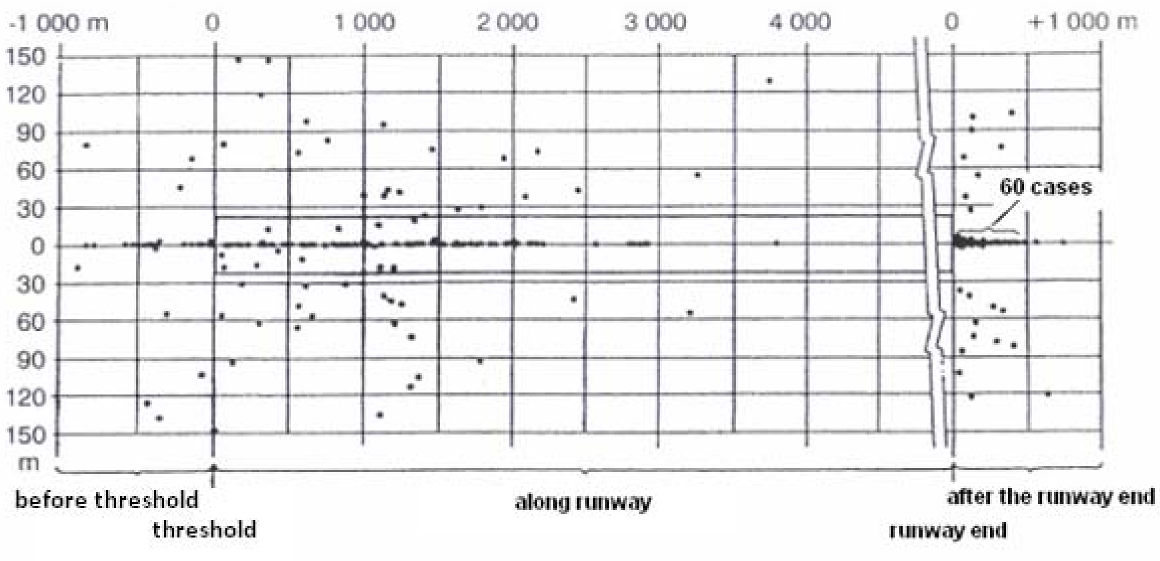

Figure 1 - Positions of accidents that occurred during landing and take-off of airplanes with maximum allowed take-off weight above 5,700kg

Continuous data collection showed that some accidents happen even several kilometres before the runway threshold during the final approach and several kilometres after the runway end during departure. Statistical distribution showed that the largest number of accidents happened in the areas prescribed by ICAO but also within 1,000m before the threshold during landing as well as 1,000m after the end of the runway during take-off.

People who reside in or pass through these areas are exposed to a certain degree of risk; called third-party risk. Areas distanced from the runway, where accidents occur, are most likely with facilities where people live, work or reside. An accident in residential or industrial area leads to heavy injuries or death of the passengers onboard as well as of the people residing at the place of the accident.

In order to protect the people on the ground, some countries have introduced public safety zones. The first public safety zones appeared in 1958 in the UK [6]. The first public safety zones had a trapezoid shape as shown in Figure 2.

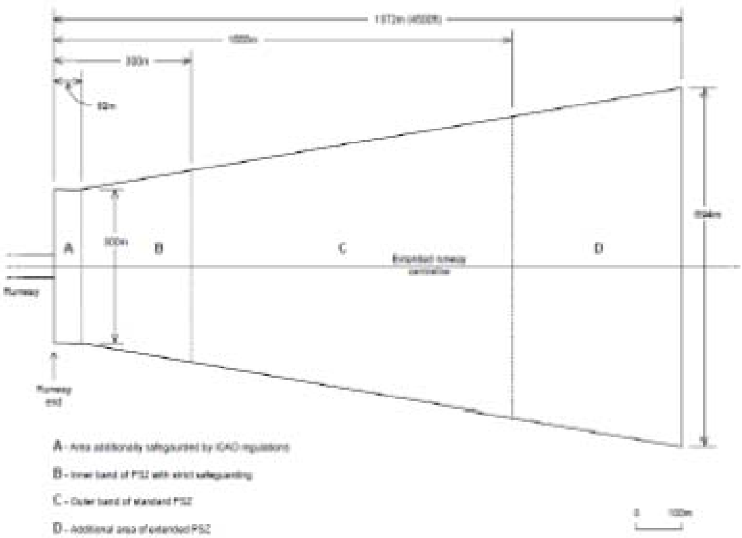

Figure 2 - Public safety zone in the 1950s [6]

A revision of the public safety zone was made in the nineties [7]. Public safety zones are located next to the ends of the runways or runway strips. Public safety zones consist of a few contours of individual risk (very often three, as follows: 10^4, 10^5, 10^6). Each contour represents an area in which a person residing in a period of one year is subject to certain risk of death. Models used for the construction of individual risk contours are: crash frequency model, crash location model and crash consequence model. Public safety zones can have a triangular form or irregular form if they are determined by computer programs, shown in Figures 3 and 4.

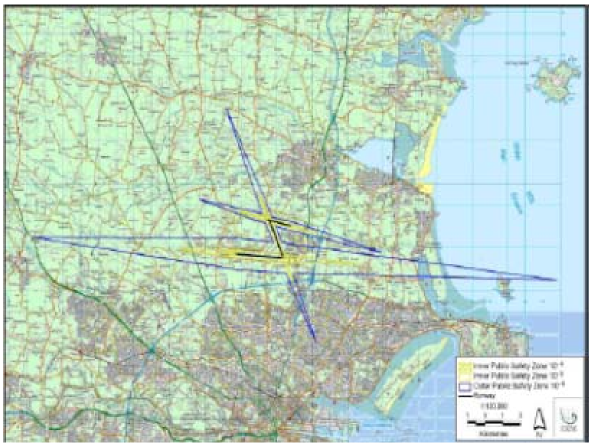

Figure 3 - Proposed public safety zone for Dublin airport runway [8]

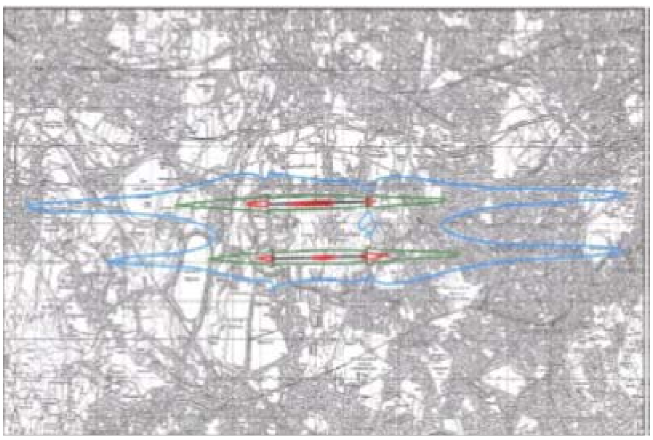

Figure 4 - Public safety zone contours of Heathrow airport [6]

Within public safety zone the construction of new buildings and objects is restricted or banned, the purpose of which is to reduce the number of people that reside in it or pass through it. In some cases the buildings and objects are being completely removed so that the risk of injury or death of people onboard as well as of people on the ground is reduced to minimum.

5. CONCLUSION

The analysis of accidents has proven that the biggest risk is during take-off and landing. In order to ensure safety, ICAO has prescribed as standard areas adjacent to runway as well as recommendations some extensions of certain areas. Every country in the world has to incorporate standards in its own regulations regarding aerodromes. Some of the countries have more detailed and rigorous regulations than ICAO. Croatia has more rigorous than ICAO.

From the data on distribution of accidents around and near aerodromes, due to the third-party risk, and the need to increase the safety of people on the ground the developed countries have introduced public safety zones. Public safety zones are located next to the ends of the runway strips. The goal of the introduction of public safety zones is to reduce the number of people residing in that area. Public safety zones have also impact on spatial planning because the building of new facilities is prohibited and some of the facilities are even removed from it. Croatia has not introduced public safety zones in spatial planning.

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DEVELOPMENT OF INFORMATION-LOGISTICS SYSTEM OF ZAGREB CENTRAL STATION FOR PUBLIC TRANSPORT IMPROVEMENT OF THE CITY OF ZAGREB

ABSTRACT

When speaking about the development of logistic activities and traffic systems one primarily considers the development of logistic services in freight traffic. However, the development of the logistic systems which has the aim of improving passenger transport is not to be neglected. In this area the development of information-logistic systems comes to the fore, as well as the development of the catering, shopping, hotel, restaurant, and tourist logistic systems.

The Zagreb Central Station is located at an extremely favourable traffic position of the city of Zagreb which allows the users of railway passenger services to arrive to the very centre of the city. Also, in the vicinity of Zagreb Central Station there is a tram stop operating a large number of tram lines towards all parts of the city, as well as a bus terminal with lines towards destinations in the southern parts of the city. In the vicinity of the Railway Station there are also shopping centers, hotels, and a theatre and multiplex cinemas as well as other services.

Such a favourable position has to be well connected by a strong information-computer system thus significantly raising the quality of the rail passenger transport services in the city of Zagreb. The development of the Zagreb Central Station information-logistic system is the first step in improving urban transport of passengers in Zagreb and suburban districts. The development of the information-logistic system of Zagreb Central Station has to be performed in three phases: preparation phase which includes defining of purpose and function, then the construction itself; after that connection with the environment, and finally further development of the information-logistic system.

1. INTRODUCTION

Past studies of the possibilities of development and improvement of passenger railway station operation in the increasing transport demand under the basic thesis: railway stations – gateway of the city, have been primarily oriented to the transport service users outside the urban area itself, with conversion and improvement of different facilities at the railway stations themselves or in their immediate vicinity. Such development of operation at passenger railway stations is possible also in cooperation with local administration and local organizations and companies. In order to be able to combine various useful information upgrade is required and/or construction of computer–information systems at railway stations.

Considering the development of the logistic operation of traffic systems what is primarily meant is the development of logistic services regarding freight transport. However, neither should one neglect the development of the logistic system whose goal is the improvement of passenger transport. In this area the development of information-logistic systems of the carrier, as well as service, cultural, commercial, hotel, catering and tourist logistic systems comes to the fore. The development of the information-logistic system is important also for the users of non-urban areas, as well as for the users of urban and suburban areas.

For the development of the information-logistic systems in passenger transport one should take as an example the passenger nodes that are located on favourable positions. One such node is Zagreb Central Railway Station, which is located at an extremely favourable traffic as well as commercial position in the City of Zagreb, which makes it possible for the users of the rail passenger services to arrive to the very centre of the city. Also, in the vicinity of Zagreb Central Station there is a tram stop operating a large number of tram lines to all the parts of the city and a bus terminal with lines towards the destinations in the southern parts of the city and a developed network of taxi transport services with several operators.

In the vicinity of the very railway station there are various services, hotels, restaurants, museums, as well as theatres and a centre with multiplex cinemas. Apart from various facilities in the near surrounding of the Zagreb Central Station, there is no systemic computer connection between the mentioned facilities and structures. In order to raise substantially the quality of services of rail passenger transport in the City of Zagreb, such favourable positions have to be well connected by a powerful information-computer system. The development of the information-logistic system of Zagreb Central Station is the first step in improving urban passenger transport in Zagreb and the suburban districts, as well as an upgrade of recognizing railway stations as the city gateway.

The paper deals further with the development of the information-logistic system of Zagreb Central Station through three phases: preparation phase which includes the definition of the purpose and function of the information-logistic systems, recognition of logistic subjects of the information-logistic system and finally, the guideline for the building itself.

2. NOTION AND FUNCTION OF THE INFORMATION-LOGISTIC SYSTEM

The author Zelenika defines the information-logistic system as a system of purposefully interconnected and inter-influencing subsystems and elements that using different components allow performance of the basic functions towards logistic corporate subjects as producers of logistic products and services as presented in Figure 1.

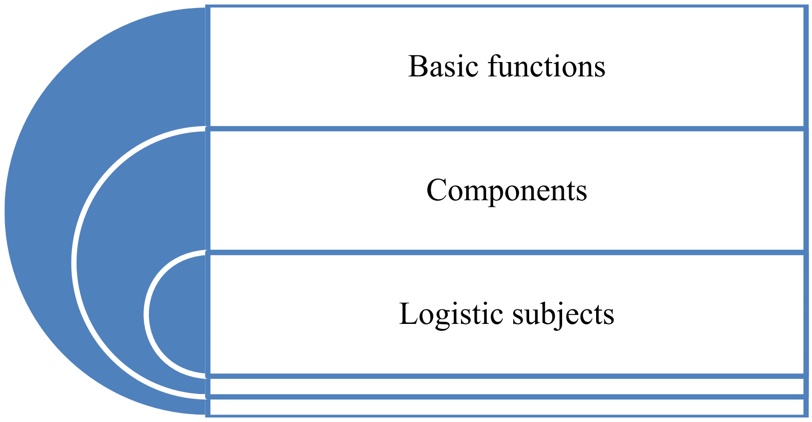

Figure 1 – Schematic presentation of the information-logistic system

A functional and well structured information-logistic system will be efficient if it can supply the interested users of logistic services with good and timely information.

In order to realize its basic functions, the information system consists of five interconnected components:

1. **human**: people who participate in the functioning of the system and who use the collected and processed information;
2. **material-technical**: all the machines, devices, and means intended for the processing of data and information;
3. **non-material**: the totality of human knowledge in the functioning of the material-technical component;
4. **transfer**: media and connections used to transfer data and information over distances;
5. **organizational**: measures, actions, procedures, rules and other elements that provide functional and efficient information system.

If one starts from the fact that no logistic process can produce logistic products without necessary information, the base of the logistic-information system lies precisely in the preparation of data for the required information, using the following steps:

1. **data collection**: in this step it is necessary to determine which data are to be collected and in which way;
2. **processing of data into information**: this is performed by means of certain hardware and software solutions;
3. **saving of data and information**: as a file (organized sets of related records), as database (sets of interconnected files), and as data bank (logically and technically connected interdependent databases);
4. **supply of data and information**: supply of timely information to the users of the information-logistic systems.

3. LOGISTIC SUBJECTS OF INFORMATION-LOGISTIC SYSTEM AT ZAGREB CENTRAL STATION

Logistic subjects of the information-logistic centre encompass a much wider area than the Zagreb Central Station itself and unify logistic subjects of various activities:

- **transportation activity**: system of the Croatian Railways, ZET – Zagreb Electric Tram with organized public transport by trams and buses, taxi service, and finally in the later phase also connection with the Zagreb Bus Station and airport Pleso;
- **commercial activity**: Importanne centre Zagreb, Branimir centre Zagreb;

- **cultural activity**: theatre Vidra, Concert Hall Vatroslav Lisinski, Cinestar in Branimir centre, museum exhibitions, City Library Zagreb;
- **hotel-catering activity**: Regent Esplanade Hotel, Hotel Central, Hotel Palace, Hotel Dora, Hotel International, Hotel Arcotel, restaurants at Branimir centre and Importanne centre as well as other facilities;
- **health care services**: health service institution Zagreb Centar;
- **service sector**: HP-Hrvatske pošte (Croatian Post).

Logistic subjects in information-logistic systems can communicate orally, in writing, or electronically. Electronic communication means communication by means of information-telecommunication technologies, and has numerous advantages over classical way of communication, including among other things: faster communication between logistic partners, reduction of administrative activities, increase of the product quality, lower costs, etc. One of the important services at information-logistic centres has the Internet, computer network on a wide geographic area with a large number of computers. Therefore, the paper uses mostly the data and information available on the official Web pages.

Figure 2 – Map of the surrounding area of Zagreb Central Station with marked facilities
Source: Google Earth

Legend:

1. Zagreb Central Station
2. ZET tram
3. ZET bus
4. Taxi service
5. Zagreb Bus Station
6. Importanne centre
7. Branimir centre
8. Concert Hall Vatroslav Lisinski
9. Theatre Vidra
10. Hotels
11. Health service Institution Zagreb Centar
12. HP-Croatian Post

3.1. Zagreb Central Station

Zagreb Central Station is the biggest railway station in Croatia. It was opened in 1892 under the name of State Railway Station, and the station building has been registered today as cultural heritage. The secondary activities of the Central Station are: left-luggage office, train seat reservations, information counter, exchange office, restaurant, advertisements and promotion, lost and found, transport of cars by train.

Figure 3 – Zagreb Central Station Building

Source: http://hr.wikipedia.org

Zagreb Central Station is the origin railway station towards the following railway lines distributed to corridor routes:

- Zagreb GK – Karlovac – Rijeka, part of corridor Vb;
- Zagreb GK – Dugo Selo – Koprivnica – state border (Hungary), part of corridor Vb;
- Zagreb GK – Dugo Selo – Tovarnik – state border (Serbia), part of corridor X;
- Zagreb GK – Savski Marof – state border (Slovenia), part of corridor X;
- Zagreb GK – Sisak – state border (Bosnia and Herzegovina).

Zagreb Central Station is open to domestic and international passenger traffic with daily numbers of trains presented in Table 1.

Table 1 – Average daily number of trains at Zagreb Central Station

Type of transport	Type of train	Number of trains (pairs)
International traffic	EC – Eurocity	3/3
	EN – Euronight	2/2
	IC – Intercity	7/6
Domestic traffic	ICN – Intercity tilting	2/2
	IC – Intercity	3/2
	High velocity trains	19/19
	Passenger trains	67/67/
	Suburban trains	51/50

On the average the daily number of passengers at Zagreb Central Station is not being recorded but rather the possible number of passengers is calculated according to the following formula: ***number of trains X 100 passengers = number of passengers***.

The majority of service users in railway passenger transport use for the continuation of their journey to their destinations tram and bus transport of the Zagreb Electric Tram, and a minority use taxi service.

3.2.Transport of passengers by ZET in the vicinity of the Zagreb Central Station

The Zagreb Electric Tram was founded in an organized manner in 1891 as the Horse Tram Company. ZET was organized for the transport of passengers by trams, buses and by funicular on regular lines in the area of the City of Zagreb and a part of the Zagreb County. In more than a hundred years of its existence, Zagreb Electric Tram has had significant impact on the development of the city, covering by its network of tram and bus lines the main directions of big daily migrations of the citizens in the area of the City of Zagreb and its catchment zone. In the area of Zagreb Central Station, Zagreb Electric Tram has organized transport of passengers by trams and buses, and the overview of lines is presented in Table 2.

Figure 4 - Zagrebački električni tramvaj (Zagreb Electric Tram)
Source: www.zet.hr

Table 2 – ZET tram and bus lines at Zagreb Central Station

Tram lines		Bus lines	
Line	**Timetable**	**Line**	**Timetable**
2 Črnomerec – Savišće	every 7 to 15 minutes	108 Zagreb GK - Savski most	Different times of bus departures acc. to line and acc. to part of day
4. Savski most – Dubec		166 Zagreb GK - Donji Dragonožec	
6. Sopot – Črnomerec		218 Zagreb GK - Savica - Borovje	
9. Ljubljanica – Borongaj		219 Zagreb GK - Sloboština	
13. Žitnjak – Kvaternikov trg		220 Zagreb GK - Dugave	
		221 Zagreb GK - Travno	
		229 Zagreb GK - Odra – M. Mlaka	
		234 Zagreb GK - Kajzerica - Lanište	
		268 Zagreb GK - Velika Gorica	
		295 Zagreb GK - Sajam Jakuševec	
		310 Zagreb GK - Petrovina	
		311 Zagreb GK - Cerovski Vrh	
		313 Zagreb GK - Vukomerić	
		330 Zagreb GK – V. Gorica	

There is no integrated timetable today between the services provided by HŽ Passenger Transport and ZET – Zagreb Electric Tram, which significantly reduces the quality of passenger public transport in the city of Zagreb.

3.3. Shopping centres in the vicinity of Zagreb Central Station

In the vicinity of Zagreb Central Station there are two big shopping centres: Importanne centre and Branimir centre with multiplex cinemas.

Importanne Centre, the first shopping centre in the city of Zagreb is located on the Starčević Square, between Zagreb Central Station and Hotel "Esplanada". The complex is infrastructurally equipped according to the highest world standards and provides shopping and catering services, additionally offering 500 parking places in a garage. According to the number of visitors of approximately 300,000 daily, it has become the urban symbol of Zagreb. The construction of an increasing number of shopping centres in the city centre, as well as the peripheral areas of the city affects also the number of visits to the Importanne centre.

Figure 5 - Importanne centre

Source: www.importanne.hr

Figure 6 - Branimir centre

Source: www.branimircentar.hr

Branimir centre is categorized as a multi-functional centre, which offers under one roof numerous facilities: CineStar (multiplex cinema with 13 auditoria with ca. 3,000 seats), Arcotel (a four-star lifestyle hotel), stores of distinguished brands, and top restaurants and modern bars, office premises and three underground levels with a garage.

Apart from the mentioned shopping centres in the vicinity of Zagreb Central Station there is also Concert Hall Vatroslav Lisinski and satirical theatre Vidra, as well as a number of museums and finally the Botanical garden. All the mentioned facilities have not been connected into a logical information-logistic system.

4. CONCLUDING GUIDELINES FOR THE BUILDING OF INFORMATION-LOGISTIC SYSTEM OF ZAGREB CENTRAL STATION

Based on the previous sections the concluding guidelines shall direct attention to three key questions i.e. problems: (1) which data and information are required for the functioning of the Zagreb Central Station information-logistic system; (2) which are the interconnected components in the Zagreb Central Station information-logistic system; and (3) who/what should be the main link that will connect all the subsystems into a logical and functional Zagreb Central Station information-logistic system.

Although the Internet has been recognized as one of the key services in electronic communication, by looking at all the official Web pages of the potential subsystems of the Zagreb Central Station information-logistic system it is obvious that the facilities are modest with useful information, poorly laid out and prevalently directed to promotion and presentation of individual subsystems. The carrier of activities related to the implementation of the basic functions of Zagreb Central Station information-logistic centre in the first place will have to carry out an analysis and overview of all relevant data and the method of their processing into useful, logical, and connected information.

In the Zagreb Central Station information-logistic system there are several subsystems of completely different activities which make it also difficult to determine all the elements of five basic interconnected components: human components, material-technical components, non-material components, transfer components and organizational components. This is a task that will have to be carried out well and professionally by all the subsystems of Zagreb

Central Station information-logistic system. In the area of railway transport the human component will have to be considered with special attention since all the processes and the procedure have been regulated by a number of official documents and regulations.

Finally, it is necessary to determine the prime mover in the building of the Zagreb Central Station information-logistic system, the key link that will connect all the subsystems into a logical and functional whole. This can be HŽ – Passenger Transport Ltd., as the most interested subsystem for the Zagreb Central Station information-logistic system, but it may also be a completely independent company that would connect all the subsystems. After having determined the theoretical assumptions for the construction of the Zagreb Central Station information-logistic system the following steps include the definition of the design task and the development of a business plan in order to implement the theoretical assumptions into a practical application.

With the building of the Zagreb Central Station information-logistic system the quality of service in public passenger transport of the City of Zagreb would be significantly improved, so that this would be direct support to the recognition of Zagreb Central Station as the Zagreb gateway.

LITERATURE

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