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The FEDERATION OF THE SCIENTIFIC ENGINEERING UNIONS (FSEU) in Bulgaria is a professional, scientific - educational, non-governmental, non-political non-profit association of legal entities - professional organizations registered under the Law on non-profit legal entities, whose members are engineers, economists and other specialists in the field of science, technology, economy and agriculture.

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IMPORTANCE OF TRAFFIC SAFETY AND ENVIRONMENTAL PROTECTION IN SERBIA

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Abstract: This paper is devoted to traffic safety and environmental protection in Serbia. Unfortunately the level of air pollution i.e. the level of emission of carbon dioxide in the world is still raising. Additional actions are needed in order to limit the effect of climate changes in the following years. People ask why electric vehicles aren’t main-stream? It seems that price has a lot to do with it. The Road Traffic Safety Agency with its systematic and responsible activities set clear guidelines for the monitoring and improvement of road safety in Serbia. In the Republic of Serbia from 1981 till 2013 in the traffic accidents 41,718 persons were killed. In the same period 632,936 persons were seriously injured. Republic of Serbia on the 16th of November 2011 began to commemorate the World’s Day of memory on victims in the traffic accidents. Law on road traffic safety came into effect in the Republic of Serbia in 2009. and brought many changes in our legal order. Majority of those changes meant harmonization with European Union regulation in the area of traffic safety. Changes made by the new Law on infractions ("Official Gazette of the Republic of Serbia", no. 65/13) in application from March the 1st 2014. show the increase of penalties for unscrupulous drivers, but drivers complain on to many regulations and difficulties to get documents for motor vehicle use. In this paper there are mentioned the most efficient hybrids we can buy today. In Serbia “FIAT automobiles of Serbia” is still the leading exporter on the list of 15 biggest Serbian exporters, according to the data of the Serbian Ministry of Finances. In April 2015 at New York Auto Show will be possible to see all new accomplishments in auto-moto industry all over the world.

Key words: SAFETY, HYBRID CARS, PROTECTION, ENVIRONMENT, SERBIA.

1. Introduction

Yet in the mid-17 th century appeared the first buses1 that were drawn by horses. The first automobile in Belgrade, capital of Serbia, appeared in year 1901. Today in 21-st century, in 2015 the record sales of the new automobiles in the world, almost 85 million of vehicles is expected, ("Observer"). While “Chevrolet Corvette”, “America’s Sports Car”, build in Kentucky moved into its seventh generation in 2014. 2 A 2015 “Chevrolet Colorado” named the best and it is truck of the year. Nowdays director of Google’s self-driving car project announced that Google plans to test the cars on Northern California roads, first with temporary controls, then without controls, after California law changes to allow it. Nowdays too, we are introducing all new 2015 Mustang. Also all new and updated SUVs coming in 2015, while “Mercedes GLB": the baby G-wagen is coming in 2019.

There are global expectations that there will be 100 million of vehicles by the year 2019.3 However in the world Jet Taxi also solves the urban transport crush. The French solution for a small city car is “Renault Twingo TCE 90”4. This small city car does not have too much in common with its predecessors and the most recognizable is with the model “Renault 5”. It is significant that the emission of carbon dioxide in this car is 99 gr/per kilometer, so we can ask the question whether the “Renault EOLAB” is the super-mini for the future? This paper is devoted to traffic safety and environmental protection in Serbia.

2. Traffic Safety in the Republic of Serbia

In the Republic of Serbia from 1981 till 2013 in the traffic accidents 41.718 persons were killed. In the same period 632,936 persons were seriously injured.

Disastrous are the facts that from 2001 to 2012. in Serbia were killed 2.813 pedestrians (there were more than 13.000 seriously injured, while 28.000 pedestrians were slightly injured). Only during the year 2013, 165 pedestrians were killed, and in 2012 there were only 10 dead persons less. Unfortunately, today, pedestrians crossings are very fateful for pedestrians in Serbia.

The Road Traffic Safety Agency of the Republic of Serbia works intensively on the protection of citizens and the results of research conducted so far are the basis for further activities. A great number, 21.914 of examinees were included in the Road Traffic Safety Agency research that brought conclusions that the most risky locations for pedestrians were badly illuminated and marked pedestrian crossings and many streets.

The leading cause of death in children aged 1 to 14 years in Serbia are the injuries to the passengers as the most common, and 43% of children injured in traffic suffers a traumatic brain injury. Unfortunately, 80% of collisions with the victims on the roads happens in inhabited places.

Data show that 59% of people on the front, and only 3% of people in the back seat of the vehicle use safety belts.

In the last 10 years 290 children were killed in the traffic in Republic of Serbia, while as many as 18.000 were injured. The authorities quote that nine children died in traffic accidents the year 2013.
With the aim that no child is killed in Serbia in year 2020, pupils in our schools will learn more on the traffic safety. Unfortunately, the secondary school pupils receive no tuition on the topic of traffic. Therefore, the newly formed governmental body for coordination of road traffic safety gave the initiative for the introduction of new classes in schools and now the final decision on that will be made by the Ministry of Education, because there is a need for change in teaching program, as well as the preparation of the textbooks and polygons for education of pupils. We believe that the new contents will be available in the Serbian schools from September 2015.

The results of the research conducted by the Ministry of Sport and Youth show that most pupils in secondary schools have up to 5 hours of leisure time daily. All of them would like to go to driving-schools, but mastering driving skills is as expensive as learning a foreign language.

The Road Traffic Safety Agency with its systematic and responsible activities set clear guidelines for the monitoring and improvement of road safety in Serbia.

Republic of Serbia on the 16th of November 2011 began to commemorate the World’s Day of memory on victims in the traffic accidents.

Law on road traffic safety (“Official Gazette RS”, no. 41/09, 53/10, 101/11) came into effect in the Republic of Serbia in 2009. and brought many changes in our legal order. Majority of those changes meant harmonization with European Union regulation in the area of traffic safety. Changes made by the new Law on infractions (“Official Gazette of the Republic of Serbia”, no. 65/13) in application from March the 1st 2014. show the increase of penalties for unscrupulous drivers, but drivers complain on many regulations and difficulties to get documents for motor vehicle use.

3. Actual eco-trends in Serbia and in the world

During 2014 “FIAT” automobiles of Serbia7 was still the leading exporter on the list of 15 biggest Serbian exporters, according to the data of the Serbian Ministry of Finances. In the first eight months of this year it exported cars for 947, 2 million euros. “Big Fica”8 is not giving up, and in 2013 in Krugujevac it was produced 117.000 of “Big Fica” and almost the entire that contingent went to Europe (80%) and United States (20%). However, the production of a more robust model “500-X” is not realized, as the responsible of the group ”Fiat-Chrysler” decided that this model will be produced in another country, and not in Serbia.

A toll payment per kilometer in Serbia could for about half a year be replaced by vignette, that is labels that allow unlimited use of roads in a given time period (usually seven days, month or year).

For the new, fourth generation “Toyota Yaris”9 it was spent about 85 million euros to redesign more than 1,000 positions for this small city car, which is known since its appearance in 1998, as a reliable, high quality and agile and small consumer. We should also mention the car “Toyota Corolla”, as well as several versions of small cars ”Kia Rio", "Kia Soul" and "Kia Forte", then the car “Mazda 3” (it gets great fuel economy) that isn’t a hybrid or a diesel, then “Hyundai Elantra” and despite these also auto “Subara”.

In April 2015, at New York Auto Show will be possible to see all new accomplishments in auto-moto industry all over the world. Great deals, going fast. So, we have to be in trend. For example, Dodge was iconic car of the last century. But “Dodge Grand Caravan” and “Ford SVT Raptor” won’t be around for 2015, either, they’re likely to come back for the 2016 model year. “Chevrolet” mild hybrids will be a thing of past after 2015 too. “Toyota FJ cruiser” was going to be a one generation vehicle and in Toyota wanting to focus on fuel cell technology.

It is already 21 years of the “Vauxhall Corsa”-e and of “Ford10 Mondeo”, a “Honda Civic type R Concept” is seen (and now “Honda” HR-V SUV) at the 2014 Paris Motor Show too, while “Mazda M-X 5” of the fourth generation11 was real hit at Paris Motor Show. We have to write down about the remarkable history of the 91 year of “Volvo” too.

At the 2015 Detroit Auto Show there were different models, from eco cars of the future to bonkers pick-up trucks. In the meantime the 2015 New York Auto Show was held in April and 2015 Chicago Auto Show too.

People ask why electric vehicles aren’t main-stream? I think that price has a lot to do with it.

Although at the Paris Motor Show in 2014 were presented 83 mpg “Porsche Cayenne S E Hybrid” set (especially prepared for Paris 2014/, and “Mercedes AMG GT” edition first leaked ahead of Paris, Lamborhini’s new 200 mph hybrid, new Volkswagen Passat and roofless “Ferrari 458 Speciale A” unleashed too, always being sought “Alfa Romeo Giulietta” right now “dragon” in the Italian style “1,4 tb 170 ks – potenca”, this is the type of Eu 5, with a six-speed manual transmission, reservoir with a maximum of 60 liters and developing maximum speed of 218 kilometers / per hour.

In Germany still in 2012, a conference was held with representatives of the “Platform for Electric Mobility” in charge to evaluate and coordinate the German strategy for electric vehicles. Will the planned target of one million electric cars on the roads of Germany until the 2020s be achieved? This is a complex task that requires the cooperation of the automobile constructors, battery manufacturers, subcontractors and other actors in the production chain. Previously, we could not imagine "BMW" with the three-cylinder engine, and with front-wheel drive, but now when the future began, now, "BMW and 8", with three-cylinder engine under the hood, if necessary, will have the help of an electric motor.

The most efficient hybrids you can buy today are:

- “BMW i3" city car is an all electric vehicle;
- “Volkswagen Jetta Hybrid” – 45 MPGE. The Jetta Diesel has made significant fuel economy improvements for the 2015. model year;

10 In “Ford” says “working very hard” on F-150 Hybrid.

11 Officially, according to the Guinness Book of Records it is the best-selling sports two-seater of all times. It is scheduled for market only for 2015, and it has been announced, so far unthinkable, installation of diesel generators.

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6 Charitable Society “Road Peace” from Great Britain in 1993. started to commemorate the World’s Day of memory on victims in the traffic accidents.

7 “Fiat” produces 160.000 to 170.000 automobiles per year.

8 Price of car model “500-L” is now about 15,000 euros with the duty of 25%.

9 The maximum speed of this car is 175 kilometers per hour, and carbon dioxide emissions of 123 g / per kilometer.

10 In “Ford” says “working very hard” on F-150 Hybrid.

11 Officially, according to the Guinness Book of Records it is the best-selling sports two-seater of all times. It is scheduled for market only for 2015, and it has been announced, so far unthinkable, installation of diesel generators.
- “Toyota Prius” plug in - 95 MPGE, “Toyota Prius C” – 50 MPGE, Toyota’s baby hybrid. The Prius has come a long way since its US introduction in 2000;
- “Ford Fusion Energi / C-Max Energi” – 88 MPGE;
- “Chevrolet Volt!” – 98 MPGE;
- “Honda Accord Hybrid”- 47 MPG, “Honda Accord plug in” -115 MPGE achieves the highest fuel economy, drivers are able to travel a total of 570 miles before filling or charging up. “Honda Civic Hybrid” - 45 MPG, still remains one of the more efficient hybrids on the market, besting the “Ford Fusion Hybrid”, “Toyota Camry Hybrid”, “Kia Optima Hybrid”, and even „Lincoln MKZ Hybrid”. Also we can mentioned “Toyota Avalon” the hybrid’s 2.5-liter four cylinder with an electric motor. And at least the “Tesla Model S” that is a great four-door luxury sporty car that happens to be electric, with its optional 85 kWh battery, that can travel between 180 and 225 miles per charge.

Among green cars we can mention too Bradley GT II Electric, Nissan leaf, Toyota RAV4 EV and a Fisker Karma too.

At the 2015 Detroit Motor Show i.e. North American International Auto Show are shown in eco cars of the future. For example, “Acura NSX” uses a new twin-turbocharged hybrid powertrain and also “Volkswagen Cross Coupe GTE Concept” with the four-wheel drive plug-in hybrid. Really they were eco-warriors, because Detroit has everything. Although, “Chevrolet’s mild hybrids” will be a thing of past after 2015. So, …..putting an end to all “Chevrolet mild hybrids.”

4. Conclusion

We should remind on duties and constant care for the environment we live in. Unfortunately the level of air pollution i.e. the level of emission of carbon dioxide in the world is still rising. Additional actions are needed in order to limit the effect of climate changes in the following years. Earth Day is an annual global event that occurs every April 22-nd, and this year 2015 it passed in the sign of the struggle against pollution and climate changes. In this paper there are mentioned the most efficient hybrids we can buy today, eco-conscious cars and in that way show support for the environment.

“Volkswagen Golf” is 2015 North American Car of the year and in April 2015, at New York Auto Show it was possible to see all new trends in auto-motor industry all over the world.

In the Constitution of the Republic of Serbia from year 2006 it is predicted that Republic of Serbia regulates and provides for sustainable development and Council for sustainable development was established by Decision on establishing of Council for sustainable development as expert and advisory body of the Government of Republic of Serbia. The fifth part of the National Strategy of sustainable development is dedicated to the issues of environmental protection and preservation of natural resources in the Republic of Serbia, as well as to the impacts of economic development on the environment. In that part the aims, measures and priorities connected with protection of natural resources (air, water, land, biodiversity, forests, mineral resources and renewable energy sources), protection from different factors of risk effects for the environment (climate changes and damage of ozone layer, waste, chemicals, accidents, ionizing and non-ionizing radiation, noise and natural disasters), protection from factors of risk for the environment effect in different economic sectors (industry, mining, energetic, agriculture, forestry, hunting and fishing, transportation and tourism), are given as well as introduction of cleaner production.

It is neccessary to stress in media and inform wider public on the importance of environmental aspects of traffic taking into consideration the well known fact how much cars reduce air quality by emission of harmful gases.

During 2011. the Ministry of Environment, Mining and Space Planning allowed the subvention for purchasing hybrid cars in our country. As the final result all cars with emission of carbon dioxide less than 100 g per kilometer ran will have certain privileges i.e. there will be additional benefits for all those who drive “green” cars. Owners of the ecologically “suitable” cars get ECO Friendly licence in the form of certificate on the occasion of vehicle purchasing. In Serbia all owners of cars with CO2 emission less than 100 g per kilometer ran will enjoy certain privileges, like more favorable insurance package, provision of free parking, more favorable conditions of financing. However, they are not exempted from customs duties, as it was announced.

Increase of vehicles using natural gas happened because of economic benefit for consumers, but they were certainly urged also by ecological interests. It is very important that the number of “green” vehicles constantly increases.

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PROSPECTS FOR THE DEVELOPMENT OF IMPORTED FOREST MACHINES
MAINTENANCE IN THE RUSSIAN FEDERATION

ПЕРСПЕКТИВЫ РАЗВИТИЯ ТЕХНИЧЕСКОГО СЕРВИСА ЗАРУБЕЖНОЙ ЛЕСОЗАГОТОВИТЕЛЬНОЙ ТЕХНИКИ В РОССИИ

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Abstract: The article considers the issues of imported forest machines maintenance technology and knowledge management in the North-West of the Russian Federation. The paper proposes a structure of technological instruction to restore parts by welding and building up. Basic requirements for the work-site arrangement are formulated. Theoretical statements are accompanied by calculated reliability assessment of forest machines. The assessment is based on the research of details durability of forest machinery John Deere 1010 and 1410. The research was carried out for four years and included 16 forest machines. The main objects of the research were details of processing equipment (manipulator), hydraulic system, and engine fuel system of forwarder John Deere 1010 D. The efficiency criteria of multicomponent reserve delivery of spare parts and consumables are formulated.

KEYWORDS: MAINTENANCE PERFORMANCE, REPAIR INSTRUCTIONS, SPARE PARTS SUPPLY

1. Introduction

Development of maintenance management of imported forest machines (FM) operating in Russia, can be considered at the general management level and at the unit level of a maintenance enterprise (Shilovsky, 2001, 2005, 2012).

Maintenance performance policy of forest machines manufacturers is one of the effective tools for expanding the market, because every consumer is interested in cost-effective operation of the purchased equipment. Manufacturers expand the market of their machinery sales and also receive additional income from organizing corporate maintenance. Sometimes this income exceeds the income from the sale of machinery. Corporate maintenance of machinery, i.e. on-site maintenance and repair of equipment, organized by the manufacturer, has an advantage over the organization of repair and maintenance of machines by independent dealer services and requires development and perfection. Corporate maintenance and repair can establish a direct link between the consumer and the manufacturer; help to get information about the machines reliability, the causes of failures as the fault of the manufacturer and the consumer, and to take quick measures to eliminate them. Therefore the main issue is to develop and implement technological instructions to eliminate the failures occurred. The most valuable part of these instructions should be the technology of the failed FM parts, units and aggregates repair, which can be competently developed only by the manufacturer.

The need for such technical documents certainly exists. Consumers and organizations involved in machines and equipment repairing are extremely interested in their speedy development. There are cases when for the elimination of cracks which appeared in the processing FM equipment, the consumer is forced to turn to specialized services to perform chemical analysis of the failed metal construction material to conduct effective welding of cracks with the right electrodes and in the right mode [1, 5].

Indeed, the manufacturer gets more profit selling a greater number of spare parts, even if they can be effectively repaired by the consumer or by specialized repair enterprises. But on the competitive market it is the manufacturer who provides more cost-effective technical operation of the equipment purchased by the consumer who wins eventually.

It is believed that the overhaul of machinery and components is not beneficial for the consumer. This depends on the remanufactured components life time and repair costs. The calculations applied to agricultural machinery show that if the cost of repair is not more than 80% of the cost of the new object, with the full recovery of the component, the repair is beneficial to the consumer.

Repair cost depends on the amount of repair production, if it grows then the price decreases. General strategic maintenance management team has to make preliminary estimates of the repair production volume and the cost of a repaired equipment unit and to suggest an optimal variant of repair volume and the cost of repaired equipment.

One of the examples of the strategic management team’s efforts can be a standard technological instruction of parts’ operable state restoration, which can serve as the basis for an operating technological instruction of specific details restoration. A standard instruction presents a list of regulations which are specified in operating instructions. For example, a technological instruction of parts restoration by welding and welding with flux-cored wires includes:

I. General regulations and a description of the process;
II. The materials used;
III. The influence of welding parameters on the configuration of the weld;
IV. Preparation of welded joints;
V. Choice of welding and surfacing;
VI. Features of a semi-automatic welding;
VII. The equipment for welding and surfacing;
VIII. The organization of the workplace;
IX. Defects and quality control of welded joints;
X. Safety;
XI. Fire-prevention measures.

Section "Workplace" plays a special role in technological instructions. Workplace organization is carried out in accordance with the working draft of a workplace, developed on the basis of the provisions of standard project workplace requirements for all types of jobs. The working draft specifies general positions of a standard project for a specific workplace. A standard project of a workplace includes:

I. General. Main rules of the workplace;
II. Methods and techniques;
III. Maintenance organization;
IV. Means for communication between a workplace and maintenance services;
V. Working conditions (lighting, sanitary requirements, aesthetic requirements, work and rest schedule);
VI. Combining of professions, team form of labor organization.

For example, a working draft of a welder’s workplace (manual arc welding) defines:

- The purpose and plan of the workplace;
- The layout of workspace;
The map of a welder’s work organization;
The machine-tool attachments;
Technical and technological documentation;
Health and safety requirements.

2. Data and Methods

A FM reliability assessment is an important issue for the maintenance service organization. Studies have been conducted to evaluate the durability indicators of FM parts «John Deere» series 1010 and 1410. Research methods included data collection in three main areas:
• Initial Data Collection on failures of parts and components;
• Initial Data Collection on the actual consumption of spare parts;
• Information Collection on the frequency of forwarders maintenance.

The research objects were the parts and operational materials (OM) of forwarders «John Deere», series 1010 and 1410. Initial Data Collection was carried out on timber enterprises of the Republic of Karelia: JSC "Ledmozersky LZH", JSC "Volomsky" and ZAO "Shuyales" in cooperation with the official dealer of «John Deere» in the Republic of Karelia "Petro John Deere Forestry" [2]. The research was carried out for 4 years and included 16 Forest Machines. The main objects of research were parts of technological equipment (a manipulator), hydraulic systems, fuel equipment of forwarder «John Deere» 1010 D. Selection of objects of research (parts) was based on the Unification between FM «John Deere» Series 1010 and 1410.

3. Results and discussion

The results of failures data processing and durability indicators of forwarders parts obtained using known statistical methods are shown in Table 1 (Salivonik, 2006).

<table>
<thead>
<tr>
<th>Part code in the catalog (title)</th>
<th>Indicators of durability for recorded failures / by the actual consumption of spare parts</th>
<th>Type of the distribution law</th>
<th>L_{\text{cp}}</th>
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<tbody>
<tr>
<td>F058748 – manipulator shackle</td>
<td>normal log-normal</td>
<td>2164</td>
<td>2314</td>
<td>549</td>
<td>0.254</td>
</tr>
<tr>
<td>RE518088 – High pressure fuel pump</td>
<td>Weibull</td>
<td>2691</td>
<td>2972</td>
<td>794</td>
<td>0.295</td>
</tr>
<tr>
<td>F0649910 – High pressure hose to the rotation of the rotor gripper</td>
<td>normal log-normal</td>
<td>496</td>
<td>568</td>
<td>198</td>
<td>0.398</td>
</tr>
<tr>
<td>F06520 – High pressure hose on the manipulator telescopic extension</td>
<td>normal log-normal</td>
<td>903</td>
<td>998</td>
<td>233</td>
<td>0.258</td>
</tr>
</tbody>
</table>

L_{\text{cp}} – estimate of the mean life, hours;
\sigma_l – estimate of the standard deviation of the life, hours;
V – estimate of the variation coefficient.

The most relevant to the data obtained law of operating time distribution between maintenances was a log-normal law with parameters \( \mu = 5.514 \) and \( \sigma = 0.066 \) in the investigated enterprises for forwarder «John Deere» 1010 [2].

This example shows the necessity of an effective system organization of spare parts supply as this plays a significant role in the FM maintenance.

The effectiveness of diversified spare parts (SP) and operating materials (OM) stock delivery can be described by the objective function of the following form [3]:

\[
L = \frac{1}{2} \cdot T + \sum_{i=1}^{N} \mu_i \cdot S_i \cdot k_i + \frac{q_i \cdot \beta_i}{T} \left( \sum_{i=1}^{N} \frac{1}{k_i} + 1 \right) \rightarrow \min, \quad (1)
\]

where \( L \) - the total cost per unit of time to ensure the supply of diversified SP and OM stock on the multiple periods system, rub.;
\( T \) - frequency of the supply, month.;
\( i \) - number of \( i \)-th simultaneously delivered SP and OM \( (i = 1, N) \);
\( \mu_i \) - average demand per month, pcs./month;
\( S_i \) - price of storage for a month, rub./month;
\( k_i \) - multiplicity of \( i \)-th SP and OM inclusion in the delivery list \( (k = 1, 2, \ldots) \);
\( q_i \) - SP and OM delivery cost, rub.;
\( \gamma \) - factor increasing SP and OM delivery cost depending on their quantity when shipped, piece \(^1\);
\( \beta_i \) - additional costs share for SP and OM supply depending on the \( j \)-th type of delivery vehicle \( (j = 1, f) \).

To solve the problem it is necessary to determine the optimal supply period \( T \) and to make the distribution of all kinds of SP and OM on the plurality of supply groups \( k_i \), providing that the sum of the costs of the supply of \( L \) would be minimal.

The quantity of SP and OM at each delivery is calculated after determining the optimum delivery periods of diversified SP and OM sets by the following expression:

\[
n_i = \mu_i \cdot T_i, \quad (2)
\]

where \( T_i \) - the optimal time of \( i \)-th SP and OM delivery.

To select a vehicle it is necessary to determine the weight and volume of SP and OM sets delivered and to determine a vehicle according to the following conditions:

\[
\sum_{i=1}^{N} m_i \cdot n_i \leq M_j, \quad (3)
\]

\[
\sum_{i=1}^{N} \nu_i \cdot n_i \leq V_j, \quad (4)
\]

where \( m_i \) – \( i \)-th SP and OM weight, kg.;
\( M_j \) – tonnage of \( j \)-th vehicle used for delivery, kg.;
\( \nu_i \) – the physical volume of \( i \)-th SP and OM, m\(^3\);
\( V_j \) – volume of \( j \)-th vehicle used for delivery, m\(^3\).

The vehicle with specific characteristics \( M_j, V_j, \beta_i \) is chosen from the existing fleet of vehicles according to the conditions (3,4).

Logging companies are geographically dispersed users of logging equipment. The process efficiency of the SP distribution among storage facilities can be assessed by the following function of time loss when eliminating failures (general view):

\[
T' (X_i) = \sum_{i=1}^{N} \min T(X_i), \quad (5)
\]

where \( X_i \) – vector of optimal allocation of \( i \)-th SP corresponding to the minimum total loss of time to eliminate FM failures.

The vector of optimal distribution of the number SP \( X_i \) is a controlled variable of the form

\[
\overline{X} = \{x_1, x_2, \ldots, x_{m\cdot M}\}, \quad (6)
\]

where \( x_1, x_2, \ldots, x_{m\cdot M} \) – number of SP in each \( m \)-th storage facility, pieces \( (m = 0, M) \).

The total loss of time on the supply of distributed FM can be represented by the objective function:

\[
T = t_{1,i} + t_{1,m,i} + t_2, \rightarrow \min, \quad (7)
\]
where $t_{ij}$ – amount of time required for delivery of $i$-th SP, located directly on $j$-th FM operating site, h.;

$t_{1,j}$ – the time required to deliver the necessary $i$-th SP, located at the nearest storage facility «m» from the $j$-th failed FM, h.;

$t_{2,i}$ – amount of time required for delivery of the $i$-th SP from an external source, h.

The mathematical model for determining the number of reserved spare parts in each storage facility “m” is based on discrete-event simulation modeling representing system model development with time and implementing the approach of “time advance from event to event” [5].

4. Conclusions

1. Development of imported FM maintenance in Russia is possible through expansion of corporate maintenance and repair in specialized enterprises, developing and implementing the technology of repair and restoration of FM parts and components.

2. Implementation of a cost-effective operation maintenance system and SP and OM supply chain will expand markets for FM, generate more profit for manufacturers of forest machines and reduce service, maintenance and repair costs for consumers.

3. Organization and development of maintenance marketing and management will improve the competitiveness of FM by satisfying growing demands of consumers.

4. One of the effective tools to improve the competitiveness of FM is to improve their maintainability, that is their constructive adaptability and high-quality maintenance and repair in regular operation conditions.

5. References


A MOBILE APPLICAITON OF REGIONAL TOURIST ROUTES

MOBILNAYA APLICAIKA REGIONALNYKH TURISTICHESKIH MARShRUTOV

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Abstract: It is impossible even imagine tourism development without using modern innovative technologies. The modern WEBGIS and Mobile systems allow putting in an absolutely new light the country’s tourist potential.

The tourist routes, tourist facilities and infrastructures indicated on the digital interactive geo-information map (GIS) with textual and visual (photo, video) information, which are integrated on the tourist web-portal and in the touch-screen devices (cell phones, graphics pads, smart-phones) make the mentioned information available in any country of the world.

The Center of Geographic Information of Georgia has developed a mobile application “TravelGIS” for the mobile devices operating on the platform of Android and IOS, which have no analog in the world. The mentioned application is designed in three languages (Georgian, English, Russian) and represents the information-communicative means for tourist organizations (companies and tour operators), tourist destinations and for promoting the whole country’s tourist potential. Any interested person can find and select on his own cell phone the information by any desired criteria – country, region, Tourist Company, infrastructure unit, type of tourist services, duration and complexity.

KEY WORDS: MOBILE APPLIKATION; TOURIST TOURE; CENTER OF GEOGRAPHIC INFORMATION

1. Introduction

Development of the world tourist market fosters search of ways for effective development of tourism. At present stage, the information technology and software tools become far more widespread in tourist industry. The activities on forming, promoting and marketing of tourist product become impossible without the adequate information management.

GIS – is a modern computer technology for mapping and analysis of real-world objects, as well as developments that took place on this planet. This technology allows combining the work with a database, for example, the query and statistical analysis with the opportunity of a full-fledged visualization and geographical analysis provided by the maps. These opportunities set GIS apart from other information systems and present unique opportunities for its use in tourism.

The GISs vary in data domain of information modeling, for instance, urban GIS, environmental GIS and so on; among them the land information systems are widely used. The problem orientation of GIS depends on those problems (scientific and applied) which are solving within it, including inventory of resources (including cadastre), analysis, assessment, monitoring, management and planning, and support for decision-making. The integrated GIS combine the functional capabilities of GISs and the digital image processing systems (remote sensing data) in a uniform integrated environment [2].

2. Preconditions and means for resolving the problem

The GIS technologies are used in various fields of man’s activity: geodesy, land resources management, urban management, assessment inventory, planning of forest resources, landscape ecology, and fire probability.

GIS helps to improve the quality of life through the use of desktop mapping application of the GGP Systems Company. The Project enables to estimate a quantity and availability of the existing recreation areas in the open air.

At the present stage, the GIS technologies are actively used in touristic designing and when organizing exploitation of tourist resources and tourist industry venues. The Google Earth service allows traveling by interactive map of the planet, which is created from the ideally “sewn” to each other satellite imageries with a detailed three-dimensional visualization. On the interactive world map it is possible to study any section and find any point (including by searching), look more closely at the area around it, and, if necessary, even to map an optimal route. When necessary, it is possible to fly over the territory at a specified height and speed, measure the distance, work with GPS and create our own map by laying the own objects on the original map of Google Earth.

There are available on the Internet the interactive maps of some cities, and we shall note that some of them are prepared at a very high level, but most of them still leave much to be desired. The GISs play a special role when developing the projects of long-term planning of tourism development in the region. A peculiarity of geo-informational approach in working out the programs for regional tourism development is creation of a uniform intellectual system, which keeps together: geo-data base, actual non-uniformly scaled digital mapping bases and satellite imageries of the average and high solution, as well as materials of video-observations; methods and technologies of the automatic spatial-temporal analysis of monitoring and modeling; modern geo-portal solutions ensuring the publication and internal use of spatial information through the WEB-technologies [3].

Combination of rich cultural and historical heritage of the Imereti region of Georgia with its natural-resource potential promotes the development of various types of tourism in the region: mental-patriotic; rural; agrarian-ethnographical; children’s and youth; business and scientific; eventful; winter tourism; spa and health tourism and so on.

The development of tourism in the Imereti region is largely dependent upon the effectiveness of government regulation and support of travel industry. For the use of tourism as one of the directions of structural economic conversion, it is necessary to increase the effectiveness of regional policy in the field of tourism, strategic planning of tourism development on the basis of systems approach, use of the program-target, design methods of management, and mechanisms of the state-private partnership. We believe that, at present tourism did not reach the required level of development for influencing the economy of the regions.

One of the topical issues of tourist activities in the regions is an organization of recreational spaces in the suburban zone for urban residents during weekends and public holidays. In this context, it is necessary to offer the scientifically justified programs for distribution of visitors on the territory of suburban zone.

Geographical Information System, which contains information on capabilities and peculiarities of a particular territory, should allow creating the project of exploitation of suburban recreation zones. Information provided by Geographical Information System should be divided into the layers dependent on lines of its application:
precisely your location and thereby to exclude the possibility of map, by using the GIS technology, you will be able to detect camping and picnic sites, etc.) are designated on the electronic map in such a way “opens’ on the electronic map on the display of your country’s regions, the Geo-Information Center of Tourism has information system on the basis of regional GIS systems, and to actively developing. It is necessary to create the national geo-information system for tourism. The conducted analysis of GISs developed in various regions of the country enables us to conclude that at present in Georgia, the scientific-practical activities on introduction and application of geo-information systems in the field of tourism for planning and monitoring of activities is not developed yet. With creation of prospective development programs in Georgia’s regions, the technologies should become the essential foundation of a uniform tourist-recreation system of Georgia.

There is established in Georgia a non-governmental organization Geo-Information Center of Georgia (TravelGIS), which is aimed at promoting the development of tourism infrastructure [3, 4]. The main direction of the activities include as follows: creation of the National Geo-Information System of Tourism; the continuous safety monitoring system of the group and individual tourist routes across Georgia by using the GIS and GPS technologies; organization of virtual trips on the country’s tourist routes for domestic and foreign travelers.

The modern GIS technologies all creating the geo-tourist GISs, in other words, the mass integrated data of tourism for organizing the tourist activities. Each traveler by using the materials of such GIS will be able to quickly accept any information in the form of maps, digital models, graphs, diagrams and other modes of visualization. The specialized tourism GIS optimally has four databases: tourist resources, service characteristics, tourist statistics, and geographical information. The development of the project of a particular GIS is carried out, as a rule, by the group of various-profile specialists engaging in work the additional executives at different stages. These stages comprise: formulation of goals and specification, determining the organizational resources and restrictions, generation and assessment of alternative projects, integral estimation of costs and profit.

Three main development stages:

- evaluation of the goal and resources (description of the goal and consumer needs, description and assessment of required data and methods of gridding, inventory of sources and specification of data files, evaluation of the system’s specification);
- generation and assessment of alternative projects (description of the requirements of equipment and mathematical support, feasibility and cost evaluation, description and assessment of legal and political aspects);
- integral estimation of the systems’ specification (final assessment of profit, costs and impact).

Aggregate of control means (a command menu, toolbars, pictograms, buttons, dialog boxes, etc.), which are used for interaction of user with the geo-information system, forms the user interface of GIS. By using these control means, the user carries out certain functions, runs applications, adjusts the required mode of operation (for example, selects the unit of measurement) and so on.

With the purpose of promoting the tourist resources of the country’s regions, the Geo-Information Center of Tourism has developed an application of tourist routes TravelGIS for the Android and IOS mobile phones. The mentioned application is designed in three languages (Georgian, English, Russian) and it can be used for choosing the required tour by some parameters – visited country, Tourist Company, type of tour and others. The tour chosen in such a way “opens’ on the electronic map on the display of your smart-phone in the form of linear object. The tourist resources (the monuments of cultural heritage, nature, museums, etc.) as well as the objects of tourist infrastructure (hotels, food-service objects, camping and picnic sites, etc.) are designated on the electronic map in the form of point objects. After pressing any of them on the smart-phone display, there will “open” the photo of this particular object and displays textual information. Here, on the electronic map, by using the GIS technology, you will be able to detect precisely your location and thereby to exclude the possibility of deviation from the route, and to ensure tour safety.

At present, the market of geo-information services is actively developing. It is necessary to create the national geo-information system on the basis of regional GIS systems, and to integrate it in the world geo-information system of tourism. The regional GIS system should contain the actual objects of tourism shown on the tourist geo-information map with the appropriate geo-information data, as well as with visual and textual information.

In accordance with the regional economic policy and on the basis of integrated territorial planning, the investment projects of tourism development in the regions should be accompanied by implementing complex measures, and first of all, by the creation of the effective geo-information map containing the map material, the objects of the world’s cultural heritage, conservation areas, national parks, road conditions, lodging objects, internal transport and so on.

The wide application of geo-information technologies should significantly foster the expansion to the required level of territorial planning, and therefore to foster the increasing validity of made management decisions, including related to the tourism development [1].

3. Conclusion

In this context, it would be advisable to develop the program of the recreation tourism development in the Imereti region on the basis of using the geo-information technologies, which should envisage:

- study of natural monuments and other tourist attractions in the region;
- designing of new tourist routes with use of geo-information systems of tourism;
- the establishment of the continuous monitoring system throughout the territory of the Imereti region with the use of modern information technologies;
- optimizing the process of choosing the tourist routes;
- issuance of information materials on tourism;
- organization of trainings, seminars, exhibitions, contests and conferences;
- participation in creating and improving the legal framework on tourism.

The development of the program of the recreation tourism development in the Imereti region on the basis of using the geo-information technologies should enable us to carry out the analysis, define the territories suitable for organizing a particular type of tourism, and identify the relationships between various parameters.

The establishment of tourism-oriented GIS of the Imereti region of Georgia will enable us to make spatial requests and carry out the analysis, define the territories suitable for the required activities, and identify the relationships between various parameters. Information placed on the map of resorts, their disposition plans, quality of service, photos of rooms, beaches, names of local cuisine dishes and other information will provide the tourism companies having access to this GIS with the considerable advantages.

4. Literature


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USAGE OF FESTO SIMULATOR FOR MARINE SYSTEMS

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Abstract: Two simulators of ship automation systems are realized by means of FESTO didactic elements and software. They are applied into syllabus for marine students and naval cadets. The analysis and advantages will be discussed between real and simulated systems.

Key words: FESTO simulator, ship’s systems, automation, algorithms.

I. Introduction

The modern vessels are equipped with unattended machinery spaces and high automation level. In the same time educational requirements and maintenance skills for operational staff going up. Lately computer-based simulators with different types of ships, engines and systems are used for training of marine officers. But the question for practical skills with real techniques stayed open. And the current price for it is impossible for a lot of educational structures. Therefore the solution could be usage of real didactic element simulators with adaptive algorithm regards to the system presented. The FESTO simulator is a good example for such a system.

II. Models done

The FESTO simulator consists of few main systems – pneumatically, hydraulically, electrically and programmed logically controllers(PLC). The different algorithms are implemented by PLC software. Input signal are coming from sensors, push-buttons and transmitters. Output signals are going to distributors, cylinders, hydromotors, signal lamps and buzzers. Final target is creating of simulating model which demonstrates normal work mode, different malfunctions and timer readjusting for separate operational steps. The following order for simulation could be applied:
- Collecting and researching of original system documentation.
- Projecting of operational algorithm with all steps needed.
- Elements choice maximum closed to real system like type and numbers.
- Program source code making through FESTO PLC software.
- Working scheme preparation by training software FluidSim, developed by FESTO.
- Program test with test device.
- System assembling with didactic elements and final test in action.

2.1 “Mitsubishi” purifier simulator

Fig.1 shows typical working diagram on purifier Selfjector subtype GSH-1.

The main components related with automation are:
- Automatic Control Panel- the block contained PLC
- 3- control water supply unit with solenoid valves
- 4- three-way valve for fuel admission (pneumatically controlled)
- 5- three-way solenoid valve controlled 4.
- 6- Multi-Monitor(MM) unit
- 7- Cleaned fluid pressure sensor
- 8- RPM sensor
- 9- Circulation line pressure sensor

Fig.2 presents the main algorithm repeats with the HIDENS mode.

The water and/or sludge discharge and separation processes are repeated by determined time interval with normal automatic operation. Two PLC units are connected in “Master-Slave” scheme due to numbers of I/O signal are too much for one. The program source code is the same independent of work mode – HIDENS or PURIFIER. Readjusting of time intervals T002 and T003 needs only.

Diagram of connected elements on the simulator (Fig.3).

Specification:
1 – air compressor(6-8 bars).
2 – compressed air bottle.
3 – hand drain air filter.
4 – pressure reduction valve.
5 – pressure gauge.
6 – 5/2 distributor with electrical control for pilot and supply air to 10 and 16.
7 – 3/2 distributor with hand controlled switch.
9,11 – 3/2 distributor with mechanical roller control for supply air to 12.
10 – double acting cylinder with reciprocating piston simulating bowl rotation.
12 – 5/2 distributor with electrical control for pilot and supply air to 10 and 16.
7 – 3/2 distributor with hand controlled switch.
9,11 – 3/2 distributor with mechanical roller control for supply air to 12.
10 – double acting cylinder with reciprocating piston simulating bowl rotation.
12 – 5/2 distributor with pilot air control actuating 10.
13,14,15 – 5/2 distributor with hand switch control actuating elements 17,18 and 19.
16 – pneumatic cylinder with single action.
17,18,19 – double-acting pneumatic cylinder.
20, 21, 22, 23 – capacitive sensors instead of revolution sensor, pressure sensor at circulating line, revolution sensor and pressure sensor at clean fluid outlet.
24,25,26 – 5/3 distributor with electrical control and spring for air supply of 27,28,29,30 and 31.
27,28,29,30,31 – pneumatic cylinders with single action instead of electromagnetic valves SV1, SV2, SV3, SV4, and SV9.
32 – buzzer activated with introducing alarm signal.
33 – lamp for electromotor stop signal.
34 – lamp for “High water contamination” alarm.
35 – lamp for “Bowl not open” alarm.
36 – lamp for “Fuel leakage” alarm.
2.2 Simulator of remote control (RC) system of ship main engine (ME).

Stand assembling requires a proper choice of pneumatic, hydraulic and electric elements to be created more realistic scheme. The main elements used for are:
- Pneumatic cylinders – single and double acting.
- Distributors 3/2 and 5/2 type.
- Logic function valves „AND“ and „OR“.
- Non-return valves.
- Lamps and buzzers for alarm signals.

The diagram is divided at five main units:
1. Turning gear.
2. Remote control.
3. Reversing mechanism.
4. Air starting mechanism.
5. Simulating of output power – ship propeller shaft.

IV. Results analysis

4.1 Differences between simulator and real separator. Main difference coming from PLC’s applied in the simulator. The presence of discrete (digital) inputs only is disadvantage in this case. It is impossible to be connected analogue sensor with this PLC type, i.e. values like pressure, temperature and revolutions are unable. Also the main PLC number of input/output ports is insufficient. For timers or counters readjusting it needs PLC to be connected with computer with installed program interface. At the real purifier this activity could be done directly through display situated on control panel.
- The centrifugal bowl rotation could be simulated with real drum instead of pneumatic cylinder and smoothly rpm increasing would be shown. So the centrifugal clutch will be expressed.
- The diagram and element connections could be exchanged so that alarm resetting without distributor 7 comes back in initial condition and the cylinder 10 not to be activated again.

4.2 The drawing presents RC system in realistic and well-introduced manner.
- Each trainee is able to control the system processes which are very closed to the real and on board are difficult for simulation.
- The scheme solution consists enough alarms activated when improper steps or activities are detected. The visual and sound signals are included.
- Possibilities for simulation and education with software comes before real diagram assembling.

Disadvantages:
- This project follows operational algorithm of real one but the didactic elements are not equal with real valves.
- Control console is missing like “Emergency” but also “Bridge” and “Control room” units.
- The propeller rotation is simulated by hydraulic motor.

V. CONCLUSION

These two simulators have established already their possibilities in the education trainings with students and cadets. They have been used for post-graduated courses with ship engineers and also for specialized pneumatic and hydraulic trainings. The simulators were good scope from collaboration between lecturers, students and naval cadets.

REFERENCES:
CHALLENGES OF BLENDED LEARNING

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Abstract: The nature of blended learning is expressed through dynamic educational process streaming towards perfect match of teaching and technology. That alone represents a blended learning strength for both, academic and business world. In higher education blended learning has been not a new term, but has intensively attached the importance owing to rapid development of available digital and social media that have been utilised for adequate learning environments. This paper identifies core issues and points to the challenges of this delivery mechanism in higher educational context. Some experience in the development of engineering graphics blended course is presented along with few directions for future course redesign and research.

Keywords: BLENDED LEARNING, ENGINEERING GRAPHICS BLENDED COURSE

1. Introduction

Blended, hybrid, mixed or interactive learning are all terms for the trend that has been widespread but always new owing to its permanent modification. The definition of blended learning has been not unique and has varied widely outgoing from the holistic approach to the subject that is not limited to academic area.

The definition according to [1] is worth to be cited first, owing to its approach generally applicable and not time limited. “Blended learning is defined as structured opportunities to learn, which use more than one learning or training method, inside or outside the classroom”. This definition embraces the factors essential for the recognition, distinction and valuation of blended learning: different learning or instructional methods (lecture, discussion, guided practice, reading, games, case study, simulation), different delivery methods (live classroom or computer mediated), different scheduling (synchronous, or asynchronous), and different levels of guidance (individual, instructor or expert led, or group/social learning).

Blended learning introduces and utilises new information and communication technologies for the development of innovative learning environment to transform and improve learning. The benefits of traditional and distributed environment have been combined and re-evaluated again and again to achieve optimal learning results. The information and communication technologies are not just a supplement, they don’t simply replace traditional learning system; they become an active part of novel one [2, 3, 4].

The way the technology and teaching are conducted and combined to transform, improve and maximize the learning process, is explicitly included into numerous definitions of blended learning.

In [2], blended learning is defined as integrated online and traditional face-to-face activities in a planed pedagogically valuable manner.

The effort was made to reduce three commonly used definitions to one essential [5]. This definition embraces two separate models that have been historically combined as the foundation of blended learning system: “Blended learning system combines face–to-face instruction with computer mediated instruction”. Two definitions that were omitted are related to the combination of instructional modalities or delivery media and to the combination of instructional methods, which is in authors’ opinion laid too broadly and can involve virtually all learning systems. Furthermore, the author emphasizes the central role of computer-based technologies outgoing from the definitions of blended learning. Heik states [6] that “it was only a matter of time before learning become “blended” by necessity”, hinting to the emerging role of digital and social media.

The trends coming from the past, taking place in the present state and predicting the future, are depicted on Fig.1 [5]. The approaching tendency of traditional face-to-face environment and permanently growing distributed one has been obvious thus keeping the continuous change of blended learning always actual.

The concepts embedded in the definition of blended learning can be found in [7] that give the emphasis to learning outcomes instead of the combining and matching different learning technologies and personal learning styles in order to maximize learning.

According to [8], the redesign of instructional model is characterised by the shift towards the student-centred instruction, increased interaction between all subjects, and integrated assessment mechanisms for instructor and student.

The following learning elements are respected when considering pedagogical decisions during the development of blended learning: “content, reflection, social/emotional, collaboration and student-generated content, dialectic/questioning, and synthesis/evaluation” [9].

In [10] blended learning is referred to four different concepts for the accomplishment of specific aim:

- to accomplish an educational goal → the combination or mixing of web-based technology modes
- to produce an optimal learning outcome with or without instructional technology → the combination of various pedagogical approaches
- the combination of any form of instructional technology with face-to-face instructor led training
- to create a harmonious effect of learning and working → the mixing and combination of instructional technology with actual job tasks.

Fig. 2 represents the matrix with constitution of blended learning that enables to distinguish what is and what is not its part [11].
In order to achieve the balance between online and face-to-face components of blended learning, important issue is how to blend. The challenge is to include the strengths and exclude the weaknesses of each learning environment (Fig. 3). The desirable amount of face-to-face and online learning varies for every course. The decision about the ratio of blending components depends on the nature of instructional goals, student characteristics, instructor background, and online resources [3].

The report about experimental comparisons of learning by means of meta-analysis was performed by U. S. Department of Education [12]. It was concluded that blended instruction is more effective than conventional face-to-face one. Furthermore, "when used by itself, online learning appears to be as effective as conventional classroom instruction, but no more so".

2. Models and Levels of Blended Learning

The development of blended learning by combining two modes of learning, face-to-face and online may occur at different organizational levels. In [5], blended learning examples are presented that arise at four different levels: activity level, course level, program level, and institutional level. The blending occur powered either by the learner at institutional or program levels, or by the designer/instructor developing the blended learning at the course or activity levels.

Two ways to categorise models are given in [11]: by considering the amount of time spent online versus a time spent for face-to-face learning, and by evaluating the relative extent to which these two learning environments are integrated. Fig. 2 shows that each blended learning model is therefore represented as specific combination.

Some authors alert that blended course should be not viewed just through certain percentage of online and face-to-face instruction, but primarily as integrated and complementary learning with certain implementation of two environments advantages [8, 11, 13].

In this paper the attention is paid to a course level blending that is very frequent and well elaborated in literature [2, 8, 11]. It encompasses separate face-to-face and online parts of the course that both, overlap in time or not.

The survey in the report by Clayton Christensen Institute [14] gives more detailed distribution of blended learning methods. In Fig. 4, blended learning methods are positioned related to the location that determines specific model of learning. Rotation Model and Flex Model are accomplished predominately on brick-and-mortar location, while A La Carte Model and Enriched Virtual Model represent entirely online learning. Starting from four models, the first one Rotation Model is subdivided into additional four models: Station Rotation, Lab Rotation, Flipped Classroom, and Individual Rotation.

Entirely online course is taken by A La Carte Model that can be accomplished either on the brick-and-mortar location or off-site. Students have the possibility to take some courses A La Carte and others face-to-face at a brick-and-mortar location. Enriched Virtual Model differs from the Flipped Classroom and fully online course because the students have seldom face-to-face learning every weekday and the face-to-face learning parts are required.

The engagement of new technologies and new pedagogical approaches for the development of blended learning are rapidly changing the blended learning models and the relationships among them.
and - paper assignments). The definition of Lab Rotation model differs from the previous Online Lab model as students rotate between the classroom and computer lab. The meaning of Flex Model is the same for the authors regardless of temporal distance. One of the most implemented and recent blended learning Online Driver model, is widely known as Flipped Classroom Model and the learning method as “flipping” [2, 14]. The students learn online delivered course material at their own pace, and in the classroom the emphasis is given to learning that provides individual help and improves student-lecturer interaction.

3. Blended Learning in Higher Education

The challenges of blended learning in higher education are numerous and their emergence is encouraged permanently based upon the innovative technological developments and interaction through traditional learning environments, which emphasises blended learning transformational force.

For higher education courses blended learning has become the reality characterized by continuous investigation and debates of the benefits, potential and effectiveness to transform and improve the learning process. New, highly interactive, meaningful and student-centred blended learning environments have been developed fostered by the current and advanced technologies. The convergence of traditional face-to-face and distributed learning environment that were sharply separated in the past has been in progress by developing blended learning environment. Different media/method combinations and the needs of different audiences have enabled the approach of face-to-face teaching in a lecturer-centred environment and person-to-person classroom activities, and distance learning system based on self-paced learning.

Numerical indicators cited by the authors, support the fact that blended learning has been embedded through higher education. In 2005 [16], was found that 93% of doctoral programs and 99% of master’s programs, but only 50% of baccalaureate programs offered blended learning classes. In [6], a short section is given considering online course frequency and going from 2003 when roughly 10% students in higher education took an online course, to 2014, when was projected that 50% of all post-secondary students would take at least one class online.

Christensen et al. [17] predicted that by 2019, 50% of all high school courses would be delivered online.

Dzuiban et al. [8] believe that “the transformational nature of blended courses creates complicated interactions among many components of the university similar to those found in the literature regarding complex and social system theories.” The primary changes in the roles and expectations of faculty, students, and administrators are presumed. As regards the student population, the learning environment drastically differs from face-to-face one. The student is forced to approach with more responsibility towards blended courses with continuous and active involvement.

The presented results of research into blended learning in undergraduate studies have considered different methods of teaching and the applied recent technology. In the authors’ opinion [4], the use of new information and communication technologies along with face-to-face learning and the developed new learning environment, demand serious and intensive examination of the effect upon student’s learning. The research was performed in two steps. First step dealt with the effect of involved blended learning on the obtained outcomes that was examined based on the dropout rate and the proportion of exam passes in the considered classes. Secondly, the students’ experience of the process was analysed through three aspects of their perception: the gained benefits, the effect on their learning experience and the derived satisfaction degree. Therefore, two outcome measures were combined, an objective measure regarding the final exam, and a subjective measure expressing perception of the applied blending learning. The conclusion was that the implementation of blended learning positively effects on both, students’ final course success and positive attitude towards learning.


At the University of Rijeka Faculty of Engineering, Croatia (afterwards Faculty of Engineering) considerable progress has been obvious in the first decade of this century as regards the acquisition and utilization of recent hardware and software. These intentions and possibilities have been crucial for the development of up-to-date engineering curriculum, as this necessity was recognised earlier but the realisation was limited by the circumstances. The favourable environment coincided with the transformation of studies through the Bologna process and the development of new curricula.

The studies of Mechanical Engineering and Naval Architecture as well as newer study of Computer Engineering at the Faculty of Engineering, all included the course dealing with engineering graphics, although not covered with equal course hours. Until the year 2008 when the curricula according to the Bologna process were implemented, engineering graphics course involved traditional teaching form where the classroom face-to-face teaching was combined with exercises based upon the use of computer and adequate commercial engineering software. The efforts were made primarily to keep this basic hardware and software always up to date, and to include new contents too, in spite of the inability to accordingly redesign the course.

Along with available resources progress, engineering graphics course redesign has occurred going towards student-centred environment. The changes embraced the method and media for delivery followed by adequate modification of course content and starting from the course goals/objectives consistent with Bloom’s taxonomy.

The course management system MudRI [18] was adopted at the University level that allows certain course designer to choose the range of possibilities offered by the system that best corresponds to the course nature and objectives.

The students approach the system by the allotted electronic identity [19] and the corresponding course password. A blended learning sequence consists of face-to-face lectures and laboratory exercises complemented by available on line resources that are not limited to the course management system.

Through the course management system students can access to general information about the course, the course content, and the additional text guides and examples related to the assignments and all forms of assessment (home works, projects, final exam). The created environment with the course content on-line gives the opportunity to make insight into the content that will be the coming one through face-to-face learning, and enables the self-paced learning. A certain content regarding the development of engineering graphics documentation is completely delivered on line and removed from the classroom.

The final student’s scores cover the results of different assessment forms that are performed during the semester (attendance and activities at lecture and laboratory classes, homework, projects) and the exam at the end of semester.

The course management system has considerably improved the communication and the interaction velocity relating both, lecturer-student(s) and student(s)-student(s), by means of forum and/or e-mail.

As engineering graphics courses run through the first year of study that is characterised by high student numbers, a blended course facilitates the delivery of course material and improves the communication. In the same time huge student population requires an extra effort to adopt proper ratio of face-to-face and on line instruction through the course management system in order to develop balanced and effective blended course.

The intended future efforts would be small steps in the course redesign firstly towards more effective communication and interaction based upon the increase of on line instruction and
the decreased participation and the lack of flexibility. In computer mediated environment, and for face-to-face environment these are human connection are in the same time disadvantages of computer spontaneity of class discussions. The absence of spontaneity and human connection are in the same time disadvantages of computer mediated environment, and for face-to-face environment these are the decreased participation and the lack of flexibility.

Some factors of influence are to be more weighted than others that are set without the possibility of intervention and regulation. First of all it is the number of students that are engaged at the courses under consideration and the corresponding number of classes needed. As the courses belong to the first year of study, the question of student’s motivation and the achieved final success is crucial for both, the courses reputation and studies credibility.

Today’s environment is promising for the acquisition and engagement of new technologies that are essential driver for the course redesign which can certainly redraw students attention and improve their motivation. In order to benefit from, the required resources have to be provided.

Another issue that is not less important concerns the reconsidering of course management system possibilities in relation to additional or other ways of student’s assessment.

The intention is to evaluate possible expected improvement of learning efficiency obtained through redesigned blended course by collecting data that concern variety of aspects.

5. Conclusion

The strength of blended learning built in its basic and mostly used definitions comes out of the combined face-to-face and online teaching methods into one integrated instructional approach.

Numerous benefits of blended learning have been reported based on its possibility to take advantage of certain environment strength and to avoid less effective elements.

Osguthorpe and Graham [3] listed and described six goals that might be expected when developing blended environments: pedagogical richness, access to knowledge, social interaction, personal agency, cost effectiveness and ease of revision.

In [5] three reasons are extracted and elaborated that foster the attractiveness of blended learning spreading: improved pedagogy, increased access/flexibility and increased cost effectiveness.

Many works explicitly indicate the benefits of blended learning, such as: class goals that can be easily met, redesigned courses with easily measured educational outcomes, students can collaborate on their own time, enhanced computer literacy of students and lecturers, temporal independence of student, improved communication, the reduced rates of drop, fail and withdraw.

The achieved benefits of blended learning model and its impact on the learning effectiveness improvement, depend on how are face-to-face and computer mediated instructions blended, i.e. how successfully the peculiarities of actual environment through which blended learning is developed are taken into consideration.

5. Literature


EQUIPMENT OPTIMIZATION IN REGIONAL AGRICULTURAL LOGISTICS CENTERS

ОПТИМИЗАЦИЯ ОБОРУДОВАНИЯ РЕГИОНАЛЬНЫХ АГРАРНЫХ ЛОГИСТИЧЕСКИХ ЦЕНТРОВ

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Abstract: A regional agricultural center is a key link in the system of supplying Georgian standard citrus cultures to the goods markets of European countries. The elements of such logistics centers are united into three groups which comprise three large logistics divisions – supply, production and distribution.

Optimization of the production subdivisions and technical equipment is carried out on the basis of optimizing the whole center by developing a simulation model based on statistical modeling of random streams. At first, a structural-parametrical (qualitative) model of agricultural center was developed. For optimizing the center’s technical equipment and operating standards, the combined optimization parameters have been developed. Based on the objective function formalization, there has been developed a system model of planning and optimizing of agricultural center by developing the system constraints. Optimization and algorithmization of subdivisions and the whole system are carried out by decomposition of model on separate blocks, which correspond to separate subsystems of the center.

KEY WORDS: REGIONAL LOGISTICS CENTER, LOGISTICAL SYSTEM, SIMULATION MODEL, STRUCTURAL-PARAMETRICAL MODEL, DECOMPOSITION, ALGORITHIZATION.

1. Introduction

Export delivery chain of citrus cultures is a complex macro-logistical international transport-logistical system, whose central core is a regional agricultural logistics center. In the center, there are carried out production and processing of products. It has the possible sustainable communications with suppliers and customers.

On the basis of the management principles of delivery chains, in the conditions of unlimited impact of environmental factors, there has been selected the type of a model of system optimization.

2. Preconditions and means for resolving the problem

For modeling of logistics processes that take place in agricultural center we introduce the following designations: $K$ – index of the citrus production farming enterprise $(k \in K)$; $i$ – index of peripheral pick-up and production sections $(i \in m)$; $j$ – index of a regional logistics agricultural center $(j \in n)$; $j_1$ – index of citrus pick-up and processing technological shop $(j_1 \in G_1)$; $j_2$ – index of temporary storage of sorted citrus cultures in refrigerating store $(j_2 \in G_2)$; $j_3$ – index of preservation technological shop $(j_3 \in G_3)$; $j_4$ – index of packaging and consolidation store $(j_4 \in G_4)$; $j_5$ – index of temporary storage of finished products $(j_5 \in G_5)$; $j_6$ – index of products delivery section $(j_6 \in G_6)$; $\mu$ – index of motor transport motive power types $(\mu \in \xi)$; $\mu_1$ – index of rolling equipment types $(\mu_1 \in \xi_1)$; $i_1$ – index of picked citrus types $(i_1 \in I_1)$; $i_2$ – index of sorted citrus types $(i_2 \in I_2)$; $i_3$ – index of preserved citrus finished product types; $i_4$ – index of citrus fruits transportation mode $(i_4 \in I_4)$; $i_5$ – index of citrus temporary storage mode in refrigerating store $(i_5 \in I_5)$; $p$ – index of the equipment for roots and packaging means $(p \in P)$; $\delta$ – index of the used transport package types $(\delta \in \Delta)$.

When implementing various projects in the field transport and logistics, there is envisaged the combined optimality criterion.

It represents: determining the effects by comparing the obtained integral results $P_i$ and costs $Z_i$; discounting the requested rates on capital and results at the initial stage, and taking into account the inflation bonus $\tau$ of discount rate $i$. These indicators are as follows: present net value maximum $\text{max}SDS$ and profitability index ($SI$), internal rate of return $\text{MSN}$. For the optimal version, the following conditions should be satisfied $SDS \geq 0$; $SI \geq 1$; $\text{MSN} \geq I^n$. The formulas for calculating the combined criteria are as follows:

$(1)$
$$\text{max}SDS = \sum_{i=0}^{T} \left( P_i - Z_i \right) \frac{1}{([1+i](1+\tau))^t} \geq \sum_{i=0}^{T} K_i \frac{1}{([1+i](1+\tau))^t}.$$

The profitability index is the ratio of the sum of the reduced effects to the value of capital investments

$(2)$
$$SI = \frac{1}{K} \sum_{i=0}^{T} \left( P_i - Z_i \right) \frac{1}{([1+i](1+\tau))^t}.$$

If $SDS \geq 0$ and $SI \geq 1$ – the project is effective and it can be implemented.

An internal rate of return $\text{MN}$ is that rate of discount, with which the value of the reduced effects equals the amount of the reduced capital investments

$(3)$
$$\text{MSN} = \sum_{i=0}^{T} \frac{P_i - Z_i}{([1+i](1+\tau))^t} \geq \sum_{i=0}^{T} P \geq E_{\text{in}}^{\text{min}}.$$

When determining effectiveness and modelling of the logistics objects, there should be examined the system “input-process-output”.

The designing and management model of agricultural center is developed on the basis of its structural-parametrical model. Each group in the structural-parametrical model is represented by vector.

The model is presented in the following form: $\vec{X}_j$ – is a vector of the input control (uncontrolled) parameters; $\vec{\phi}(t)$ – a vector of the intermediate parameters; $\vec{Z}(t)$ – a vector of the output controllable (state) parameters; $\vec{Y}(t)$ – a vector of the output controllable (state) parameters; $\vec{g}(t)$ – a constraint vector.
The output parameters of mathematical model of the center, which represent its functioning are divided into: 1. General parameters of functioning of the center: \( Q_{j1} \); \( P_{j1} \); \( K_{j1} \); \( C_{j1} \); \( R_{j1} \); \( SDS_{j1} \); \( MSN_{j} \); \( SI_{j1} \); 2. Economic indicators of operation of each sub-system of the center: \( K_{j2} \); \( C_{j2} \); \( Q_{j2} \); \( Q_{j2}^* \); \( P_{j2} \); \( N_{darnj} \); \( S_{j} \); \( r_{j}^d \); \( S_{j}^{pr} \); \( r_{j}^{pr} \); \( r_{j}^{cad} \); \( r_{j}^{cad} \); \( t_{ext} \); \( N_{j} \); 3. Labor resources and specific indicators assessing parameters: \( P_{opt} \); \( P_{req} \); \( P_{amp} \); \( C_{sd} \); \( 3_{max} \); 4. Specific indicators.

Comparison of different versions of the investment projects of the agricultural center and selecting the best one from them is recommended to be carried out on the basis of: net present value (NPV); profitability index (\( \Pi \)); internal rate of return (\( i_{IRR} \)); and recoupment period (\( T_{rec} \)). This problem can be presented in the vectorial form as follows:

\[
\vec{\Pi}_{jAC} = \text{Y}
\left( \max \vec{Q}_{jAC}^{br}; \max \vec{P}_{AC}; \min \vec{3}_{AC}; \max \vec{R}_{AC}; \max \vec{SDS}_{AC} \right).
\]

The methodology for different ways of solving multicriteria problems is described in the professional literature [3,4].

In order to construct a mathematical model of the center it is necessary to formulate the set of all constraints of the system and general intersubsystem constraints, select the objective function for each of them and for the system as a whole. The objective function, in the general form and with account for auxiliary criteria, is represented in the form of the equations (1-4).

For developing a mathematical model there are used the following designations [1].

In general, the optimal equipment of the regional agricultural center and selecting the best one from them is recommended to be carried out on the basis of: net present value (NPV); profitability index (\( \Pi \)); internal rate of return (\( i_{IRR} \)); and recoupment period (\( T_{rec} \)). This problem can be presented in the vectorial form as follows:

\[
\vec{\Pi}_{jAC} = \text{Y}
\left( \max \vec{Q}_{jAC}^{br}; \max \vec{P}_{AC}; \min \vec{3}_{AC}; \max \vec{R}_{AC}; \max \vec{SDS}_{AC} \right).
\]

The condition of variables integrality and positivity property:

\[
\sum_{i=1}^{i=5} \sum_{j=1}^{j=5} X_{j_{opt}} = \sum_{i=1}^{i=5} \sum_{j=1}^{j=5} A_{ij_{opt}} \cdot \beta_{ij}.
\]

2. The condition of meeting the demand for finished products

\[
\sum_{j_{opt}} \sum_{i=1}^{i=5} \sum_{j=1}^{j=5} X_{j_{opt}} = \sum_{i=1}^{i=5} \sum_{j=1}^{j=5} X_{j_{opt}} = \sum_{j_{opt}} \sum_{i=1}^{i=5} \sum_{j=1}^{j=5} D_{j_{opt}} = \sum_{j_{opt}} \sum_{i=1}^{i=5} \sum_{j=1}^{j=5} D_{j_{opt}}.
\]

3. The condition of using of roots and packaging

\[
\sum_{p_{opt}} \left[ (1 + K_{opt} + K_{rem}) \sum_{t=1}^{t=5} \sum_{j=1}^{j=5} \left( X_{j_{opt}} \cdot \beta_{ij} \right) + \sum_{p_{opt}} \sum_{t=1}^{t=5} \left( G_{j_{opt}} \cdot T \right) \right] \leq N_{j_{opt}} + N_{j_{opt}}.
\]

4. The condition of using of labor resources

\[
\sum_{i=1}^{i=5} \sum_{j=1}^{j=5} \sum_{k=1}^{k=5} \sum_{m=1}^{m=5} Q_{j_{opt}} \cdot H_{j_{opt}} \leq SR_{j_{opt}}.
\]

where, \( r \) – labor resources multiplicity index; \( H_{j_{opt}} \) – labor resources norms when performing the operations; \( SR_{j_{opt}} \) – the condition of the existence of labor resources multiplicity during the time of market sub-systems \( G \).

5. The condition of variables integrality and positivity property:

\[
X_{j_{opt}} \geq 0; X_{j_{opt}} \geq 0; X_{j_{opt}} \geq 0; X_{j_{opt}} \geq 0; X_{j_{opt}} \geq 0; X_{j_{opt}} \geq 0; X_{j_{opt}} \geq 0; X_{j_{opt}} \geq 0.
\]

A mathematical model (5-10) is solved through its decomposition on the separate blocks, which correspond to the sub-systems and components of agricultural center.

3. Conclusion

1. A regional agricultural center is a multi-purpose complex, production logistical system. It pertains to the category of integrated production-distributing logistical systems, which operates under conditions of ambient probability-infinity factors;

2. Studies of optimizing technical equipment and operation of agricultural center should be carried out on the basis of methodology for analysis and synthesis of the complex systems, which envisages its structural-imitating modeling based on statistical simulation. The use of these models allows taking account for real working conditions in designing that increases efficiency of designing.

3. With the purpose of extension of operation life of agricultural center, we believe that it is expedient to raise the issue of increasing operation durability of such-type objects by changing their specialization that will ensure its operation throughout the year.

4. Literature


METHODOLOGY OF TICKET MACHINE DESIGNING IN PASSENGER RAILWAYS VEHICLES

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Abstract: The task of integrated transport system in passenger transport is connection between their other modes. One part of implementation of integrated transport system is set up the ticketing system for validation. This problem can solving by the ticket machines and their location. When ticket machines are located in vehicle, we create conditions for Self-Service System in public transport.

The paper is focused on the description of factors, which influences number of ticket markers in railway passenger vehicles. For example these factors is circulation time of vehicles, transport distance, travel speed and etc. One part of paper includes the methodology of calculation the ticket markers for rail passenger vehicles.

KEYWORDS: INTEGRATED TRANSPORT SYSTEM, MARKING MACHINE, THE SELF-SERVICE SYSTEM, TRANSPORT TICKET VALIDATION

1. Introduction

Integrated transport system (ITS) allows passengers to use one ticket by travelling with all transport modes in integrated area. The important question by the ITS is to solve problems with service system of passengers. Service system of passenger can be in several forms. One of the ways to ensure passenger expedition is located the ticket machines to vehicles. When ticket machines are located in vehicle, we create conditions for Self-Service System in public transport. Carrier has not ensured a conductor that will be validating the travel ticket. When carrier is using Self-Service system, passenger must validate the travel ticket in ticket machines after entry into the vehicle. The advantage for carrier, which is using of Self-Service system, is low economic burden (personal costs).

2. Self-Service system

One form of Self-Service system is based on the location of ticket machines in vehicles. The most frequent place, when the ticket machines are located is the place near to door of vehicle. (Fig. 1).

Fig. 1 Place for the ticket machine in vehicle

Railway lines and vehicles with Self-Service system in use are identified by special symbol (Fig. 2). This system for passenger is known from public transport. The Passengers must buy transport ticket even before the boarding vehicle on. For passenger it is compulsory to validate transport ticket by ticket machine as soon as possible.

Fig. 2 Pictogram of Self-Service system

3. Basis for determining the number of ticket machine

Methodology for calculation to required number of marking machines is based on the theory of modelling the transport systems in passenger transport. The modelling the transport system imposes requirements for the relocation of persons, i.e. transport elements – passengers. The bases for determining the required number of marking machines are:

- Transport network of integrated area
- Distance matrix.

3.1 Transport network of integrated area

Transport network of integrated area is composed of a finite set of nodes and edges (Fig. 3). Edges on the transport network (marked by green colour) create oriented connections between two nodes. On these edges are moving ensembles. Ensembles are moveable objects in the transport process (for example train is ensemble).

Fig. 3 Transport network of integrated area

3.2 Distance matrix

For all edges of transport network we can define its long distance (S), capacity (c) and speed (v). Long distance of single edges in integrated area is possible record write down in the distance matrix. (Tab. 1).

Table 1: Distance matrix

<table>
<thead>
<tr>
<th>i/j</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>39</td>
<td>88</td>
<td>58</td>
<td>105</td>
</tr>
<tr>
<td>1</td>
<td>39</td>
<td>0</td>
<td>49</td>
<td>19</td>
<td>66</td>
</tr>
<tr>
<td>2</td>
<td>88</td>
<td>49</td>
<td>0</td>
<td>68</td>
<td>17</td>
</tr>
<tr>
<td>3</td>
<td>58</td>
<td>19</td>
<td>68</td>
<td>0</td>
<td>85</td>
</tr>
<tr>
<td>4</td>
<td>105</td>
<td>66</td>
<td>17</td>
<td>85</td>
<td>0</td>
</tr>
</tbody>
</table>
4. The calculation the required number of marking machines

The exact number of marking machines, which will be equipped ensembles in the integrated area, depends on the following factors:

- the design of the door on the set,
- composition sets (train composition),
- the number of sets.

4.1 The design of the door on the set

Set is a dose (rail vehicle) that is creating by the defining rules. When replenish a dose with appointed objects, we are create the ensemble.

The technical design of the door on the set affects the number of marking machines, which are located near the door. Also type of transport influences the technical solution of door on the vehicle.

Technical solution of used doors can be divided:

- single door (Fig. 4) – simple wing with basic (standard) width,
- one and half size – simple wing (wider single doors),
- double doors (Fig. 5) – usually double wings with double width.

Vehicles are using on these type of transport:

- long distance transport,
- regional transport,
- sub-urban transport.

Set with single technical construction of door are mostly using on long distance transport. Long distance trains create the frame of rail passenger transport [1]. This type of train stops only on the main stations, therefore entrance and exit of passenger from vehicle is not often. Single construction of door allow to entrance (or exit) only one passenger at the same time. In this type of vehicle we must located one marking machines by every door.

![Fig. 4 Technical solution of single door](image)

Public transport is provided by regional trains to shorter distance [2]. In this case is technical construction of doors on a half size. This construction allow to faster entrance (exit) of passengers to vehicle, but only one passenger can boarding at the same time.

Another situation is in the sub-urban transport. Technical construction of door in sub-urban trains is double and two passenger can entrance (exit) to vehicle at same time. Based on this situation it is necessary located two marking machines at the door. Sets with this type of doors is provided on the regional trains, where is high frequency of passengers.

![Fig. 5 Technical solution of double doors](image)

Based on the technical contraction of door on the vehicle are determined the coefficients technical solutions of doors (CD). Tab. 2

<table>
<thead>
<tr>
<th>Solutions of doors</th>
<th>$C_D$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single door</td>
<td>1</td>
</tr>
<tr>
<td>One and half size</td>
<td>1</td>
</tr>
<tr>
<td>Double doors</td>
<td>2</td>
</tr>
</tbody>
</table>

4.2 Composition sets (train composition)

Railway undertaking must provide on the integrated area transport performance sufficiently. Transport performance in public transport is established based on order from public authority.

Traffic performance is determined on the basis of train-kilometers (ordering unit) [3]. The formula for its calculation is following:

$$N_{\text{train.km}} = \sum_{i=1}^{n} q_i \times S_i \ [\text{train.km}]$$  \hspace{1cm} (1)

where:

- $N_{\text{train.km}}$ train-kilometers [train.km],
- $q_i$ number of sets [train],
- $S_i$ distance between two nodes [km].

The transport performance is determined on the basis of seat-kilometers [3]. The formula for its calculation is following:

$$N_{\text{seat.km}} = \sum_{i=1}^{n} K_i \times S_i \ [\text{seat.km}]$$  \hspace{1cm} (2)

where:

- $N_{\text{seat.km}}$ seat-kilometers [seat.km],
- $K_i$ capacity of sets [seat],
- $S_i$ distance between two nodes [km].

Based on the proportion of these indicators is determinate average capacity of ensembles, i.e. average composition of ensembles.

$$N_{\text{capacity ensembles}} = N_{\text{seat.km}} / N_{\text{train.km}} = \sum_{i=1}^{n} K_i S_i \ [\text{seat.train}^{-1}]$$  \hspace{1cm} (3)

where:

- $N_{\text{capacity ensembles}}$ average capacity of ensembles.

4.3. The number of ensembles

The average capacity of ensembles (trains) is not sufficient indicator the number of marking machines, which carrier need to place in the vehicle. The next necessary indicator is number of ensembles (trains), which railway undertaking will be provided transport serviceability on the integrated area.

At first, it is necessary to determine the train hours that specify what is the time period of serviced activity in conditions of selected line section performance.
Calculation formula is:

\[ T_h = \frac{\sum t_s \cdot S}{V_{oe}} \text{[train.hours}^{-1}] \]  \hspace{1cm} (4)

where:

- \( T_h \): train hours [train.hours}^{-1}],
- \( V_{oe} \): the rate of turnover ensembles [km.h}^{-1}].

Turnover rate of ensemble depends on the length of line section, travel time and well time in the station. In terminal station (terminus) it is needed to calculate with an additional time of operational preparation of vehicle (cleaning, refilling of water, etc.) and the waiting time for the next performance (Fig. 6).

![Fig. 6. The ensembles turnover period](image)

Formula for calculating the rate of turnover follows:

\[ V_{oe} = \frac{S}{t_s + (t_r + t_z)} \text{[km.h}^{-1}] \]  \hspace{1cm} (5)

\[ t_s = t_1 + t_2 \]  \hspace{1cm} (6)

\[ t_s = t_1 + t_2 \]  \hspace{1cm} (7)

\[ \sum T_s = n + t_2 \text{[min]} \]  \hspace{1cm} (8)

where:

- \( V_{oe} \): the rate of turnover ensembles [km.h}^{-1}],
- \( S \): long distance [km],
- \( t_s \): travel time [min],
- \( t_r, t_z \): margin to start and stop [min],
- \( t_{op} \): the time of operational preparation of ensembles [min],
- \( W_t \): the waiting time for the next performance [min],
- \( n \): number of nodes,
- \( t_s \): times stay[min].

Turnover rate of ensembles can also be calculated using a traveling speed. However, in this case, the time of operational preparation of vehicle and waiting times is not considered. At the beginning of calculation it is necessary to pre-calculate proportion of travel time, cleaning time and the waiting time for the next performance. Consequently, the cruising (traveling) speed is multiplied with this factor that results in a turnover rate of ensembles.

The following formulas are:

\[ V_{tt} = \frac{5}{t_r + (t_r + t_z) + W_t} \text{[km.h}^{-1}] \]  \hspace{1cm} (9)

\[ K_{tt} = \frac{t_r + t_z + W_t}{t_r} \]  \hspace{1cm} (10)

\[ V_{oe} = V_{tt} \times K_{tt} \text{[km.h}^{-1}] \]  \hspace{1cm} (11)

where:

- \( V_{tt} \): travel speed of ensembles [km.h}^{-1}],
- \( K_{tt} \): coefficient of timetable [-].

The total amount of ensembles is set as the ratio of the train hours and operating time on the line section. It is very important to take in consider the reserve of value 15% in case of disturbances (disorders, reparations etc.)

The formula is:

\[ N_\text{e} = \frac{T_h}{t} \times R \text{[total amount of ensembles]} \]  \hspace{1cm} (12)

where:

- \( N_\text{e} \): total amount of ensembles,
- \( T_h \): train hours [train hours],
- \( t \): operation time [hour],
- \( R \): reserve [%].

Total number of ticket marker in vehicle it is provided on the base number of vehicle (train consist structure), number of doors, coefficient doors and total amount of vehicle.

The formula is:

\[ N_\text{tm} = \frac{N_\text{e \ ensemble}}{N_\text{e \ capacity}} \]  \hspace{1cm} (13)

where:

- \( N_\text{e \ ensemble} \): average of ensembles,
- \( N_\text{e \ capacity} \): average of capacity ensembles,
- \( N_\text{e \ capacity \ sets} \): average of capacity sets.

\[ N_\text{tm} = \left( \frac{N_\text{e \ ensemble}}{N_\text{e \ capacity}} \times N_\text{D} + C_D \right) \frac{1}{\frac{N_\text{e \ capacity \ sets}}{K_{set}}} \]  \hspace{1cm} (14)

where:

- \( N_\text{tm} \): number of ticket marker [number],
- \( N_\text{e \ ensemble} \): number of ensembles in ensembles [number],
- \( C_D \): coefficients technical solution of doors:
  - single door \( C_D = 1 \),
  - one and half size \( C_D = 1 \),
  - double doors \( C_D = 2 \).

5. Conclusion

Determination of marking machines depends on composition of ensembles, their numbers and technical constructions of doors in sets (vehicles).

Coefficients technical solutions of doors were determinate according to construction of doors on the vehicle. They also were determinate based on the operation of vehicle in different types of transport (long distance, regional and sub-urban). These coefficients were used to calculation to the number of marking machines, which are located in the vehicles.
Carrier is obliged to provide transport performance based on the order by public authority, with own ensembles (vehicles), on the whole integrated area. Proportion of these values (based on train and seat kilometres) gives the average capacity of the ensembles (trains).

The number of ensembles (trains) is based on the train hours and return speed of set. These values determines of time period transport serviceability of the territory. Faster transport serviceability of the integrated area we achieve with increasing of return speed of sets.

**Acknowledgement**

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THE ROLE OF BATUMI STATE MARITIME ACADEMY IN TRAINING OF THE FUTURE SEAFARERS IN ACCORDANCE WITH THE MODERN REQUIREMENTS

РОЛЬ БАТУМСКОЙ ГОСУДАРСТВЕННОЙ АКАДЕМИИ В ПОДГОТОВКЕ БУДУЩИХ МОРЯКОВ В СООТВЕТСТВИИ С СОВРЕМЕННЫМИ ТРЕБОВАНИЯМИ

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Abstract: The present paper deals with a brief history of Georgian Maritime traditions and development of Georgian seafarers. It also describes the collapse of Georgian fleet and hard condition of Georgian seafarers. A negative dynamics of the last 20 years which damaged popularization of the seafarer profession and caused letting down of the high class specialists from the fleet and their degradation. A positive dynamics of the last years - the state interest towards Maritime Education sphere is resulted in update of Maritime Academy infrastructure, material technical resources are also improved. The laboratories provided with the modern equipment and updated educational programmes tuned to the IMO requirements promote education and training of highly competitive seafarers in accordance with the international requirements.

KEY WORDS: SEAFARER, GEORGIAN FLEET, SHIPPING, MODERN REQUIREMENTS OF MARITIME FIELD.

1. Introduction

Nowadays, merchant fleet is a main factor of the world economy. It is the cheapest means of the cargo transportation which positively developing average share in the total turnover is 70%.

Taking into account the ports and the nearest’s past fleet, Georgia is considered as a country with good maritime traditions. Georgian seafarers successfully serve in the best world maritime companies. Nowadays Georgian seafarers are considered as one of the best and well paid specialists. Such position, taken in the conditions of a high competitiveness also underlines a high level of our seafarers’ training, education and competence.

Development of Georgian fleet and recognition of Georgian seafarers started in the first half of the XXth century. Establishing of the Maritime College in 1929 in Batumi promoted this process. Increasing number of competent maritime personnel, as well as the existence of the Port of Batumi promoted creation of Georgian Shipping Company. As the result, Georgian seafarers, because of their diligence and high competence served a high appreciation among the leading maritime and crewing companies. Georgian captains, chief engineers were considered as the best and required specialists. The photos and histories of the Georgian seafarers are widely kept at the maritime museums on the whole Post-Soviet space.

2. Preconditions and means for resolving the problem

The Soviet collapse and the process of the new states establishingaggravated conditions of the Georgian seafarers. Russia, as the Soviet Union heir made everything to disconnect the links between Post-Soviet shipping companies. As the result of Russian policy, the sums accumulated on the common account were not shared between the shipping companies and accordingly the shipping companies were bankrupted, at the same time, the cargoes became under Russian control which left newly created shipping companies without chances of their development. The newly created states had no proper business plans of the shipping companies development, different teams fought for political impact which caused chaos in Georgia, as well as in other post Soviet republics. Weakstatecontrol, disconnection of the business relations caused an improper management of the fleet, causing improper usage of the ships and working on the dumping prices. As the result, Georgian Shipping Company, having 56 ships was completely destroyed. The same problem was related to the Filsery Department with the tens of the trawlers, Batumi and Poti Shipyards and 10 000 t. dock. Georgian ports, despite their military-strategic importance ports were long term leased. The same problems touched maritime education - Batumi Maritime College – further Batumi State Maritime Academy, #1 Vocational College and Maritime Training Centres. All above said resulted in the fact of Georgian diplomas invalidation.

Collapse of Georgian fleet put Georgian seafarers in the hardest condition. Employment of Georgian seafarers became very difficult. There were only several crewing companies which had limited employment resource. Level of Georgian seafarers did not meet the international requirements, especially regarding the English language competence. Many experienced seafarers left maritime activity, young specialist could not get onboard training and it became difficult to link with potential employer. Only two or three crewing companies monopolized employment stating low salaries and difficult conditions. Maritime specialty gradually became nonpopular. Unfortunately there was no government support of the seafarers.

But the people having old maritime traditions and world famous maritime specialists did their best to manage such hard problems. The experienced seafarers with their love of the profession and their young energetic colleagues made their best and got serious results in the shortest terms. Georgian maritime legislation, Batumi State Maritime Academy and the training centre were tuned to the International Maritime Organization requirements. It also should be noted that as the result of the documents invalidation, Georgian maritime sphere became under the special control. It was a hard task to manage these problems. This task was successfully decided, which was appropriately stated in EMSA 2013 September report. It also should be noted that the members of commission were not only satisfied by the Maritime Agency and Maritime Academy conditions but also expressed appreciation by them. The members of commission were especially satisfied with the Maritime Training Centre and declared that the Centre is one of the best among the centres existed in the Balck Sea basin. Comparison with Turkish, Bulgarian, Romanian, Ukrainian and Russian centres was very important for our centre because the stated countries budgets considerable exceed Georgian one [3].

The main role in this success belongs to the Government of Georgia and the Ministry of Economy which during the last years despite the other critical problems put millions investment into Maritime Academy development. The great role played by Georgian Maritime Agency in this success should also be especially noted. The Agency controlled and supported Academy, especially in the process of curriculum tuning to the standards of the International Maritime Organization. The Government of Autonomous Republic also greatly supports Maritime Academy. Municipality of Batumi also supported Academy when provided BSMA with one of the most important building in which a newly constructed and equipped Training Centre was placed.
After the Soviet collapse, onboard training became the most important problem for the Academy graduates. The training is the integral part of Maritime Education. Many rectors together with the government tried to manage the problem, but unfortunately it was fruitless. It is necessary to coordinate activities of several structures and the government’s will in order to manage this problem [1].

The shipowners’ choice of personnel employment is based on their real education and training level. It is caused by a number of seafarers, exceeding the number of vacancies. At the same time, it is not a secret that many ship masters promote and provide their own countries-oriented employment policy and often unfairly block employment of Georgian seafarers. Taking above said into account education and training of our seafarers should fully correspond the international standards and protect them from possible problems.

Batumi State Maritime Academy provides all conditions, necessary to educate and train such personnel.

It is a very important fact, that some neighbouring countries which have no approach to the sea expressed their wish to send their students at Batumi State Maritime Academy. A successful implementation of this project will be the best advertisement for Academy. The choice of Batumi State Maritime Academy is caused by some logical reasons. Nowadays there are several popular higher maritime institutions in the Black Sea basin and the choice of Batumi State Maritime Academy has a set of fundamental reasons. The academic level of the students who, in the frames of academic mobility were enlisted at Batumi State Maritime Academy from the similar institutions differs from the level of BSMA students. During the last decade I worked with the graduates of different maritime institutions and can’t say that their level exceeds the level of BSMA students. It is caused by some objective and subjective reasons and the positive difference of our maritime education and training should be appropriately promoted among the structures related to the employment of the seafarers [2].

It should be noted that the countries which express their desire to provide their citizens with Maritime Education in Georgia are expected take active part in transcontinental projects and it is not excluded that were going to participate by their own fleet and personnel. It will be a patriotic activity which also should provide a great profit from the named projects.

It would be better if Georgian Government discusses Georgian fleet and seafarers participation in the process of economic development of our country’s economy. One of the main problems - manning of the fleet will be decided by the local personnel inclusion.

3. Conclusion

The role of Academy administration and the Rector should be especially noted, whose great love of the maritime sphere resulted in the Academy rapid and fruitful development process, which was appropriately appreciated by the International Maritime Organization and the crewing companies.

Such attention increased motivation and moral obligation sense of Academy personnel and created appropriate working conditions.

4. Literature

INNOVATIVE APPROACH TO THE SERVICE QUALITY IN RAILWAY FREIGHT TRANSPORT

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Abstract: This article describes the results of research focused on service quality after transportation by railway freight transport. Importance of these services completes final quality of services and it has crucial importance in customer considering on the future use of railway transport. Processes filling the customer demands and output quality assessment were defined as a part of the research. In this contribution is introduced the map of quality planning and the algorithm of applied methodology.

Keywords: QUALITY OF SERVICES, RAILWAY FREIGHT TRANSPORT, MAP OF QUALITY PLANNING

1. Introduction

Service quality in railway freight transport is possible to follow within the frame of all transportation chain or in division on its single stages. Very actual becomes problem to identify quality not only before start of transport and during it but also after ending transportation. At that time the customer often requires supplementary services, eventually, if the customer is not content with the transportation, he solves claim. (KEGA 026ŽU-4/2015)

In term of breakdown of single characters of transportation exist within the frame of world and domestic researches several methods. For needs of search within frame of research carried on Department of railway transport, University of Žilina in Žilina, in collaboration with Railway company Cargo Slovakia, Inc., was applied model, which take into account characters of transportation with linking a perception services quality in ordinary and extraordinary operation. Specifies the partial processes necessary at valuation of services quality offered, whereby are distinguish two different dimensions of quality namely routine dimension and dimension of especial condition. Both are possible watch also after realization transportation. The characters of routine dimension are typical for normal operation, when the service is provided in normal conditions.

Characters of dimension of especial condition customer expects in special situations only. It may be caused to weaker performance, a mistake by transporter as service provider, mistake caused by manager of infrastructure or exceptionality arises in connection with the necessity unusual access to customer, who requires this individuality. These characters simultaneously include also supplementary performances in care for customer, which customer not expects, for example after completion of the transportation itself. Generally according researchs expectations of customer, in order his specially requirements were solved quickly, are relatively low. In that case there arise opportunity for transporter, who can exceed expectations and leave the impression of good quality and high competences in solving problems and after ending transportation.

2. Characters of quality for the phase after ending of transportation

A wide range of metal powders (from light alloys through steels to super-alloys and composites) is currently available for DMLS process and other new materials are under development. Table 1 lists mechanical properties of selected powder materials. (Čamaj et al, 2010)

Selection of characters was realized in accordance with algorithm (see Fig. 1). Figure documents the activities, which were within the frame of research realized and served on identification of customers, determination to needs of customers and processes, which are able to reach required quality. After detailed findings and search was this scheme used as so called map of quality planning, because quality planning underway continue in these systematic steps. (Nedeliaková et al, 2014)

For the last phase of the transportation chain, after the transportation was finished, was defined six basic characters of quality in the research information, availability, reality, flexibility, customer care, understanding and knowledge of customers.

Fig. 1 Map of quality planning with selecting characters of evaluation

Characters of quality were closer explained following way (Nedeliaková et al, 2013):

Information = systematic providing of knowledge about the system of railway freight transport, which have to assist in the realization of acts after the execution of transportation.

Availability = scope of the process in terms of time, frequency, geography and suitability of railway operation techniques.
Reality = temporal, spatial and informational security of the phase after transportation, including ensuring the intactness of the consignment after transportation.

Flexibility = speed of handling complaints in case other additional customer requirements after transportation, including exact invoicing of fees for transportation.

Customer care = reinsurance of operations related with unloading of consignment in destination station, solution the problems that arise after the end of the transportation.

Understandings and knowledge of customer = help and support customer needs, knowledge of customer needs.

Figure 2 characterizes a sequence of steps that were made within application of the methodology in real conditions of the transport market.

Table 1: Rating scale

<table>
<thead>
<tr>
<th>Number of points</th>
<th>Quality level</th>
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<tbody>
<tr>
<td>0 - 20</td>
<td>unsuitable quality</td>
</tr>
<tr>
<td>21 - 40</td>
<td>partially suitable quality</td>
</tr>
<tr>
<td>41 - 60</td>
<td>standard</td>
</tr>
<tr>
<td>61 - 80</td>
<td>over-standard</td>
</tr>
<tr>
<td>81 - 100</td>
<td>fully suitable target quality</td>
</tr>
</tbody>
</table>

Characterized by way rating were monitored not only transporter services, as well as with them related equipment railway stations and it according to mentioned the data for a period of one year, when have been identified gaps in exactly defined characters of quality.

Suitably chosen methodology for identifying the level of quality of transportation services must meet the requirements in the environment transportation market Slovak Republic and in specific examples, for a selected stations and track sections to provide relevant results. This methodology allows to monitoring quality of processes provided throughout the transportation chain, therefore before the realization the transportation, during it, and after the ending of the transportation.

4. Conclusion

The benefits of methodology consist in the clarity and in selection of the new characters for rating quality of processes and services It was created universal, therefore with possibility application on the whole transportation chain providing railway freight transport. The benefit to research is newly created methodology, with exactly defining and detailed characteristic of quality characters, which is designed for the management railway companies.

The research revealed that the biggest problems occur within evaluated services with technical securing, but also with related insufficient equipment of railway stations (spaces, ramps, general loading and unloading track), or insufficient condition and number of certain types of wagons. These problems interfere up to the phase of transportation chain after the end of the transportation and play an important role in normal and extraordinary operation.

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IMPORTANCE OF MERCHANT FLIIT IN COUNTRY TRANSPORT INFRASTRUCTURE IMPROVEMENT

ЗНАЧЕНИЕ МОРСКОГО ТОРГОВОГО ФЛОТА В СОВЕРШЕНСТВОВАНИЕ ТРАНСПОРТНОЙ ИНФРАСТРУКТУРЫ СТРАНЫ

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Abstract: The present paper deals with Georgian State transitive importance, its transport infrastructure effectiveness improvement. It also deals with importance of maritime infrastructure in the transport artery development and the prospects of turnover increase based on the positive calculations of the experts who consider Georgia as the shortest link between Asia and Georgia. The paper also presents the prospects of Georgian transport infrastructure and Merchant fleet inclusion into the intercontinental projects implementation.

KEY WORDS: ECOSYSTEM OF THE BLACK SEA, “NABUCCO” PROJECT, ECOLOGICAL CONDITION OF THE BLACK SEA

1. Introduction

Nowadays, when Georgia tries to hold a position of regional centre in Caucasus it is very important to use its geopolitical and economic potential. It is well known that Western developed and rapidly developing Asian countries are interested in Georgia as in the transit country. If some of serious corporaions or the groups of businessmen tries to invest into Georgia, they will be first of all interested in the hydrosources or the transport artery of Georgia. During the last years, the process of the hydro resources development is actively being implemented, but the transport sphere is not so actively developed. The choice of the hydro resources development is chosen because of a rapid feedback from the investments put, money invested into the transport infrastructure are not so fast returned. It is absolutely acceptable from the business approach, but Georgian party should act differently. Their attempt should make transport infrastructure presentation as attractive as it is possible, they should do their best to attract investments and provide a basis for a long term profit oriented sphere development which is critically important for our country. Georgian transport infrastructure capacity should be studied in case of its full resource use, it also is important to provide an appropriate legislative background, the tariff policy should also be revised, especially on the railway. The international experience, especially of developed Western countries, should be taken into consideration on all stages of presented chain development.

2. Preconditions and means for resolving the problem

The location of Georgia and the fact that it is a maritime gate of the South Caucasus, preset its geopolitical priority, the use of which should be appropriately implemented. Georgia, having such geopolitical location, may become transport-logistical centre of Caucasus, partly function of which is performed nowadays. But, taking into account intensified interest of different European countries and the international corporations towards the countries of the region and wish of Georgia to integrate into European Union, it becomes obvious, that Georgian economic resource will be fully put into operation an our state will join EU. Accordingly, Georgia should develop well planned schedule of its economy development paying special attention to maritime infrastructure improvement.

Importance of Georgian ports for Caucasian the Middle East countries significantly increases because of rapid development of scientific-technical progress and especially because of increasing need of carbonaceous raw. These countries have considerable reserves of oil and gas, at the same time, the countries produce cotton – one of the best raw for industry, the countries are distinguished by a stable indicators of profits and the routes passing through Georgia are the best ones for these countries. All this promotes the process of making the country as the key transit region. Iran, which kept possibility of transit even after the Russian Empire invasion into Caucasus, actively used Georgian maritime corridor in the XVII-XIXth centuries.

Accordingly it is possible to turn back Iran interest to such possibility, giving Georgian ports a chance of their attractiveness and importance increase.

Russia implements the main cargo turnover of the Middle East countries, the fact of which is caused by many artificial factors, such as: pipeline and well developed railway network between Russia and the Middle East countries; well developed and equipped Black Sea ports existed in Russian management. Port operations costs are low and loading discharging operations are well organized; distance of Russian railway is longer than passing via Georgia, but it is compensated by low railway tariffs.

A sector shortening transit routes which pass Caucasus as well as its natural location present the main priority for the Middle Asia transport corridor and it needs appropriate usage in connection with other types of transport to determine the proper development of Georgian ports. The world economy is interested in the transit routes diversification to provide a free competition. Thus, changes in political climate will not significantly impact upon the economic stability. The stated reason has a high importance for Georgian ports sustainable development.

Caucasus, because of its geopolitical location and natural resources is a unique world region. That is why this region is so important for the Central and Eastern Europoe and for economic relations development of the South Caucasian countries. During the last decade, Caucasian factor became increasingly important and the region became in the focus of the interest of world largest countries, the international organizations and the largest transnational corporations. Accordingly, Georgia became the centre linking two parts of the Earth – Europe and Asia.

European Union supported “TRACECA” project will link the countries of the Central Asia and the river Danube basin. This Europe-Asia transport-communication corridor having many branches will pass our country, providing facors of stability and economic development.

“TRACECA” project is considered as a factor of Georgian economic relations development which should define the strategic directions of country’s development.

The project deals Georgian branch of modernized variant of historical “Silk Road” branch. Shipping of strategically important cargoes, such as oil, cotton, gas, mineral raw materials will be provided by this route.

Initiative of Georgia and Azerbaijan on a “New Silk Road” which is also supported by European Union will be a new stage of Eurasia corridor development. Eurasian route will create...
completely new transcontinental link from the Pacific to the Atlantic ocean. Solution of the stated problems is closely related with Georgian economic development, gaining the appropriate political importance, accordingly, the projects are critically important for Georgia.

It is impossible to imagine Georgian transport infrastructure without development of Georgian ports, especially of Batumi and Pot ports because of their major role in cargo handling. At the same time, the other transport sectors should be proportionally developed. Intensive works of capacity increase are held on construction of the East-West highway and Georgian railway. Accordingly, it is necessary to provide scientific research of Georgian transport infrastructure development.

Georgian economy is on development stage. There is a low domestic product level for per capita population, but natural resources of Georgia, education promotion, professionalism and inclusion of the country into the world economic processes will cause its rapid economic development. Naturally, in this case demands on the transportation, especially on shipping will significantly increase. This also is one of the most important factors of the actuality of the stated issue.

Unfortunately nowadays Georgia does not have its own fleet, but in future, development of economy will put creation of the fleet into the agenda of Georgian ports sustainable development. Issues of the ports development and organization are less studied by the world economic science, especially in the cases of Georgian ports. That is why the modern scientific methods of planning and management are not actively used in Georgian ports, accordingly, shiphandling is not of the planned rhythmic character with growing of the cargo handling costs. Resolving of the stated issues presents a vital importance for the ports effective development.

In order to implement innovations in maritime industry, as well as in all other ones, it is necessary to study local and global markets. Demands determine the prospects of the directions development. It is necessary to create state agency for resources studies, with representation of the air, marine and railway departments, involving appropriate specialists to identify and resolve existed problems. Scientific research works in the transport sphere are very limited in Georgia. The Ministry of Transport was disaffirmed as the result of reform. There is no person in the parliament or in the government to speak about transport problems, innovations or ideas. During the last 10-15 years it was a good idea about the ports and fleet development, but unfortunately, it was not implemented. It was the result of the policy which was implemented in the country transport system when non specialist made decisions or decision were made only one person only because of his discretion. Neither national interests nor long term prospects were taken into consideration.

The absence of conduction of the special scientific researches and the control of maritime infrastructure development caused falling behind of Georgia from the world economy rhythm. There is no a list of attractive projects in Georgia. The investors interested in Georgia have no access to the potential projects and the companies interested in the projects development should conduct all preparatory works, during conduction of which they consider firstly their own profits and accordingly, Georgia should follow their conditions or refuse their projects implementation. All this creates a negative investment background and damages the country’s image.

In 2012 the International Maritime Organization and the United Nations Organization in the frames of RIO+20 Conference worked out the strategy of sustainable maritime transport sphere development. The states, interested in the strategy development jointed for its implementation. Large tonnage container ships effectiveness and the principles of their fuel supply were in focus of their interest.

Capital Ship Management Corporation announced Joint Development Project, developed by Lloyd’s Register, Daewoo Shipbuilding and Marine Engineering at the “Poseidon” conference held in the Athens in August, 2014. The project is aimed at research of alternative fuel, liquified gas use on large container carriers of 14000 TEU and more. If we take into consideration, that TRASECA member states, Azerbaijan and Kazakhstan have lots of liquified gas reserves, we’ll have effective decision of Georgian fleet supply by the fuel.

Ship-owner companies, actively discuss liquified gas usage in shipping. As it is said in Regional Register Manager, Apostle Pulovassili’s report, by 2030 11% of the world fleet will use liquified gas as the fuel. By the opinion of Capital Ship Management’s leaders, ultra large container ships working on liquified present ideal ship model. The company analyzes the costs and effectiveness calculation and risks related to such ships operation.

3. Conclusion

The main aim of these calculations to make liquified gas the main source of ships bunkering, innovations of the maritime sphere should be appropriately studied to improve the “general corporate effectiveness” which means effectiveness of fuel use, crew comfort and nature environment protection. Lloyd Register provides the project analysis and the risks assessment. Despite Georgia does not have its own gas resource, it is necessary for the government of Georgia to take into consideration the fact and to put ship bunkering into long term perspective. It should be noted that issue of the bunkering provision is not appropriately managed in Georgian ports despite its significant logistical importance.

4. Literature

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3. WWW batumiporti.com
EVALUATION OF THE EFFECTIVENESS OF LIBERALIZATION OF THE RAIL FREIGHT MARKET IN SLOVAKIA

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Abstract: Actual problems from the point of view of sustainable transport are limited capacity and level of transport infrastructure and major differences between the capacity and quality of transport infrastructure in western and eastern Europe. Subvention of multi-modal chains in the country is highly differentiated from high subvention towards environmentally friendly mode of transport to very little subvention from the state. The paper deals with legislation relative to conditions of the railway freight transport market liberalisation structure of international documents and national law, conditions of access companies to transport infrastructure and business conditions in the railway transport market. In Slovak republic it was changed of charging schemes for rail infrastructure from 1.1. 2011. We have researched impact this change to modal split. The paper presents measures to improve competitiveness of railway freight transport.

Keywords: RAIL FREIGHT MARKET, SUSTAINABLE TRANSPORT, MODAL SPLIT, TRAFFIC PERFORMANCE

1. Introduction

Among one of the important tools to ensure sustainable transport include the railway freight transport market liberalisation, whose main objective is to increase the competitiveness of railways transport and reducing the negative impacts of transport on the environment. Today the issue of competitiveness of rail transport deals Directive 2012/34/EU of the European Parliament and of the Council of 21 November 2012 establishing a single European railway area. The basic requirements include the creation of appropriate procedures for the allocation of railway infrastructure capacity in order to achieve a better balance between modes of transport. The fee for the use of railway infrastructure should be qualified so that railway could meet a demand and these height should be at their own costs resulting from the operation of the train.

2. Legislation regulating business in the railway sector in Slovakia

The basic legislative conditions for railway construction, operation of railway infrastructure, operation of transport on railway infrastructure, as well as the rights and obligations of the natural and legal entities related to these activities are stipulated by the Act on railways and its implementing decree:

- Act of the National Council of the Slovak Republic No 513/2009 Coll. on Railways and on amendment and completion of certain acts as amended by later regulations (hereinafter “Act on Railways”)
- Act of the National Council of the Slovak Republic No 514/2009 Coll. on Railway Transportation as amended by later regulations (hereinafter “Act on Railway Transportation”)
- Act of the National Council of the Slovak Republic No 258/1993 Coll. on the ŽSR as amended by later regulations
- Decree of the Ministry of Transport, Posts and Telecommunications of the Slovak Republic No. 351/2010 on Railways Traffic Order as amended by later regulations
- Decree of the Ministry of Transport, Posts and Telecommunications No.205/2010 Coll. on Determined Technical Appliances and Determined Activities and Activities on Determined Technical Appliances
- Decree of the Railway Regulatory Authority No. 3/2010 of 2 December 2010 setting the charges for the access to railway infrastructure
- Decree of the Ministry of Transport, Posts and Telecommunications No.245/2010 Coll. on expert competences, physical and mental competences of persons in railway operations and transport on railway as amended by later regulations
- Decree of the Railway Regulatory Authority No. 2/2010 of 18 August 2010 on the regulatory framework for laying down charges for the access to railway infrastructure
- Decree of the Railway Regulatory Authority No. 7/2012 of 24 May 2012 by which the Decree of the Railway Regulatory Authority No. 3/2010 of 2 December 2010 setting the charges for the access to railway infrastructure is being amended.

The basic legislation regulating business conditions in rail transport in the SR is Act no. 514/2009 Coll. the service on track. General conditions of access to railway infrastructure are the following:

- A railway company (RC), legal person is the holder of a valid license for the rendition of services to the railway, which is issued by the licensing authority of a Member State
- RC is the holder of security certificate
- RC take out third party liability insurance during from the operation of rail transport
- RC has had allocated train path or performs services for a legal person who has had allocated train path
- RC has concluded a contract on access to rail infrastructure with the Manager of infrastructure
- RC has had concluded a contract with the Railway energy where he will carry on the service with driving railway vehicles of dependent traction
- RC has firmed up technological processes in originating and terminal railway station with Regional Directorate of ZSR [7]

The Directive 2012/34/EU of the European Parliament and of the Council of 21 November 2012 establishing a single European railway area is a basic European legal enactment for activities Transport authority in the area of issue a license. The license is issued based on licence application.

The licence application must contain:

- Business name, legal form, identification number of the state statistics, registered office
- Names and surnames of members of the statutory body responsible representative if it is established
- Data according to § 11 paragraph 3-6 of Act No. 514/2009 Coll. on Railroad Traffic as follow:
  - proof of special qualification of managers
  - adequate insurance cover for damage that may be caused by the rendition of transport services

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  - proof of special qualification of managers
  - adequate insurance cover for damage that may be caused by the rendition of transport services
railway undertaking must have a safety certificate. Safety certificate is issued by Transport Authority on the base of railway undertaking request.

3. Comparison of the development of traffic performance on the railway network ZSR

The aim of the liberalization of the rail transport market is to increase the competitiveness of rail transport to road transport. This aim should be to help on change of railway infrastructure charging system, which significantly reduced the charges for the use of railway infrastructure, mainly for through trains. The following figures show a comparison of transport performance in passenger and freight transport on the railway network ZSR. [1-4]

![Fig. 1 Development of traffic performance in train-km](image1)

![Fig. 2 Development of traffic performance in gross tonne-km](image2)

Development of traffic performance of passenger transport in train-km has a steady character since 2003 and varies from 31 to 32 mph. train-km per year. Traffic performance in gross tonne-km also develop equally, a slight decrease in last years is due to the use of electric motor train set eventually diesel motor train set whose net weight is considerably lower than a classic train set.

In goods traffic, there was a continual decrease in traffic performance from 2001 to 2009. We can see in Fig. 1 and Fig. 2 that the traffic performance increased slightly in 2014 compare to 2010.

The main railway freight operator is ZSSK Cargo Slovakia in the Slovak Republic. Its share of transport performance is approximately 80%. The following figures show a comparison of the share of transport operators on the traffic performance. [1-4]
Share of state railway operator ZSSK Cargo Slovakia is decreased continually in the rail transport market. While in 2009 the share of ZSSK Cargo was nearly 95% in 2014 was only 80%. At the same time traffic performances of private railway operators increase. The best share of all private railway operators had METRANS Danubia, their share was 4.0% of the train km and 3.9% of gross tonnes km in 2014. The following table shows comparison the share of train km of top ten railway freight operators.

Table 2: The share of train km of railway freight operators

<table>
<thead>
<tr>
<th>Carrier</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZSSK Cargo Slovakia, a. s.</td>
<td>82.5%</td>
<td>80.6%</td>
</tr>
<tr>
<td>METRANS /DANUBIA/, a. s.</td>
<td>3.6%</td>
<td>4.0%</td>
</tr>
<tr>
<td>CENTRAL RAILWAYS, a. s.</td>
<td>1.9%</td>
<td>3.0%</td>
</tr>
<tr>
<td>Express Group, a. s.</td>
<td>2.0%</td>
<td>2.6%</td>
</tr>
<tr>
<td>Prvá Slovenská železničná, a. s.</td>
<td>2.5%</td>
<td>2.2%</td>
</tr>
<tr>
<td>Railtrans International, s. r. o.</td>
<td>0.4%</td>
<td>1.5%</td>
</tr>
<tr>
<td>PKP CARGO, S. A.</td>
<td>0.3%</td>
<td>0.3%</td>
</tr>
<tr>
<td>LOKORAIL, a. s.</td>
<td>1.9%</td>
<td>0.7%</td>
</tr>
<tr>
<td>LTE Logistik a Transport., Slovakia, s. r. o.</td>
<td>0.9%</td>
<td>0.9%</td>
</tr>
<tr>
<td>SŽDC, BA</td>
<td>0.7%</td>
<td>0.9%</td>
</tr>
</tbody>
</table>

Source: ZSR

Increasing the share of private companies in the train kilometres as well as in the gross tonne kilometres is most often caused by an alteration in percentage distribution (due to a decrease in the share of transport activities ZSSK CARGO Slovakia) and not increasing the volume of goods transported. Nowadays the valid license has 49 railway companies but actually 20 private companies realize traffic in the network of ŽSR.

4. Modal split

The main actors in the transport market include freight carriers, haulers, state and forwarding organizations. Each of the entities located in this market follows its interests. Hauler requires the transport with high quality at a reasonable price, carriers and forwards organizations require a reasonable profit, the state role of the state is the tendency of sustainable mobility. [9]

The following figures shows the modal split in the Slovak republic. Figure 5 shows the modal split before the full liberalization of the rail freight market. [5, 12]

Figure 6 shows the modal split from full liberalization to change of charging system of railway infrastructure. [5, 12]

Figure 7 shows the modal split after change of charging system of railway infrastructure. [5, 12]

Modal split in freight transport is somewhat simplified by some transport may take place only certain types of traffic due to the characteristics of goods and operational and technical characteristics of the department of transport. However, currently dominate the production of such products whose specific characteristics allow transport of various modes of transport and the carrier has a choice by comparing the price and quality. [6]

Modal split in the Slovak Republic is comparable to modal split in the EU. It is characterized by a high proportion of road freight transport and the ever decreasing share of rail freight transport.
5. Result and discussion

Comparative analysis showed that the liberalization of the railway market as well as the change of the charging scheme of railway infrastructure in Slovakia has not yet produced the desired effect. Performance of goods rail traffic is volatile downward trend, whereas the average annual decrease since 2001 is more than 3%. In contrast, the performance of road freight transport recorded after a slight dip in 2009, in 2011 increase again and move to the level of 2008 and it increase continually since.

The main reason of this decrease can be defined as follows:
- Change of productions in the national economy
- Low flexibility of providing transport services
- Low portfolio of additional transport services
- Problems with interoperability railway vehicles as soon as train crews and drivers
- Dependence on manager of infrastructure
- High capital and running costs
- Challenging maintenance of rail vehicles
- Closing of line to traffic of manager of infrastructure
- Norms of weight or length train in the regional line is not enough
- Longer term of delivery compare to road transport
- High cost during transport small number of wagons in the train
- High costs of operation, maintenance and managements of railway siding
- Need for professional employees with specific skills etc.

We are realized the pilot research in the some selected industrial companies with a view to find out what influence costumers when choosing a mode of transport. The research was realized through personal questioning in the largest companies in two region with different economic level. Choice of regions was done designedly with a view to find out differences between economically developed and economically weaker regions.

The majority of addressed companies carries their product to medium and longer distances. Half of these companies used the services of road haulage operator, 33% of rail freight traffic and 17% of companies have own vehicles.

We determined these factors based on previous research:
- Price
- Speed of transport
- Meeting delivery terms
- Safety
- Environmental aspect
- Providing additional services

The companies considered the price as the most important factor when choosing a mode of transport for transportation of their products and the least important factor was environmental aspect in the both regions. Different results were only at two factors – speed of transport and meeting delivery terms. The companies in the regions with higher economic level considered speed of transport more important than meeting delivery terms and in the companies in the region with lower economic level it was other way round.

6. Conclusion

One of the aims of European transport policy and Slovak transport policy too is improving competitiveness of railway transport in the transport market. In the Slovak republic has been realizied a number of measures from full liberalization of freight railway transport to change charging schemes of railway infrastructure since 2001. Despite these measures the share of the railway transport in the transport market didn’t increase.

In the market economy freight transport it is part of the logistics management, which plays an important role in safeguarding corporate activities and affects the quality of processes. The role of the carrier is to know customer needs and respond on them to supply of needed transport services. Nowadays, the companies in Slovak republic consider the price as a major factor which influence choose of transport mode.

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References

DETERMINE THE OPTIMAL ROUTE OF THE ROUTING OF THE SINGLE WAGONS METHOD CPM ON THE NETWORK ŽSR

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Abstract: In the sector of railway freight transport is considerable part of performance carried out through the transportation of single wagons from the departure station to the destination station which show decreasing trend in the last period. Currently, the transportation of the single wagons is realized according to long term established procedures, which do not take into account its direction on the basis of the optimal costs for the individual carriers on the network of ŽSR. Transportation of single wagons is realized based on train formation, which is regularly analyzed and adjusted on the basis of strength of wagons lane and requirements of the Business Department. By the application of different optimization methods it is possible to achieve reengineering of these procedures and optimize costs. The paper deals with the reengineering of the single wagons routing by application Critical Path Method (CPM) on the selected particular traffic relation on the network of ŽSR. Through application of CPM method and by reengineering of technological processes it is possible to achieve cost savings for the customer as well as for the carrier for the carriage of goods and truncation the delivery time of shipment to the customer as well as to increase the competitiveness of the railway company.

Keywords: SINGLE WAGON, CPM METHOD, NETWORK OF ŽSR, FREIGHT TRANSPORT,

1. Introduction

The railway transport is integral part of the transport sector of the European Union, and simultaneously, it is one of the ecological means of transport. The decreasing trend of the freight rail transport has coerced European community to strengthen its position and to adopt necessary legislative measures. The directive of the European parliament and the Council 2012/34 of the European Union through which regulates the unified European railway area emphasizes that the member states should adopt such measures which will support rail transport competitiveness and they will take into account individual characteristic features of the railways. [3]

Rail transport market in the Slovakia has constantly changed since 1993. There was only one company in the Slovakia until 2002 – Železnice Slovenskej republiky (ŽSR). This company had been divided into two companies since January 1st 2002 – ŽSR as an administrator and operator, and Železničná spoločnosť a.s. which provided services. Finally, three companies started to operate on the transport market after the transformation in 2005 – Železnice Slovenskej republiky, as a manager of the infrastructure, Železničná spoločnosť Slovensko a.s., for passenger transport, and Železničná spoločnosť Cargo Slovakia a.s., for freight transport. The transformation of the rail transport in the Slovak republic is depicted in Figure 1. [2,3]

Fig. 1 Transformation of the rail transport in the Slovak Republic

Strong competition for customers currently takes place on the transport market among the carriers providing the transport services. The most important thing in the competition game is to best fulfill demands of the customers, which mostly are the delivery in time, at the required place, in the required quality and amount, and mainly for the optimal price.

The considerable part of the performances in the freight rail transport sector is carried out by transport of the single wagon consignments from the station of departure to the station of destination. This kind of transport has recently shown a downward trend. If the companies want this transport to be competitive, it is necessary, not only to adjust the legislation, but also to search the technological possibilities of the transport and shipping process optimization which will lead to better prices and quality of the provided services.

2. Current routing status of the wagon transportation

The contemporary model of the organization of the wagon currents on the Slovak railway network is not based on any freight train composition concept. It has been carried out on the basis of the long term established practices since 1995. The single wagon transport on the Slovak railway network is provided only by national carrier – ZSSK CARGO a.s. The private carriers operating on the Slovak railway market implement solely transport of the direct integrated trains.

The routing of the wagon currents on the Slovak railway network is carried out among the train formation stations. There were 31 formation stations in the network of ŽSR for the period of operating schedule 2014/2015. They are depicted in the figure 2. Some of the stations are enlisted among the main marshaling yards where the direct freight trains are composed; for example Bratislava východ, Zvolen freight station, Žilina – Teplička and Štúrovo. [2,5]
contains regulations of the freight wagon transport routing. The wagon consignments transport is regulated by the directive of ŽSR SR 70 – Transport points classifier of the Slovak railway network according to attachment 1 and the directive D16. The cargo routing in the freight stations is based on the Routing book which is designed for every station.

The single wagon routing is based on the train formation plan of the freight transportation which analyzes and regulates every step according to the requirements of the commercial department. It is done on the basis of the part A – formation of the relational cargo from the routing stations according to cargo table depicted in figure 3.

The transport may be carried out from and to all the stations with dispatching license on the network of ŽSR, from and to all the tariff transfer points, and from and to all the transport cities and points.

3. The characteristics of the Critical Path Method

The Critical Path Method (CPM) is classified among the optimization network models which help to plan the projects and to define the time of their duration on the basis of the length of the so-called critical route. It is possible to analyze and search for critical places or activities in the scheduling of the successive and interconnected activities with the help of this method. One factor is taken into an account in the method – time because the method is also called as the method of time planning. The simplicity and illustration of the solution are two the most important advantages of this analysis which are used in the practice. [4,6]

The critical route may be defined as the longest possible route from the point of time from the beginning point to the endpoint of the diagram. There is always at least one critical route which consists of successive and interconnected activities in every “project” solved by the CPM.

The practical application of this method is mainly used to estimate the total duration of the investigated “project”. It is possible to estimate precise duration with the high level. The method may be used for researching in the area of logistics and transport.

It is necessary to follow the steps to fulfill the objective while realizing the “project” with this method: [4,6]

Step 1:
• Identification of the essential activities carried out in the specific “project”,
• Division of the activities according to the importance, respectively the sequence of progression
• Specification of the tendering period of the activity,

Step 2:
• Outline the chart with the rim assessment based on the identified project activities and their duration, see figure 4.

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Step 2:
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Table 1: The characteristic of the variants

<table>
<thead>
<tr>
<th>route direction</th>
<th>line category</th>
<th>traction</th>
<th>distance (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>variant 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plaveč</td>
<td>Košice</td>
<td>A E</td>
<td>88</td>
</tr>
<tr>
<td>Košice</td>
<td>Žilina</td>
<td>A E</td>
<td>242</td>
</tr>
<tr>
<td>Žilina</td>
<td>Bratislava</td>
<td>A E</td>
<td>198</td>
</tr>
<tr>
<td>Bratislava</td>
<td>Štúrovo</td>
<td>A E</td>
<td>128</td>
</tr>
<tr>
<td>variant 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plaveč</td>
<td>Košice</td>
<td>A E</td>
<td>88</td>
</tr>
<tr>
<td>Košice</td>
<td>Lenártovce</td>
<td>A E</td>
<td>115</td>
</tr>
<tr>
<td>Lenártovce</td>
<td>Zvolen</td>
<td>B N</td>
<td>118</td>
</tr>
<tr>
<td>Zvolen</td>
<td>Levice</td>
<td>B E</td>
<td>77</td>
</tr>
<tr>
<td>Levice</td>
<td>Štúrovo</td>
<td>C N</td>
<td>52</td>
</tr>
<tr>
<td>variant 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plaveč</td>
<td>Košice</td>
<td>A E</td>
<td>88</td>
</tr>
<tr>
<td>Košice</td>
<td>Žilina</td>
<td>A E</td>
<td>35</td>
</tr>
<tr>
<td>Žilina</td>
<td>Margecany</td>
<td>95-C</td>
<td>105-B</td>
</tr>
<tr>
<td>Margecany</td>
<td>Zvolen</td>
<td></td>
<td>198</td>
</tr>
<tr>
<td>Zvolen</td>
<td>Levice</td>
<td>C N</td>
<td>52</td>
</tr>
</tbody>
</table>

1st Variant

The wagon load transport route Plaveč – Košice – Žilina – Bratislava – Štúrovo is considered in the first variant. This wagon load will be reviewed in every train formation station on the route. The kilometer distance represents 656 km.

2nd Variant

The route Plaveč – Košice – Lenártovce – Zvolen – Levice – Štúrovo is considered in the second variant. The wagon consignment is recasted in two ways. Firstly, the wagon consignment is directly transported by a transversal freight train to Zvolen, and secondly, it is carried out by recasting in the railway station Košice. The distance is 450 km, and it represents the saving of 206 km in comparison to the first variant.

3rd Variant

The route Plaveč – Košice – Margecany – Zvolen – Levice – Štúrovo is considered in the third variant. The wagon consignment will be recasted in each station. The distance is the same as in the second variant, 450 km, thus it also represents the saving of 206 km in comparison to the first variant.

Identification of the essential activities

Identification of the essential activities is the basic step for the calculation application of CPM on the network of ŽSR. Within the wagon current optimization, these activities consist of individual freight train routes which follow one after another after the wagon consignment is recasted in the train formation station or in the shunting yard. While we are solving the selected relation Plaveč – Štúrovo, the activities involve the transport by the transversal freight trains or manipulation freight trains. The activities are divided as follows: [5]

A. The single wagon transport Plaveč – Zvolen,
B. The single wagon transport Plaveč – Košice,
C. The single wagon transport Košice – Žilina,
D. The single wagon transport Košice – Zvolen,
E. The single wagon transport Košice – Margecany – Zvolen,
F. The single wagon transport Zvolen – Levice,
G. The single wagon transport Levice – Štúrovo,
H. The single wagon transport Žilina – Bratislava,
I. The single wagon transport Bratislava – Štúrovo.

The tendering period identification of the activity

All the activities, which help to carry out the single wagons routing from the place of departure to the place of the destination, must have their assessment that determine the chart rings during the CPM calculation. In this case, the individual activities are assessed by the tendering period in minutes.

A. The tendering period of the activity 678 min,
B. The tendering period of the activity 336 min,
C. The tendering period of the activity 967 min,
D. The tendering period of the activity 1 000 min,
E. The tendering period of the activity 573 min,
F. The tendering period of the activity 92 min,
G. The tendering period of the activity 69 min,
H. The tendering period of the activity 204 min,
I. The tendering period of the activity 302 min.

Fig. 6 The chart of the wagon consignment transport activity

The next step for the CPM calculation is to create the table of the activities which follow up one after another during the wagon consignment transport from the station of the departure to the station of the destination. The following up activities are depicted the table 2.

Table 2: Description of the activities during the goods transport

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description of the activity</th>
<th>Tendering period [min.]</th>
<th>Previous activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Single wagon transport</td>
<td>678</td>
<td>-</td>
</tr>
<tr>
<td>B</td>
<td>Single wagon transport</td>
<td>336</td>
<td>-</td>
</tr>
<tr>
<td>C</td>
<td>Single wagon transport</td>
<td>967</td>
<td>B</td>
</tr>
<tr>
<td>D</td>
<td>Single wagon transport</td>
<td>1 000</td>
<td>B</td>
</tr>
<tr>
<td>E</td>
<td>Single wagon transport</td>
<td>573</td>
<td>B</td>
</tr>
<tr>
<td>F</td>
<td>Single wagon transport</td>
<td>204</td>
<td>A,B,D,E,F</td>
</tr>
<tr>
<td>G</td>
<td>Single wagon transport</td>
<td>369</td>
<td>A,B,D,E,F,G</td>
</tr>
<tr>
<td>H</td>
<td>Single wagon transport</td>
<td>204</td>
<td>B,C</td>
</tr>
<tr>
<td>I</td>
<td>Single wagon transport</td>
<td>302</td>
<td>B,C</td>
</tr>
</tbody>
</table>

The application calculation of the CPM was based on the definition of the essential activities and the table in the spreadsheet application Excel.

Fig. 7 The CPM calculation
The chart consists of several parts. The circles represent individual stations on the transport route, where the variant of the transport route is depicted by the connection of the following activities. The circles are divided into three parts and their description is characterized in the following figure.

Fig. 8 The junction characteristic

The solution of the optimal route of the wagon consignment transport from the station of the departure to the station of the destination was carried out by three possible variants:

1st variant
Plaveč (1) – Košice (2) – Žilina (4) – Bratislava (6) – Štúrovo (7)

2nd variant
Plaveč (1) – Košice (2) – Lenártovce - Zvolen (3) – Levice (5) – Štúrovo (7)

3rd variant
Plaveč (1) – Košice (2) – Margecany - Zvolen (3) – Levice (5) – Štúrovo (7)

We saved the time of the transport by the comparison of all the variants after we identified critical route with the application of the CPM on the selected transport relation of the wagon consignment and possible transport routes available for the transport.

With the implementation of the CPM, the first variant emerged as the critical route whose tendering period is 1809 minutes without the time slack during the transport from the place of departure to the place of the destination.

The second variant has got two alternative solutions. Variant 2a – the wagon consignment will be directly transported by the freight train from Plaveč to Zvolen, and it will be carried out in Košice without the recast with 1594 minutes of the time slack. Variant 2b – The single wagon will be recasted in Košice and transport route will continue through Lenártovce with 936 minutes of the time-saving.

When we determined the assessment period in the third variant, it resulted in 1363 minutes of the time reserve.

The result of the CPM calculation in the selected relation Plaveč – Štúrovo is the identification of the critical route, which is represented by the first variant where all the activities must follow one another without any time reserve. The most appropriate variant of the transport is the variant 2a where we can save 1594 minutes during the same transport. [6]

5. Conclusion

There is a possibility to achieve time-saving of the single wagon delivery from the place of the departure to the place of the destination and also cost saving for the customers and the carrier. It may be achieved by the optimization of the wagon currents with the usage of the optimization methods and identification of the restrictive criteria.

Based on the calculations by means of the CPM, which is enlisted among the optimization methods, it is possible to achieve considerable time saving of the consignment delivery by the optimization of the single wagon consignment routing. We compared three variants of the transport on the selected relation and we found out that it is possible to achieve time saving of 1594 minutes and to decrease the running time of the wagon consignment by 206 km when all the activities follow one another.

To increase the competitiveness of the rail freight transport, it is necessary to create an effective system of the wagon currents organization, which will take into an account economic criteria of the carriers and simultaneously it will consider the capacity of the infrastructure manager.

**Contribution is processed in terms of solving grant problem VEGA 1/0707/14 “The impact of the railway freight transport market liberalisation on the social transport costs” which is being solved at Department of Railway transport, Faculty of operation and economics of transport and communications, University of Žilina.**

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INTERNET AND SEO METHODS BY ROAD TRANSPORT BUSINESS

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Abstract: This paper deals with the use of Internet by the road transport business, especially with the marketing web services. The aim is to show the importance of the Search engine optimisation (SEO) methods for the creation of webpages, as their consistent implementation is relevant for improving marketing communication and improving the search-engine rankings. The results of a survey among small and medium enterprises in the road transport business show that proper attention given to the creation of a company website brings clear economic effects.

Keywords: INTERNET SERVICES, MARKETING COMMUNICATION, SEARCH ENGINE OPTIMIZATION, SEO

Communication over Internet

The use of modern information and communication technologies and Internet services is nowadays an inherent part of the management and decision-making process and in-house communication. Knowledge-based economy can be characterised by greater dependence on knowledge, information and highly-qualified skills and by increased need of both private and public sector to access them. Important changes occurred also in the area of marketing communication. Traditional forms of communication are insufficient; market situation requires targeted use of the Internet services. This naturally concerns also companies in the transportation sector.

Communication over the Internet is a natural requirement of today's national and international transportation. E-mail and online voice and video communication are commonly used. These means of communication in the area of transportation and logistics are used not only for marketing communication, but, considering the nature of the enterprise and workers' goods' and vehicles' mobility, also for the communication between drivers and dispatch, which leads to decrease in administration work, communication costs and to more efficient use of working time. The Internet access is also important, and it is, because of the necessary mobility, ensured through wireless access.

E-mail is one of the oldest Internet services. This service, especially after the implementation of the Act on electronic signature, has a tendency to fully replace the older way of communication by ordinary mail. Other tools of internet communication are newsletters, discussion fora, chat and messengers. Newsletters are electronic news outlets sent to registered users by e-mail. They contain articles related to the company's area of operations, including news in its field, invitation to events as well as advertisement. [1].

Discussion fora are to be found relatively often. This communication tool enables participants to discuss the given topic using short text messages. Unlike the previous ways of communication that do not require real-time Internet connectivity, chat is an on-line way of communication, or, in another way, electronic group discussion, just as tradition phone-call, where all the participants are connected to the Internet in the real time. Messengers are software tools of internet communication, e.g. Windows Messenger. The applications used are usually free of charge or are a part of the operation system.

One of today's progressive technologies is Voice over IP (VoIP). It is a methodology and group of technologies for the delivery of voice communications and multimedia sessions over Internet Protocol (IP) networks, such as the Internet. [1].

The particularity of the use of Internet in the transportation is transportation databases. These network application offer online interface for use of other companies' capacities of transportation (trucks and other cargo vehicles) and for offer of one's own transportation capacities. Freighters and other prospective clients can find out about the most efficient use of their vehicle and possibilities of transportation of their goods. These services are

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offered by multiple companies, such as RaalTrans.sk, Timocom.sk, Trans.eu and others.

Use of webpages

The use of webpages is an important part of company's informatics and a strong marketing tool. Webpage is – in a way – is a space, a folder on a server that is publicly accessible and includes information (text, graphic) to be published in the form of hypertext documents. A solid and prosperous company in particular should represent itself on its own domain, the title of the web. The content of the webpages should serve to present the company for the public, to prospective clients, as well as for communication with them. A current requirement is that the webpages are dynamic, allowing the clients to send queries, orders or to fill in a form. Webpages that are too slow are a great deficiency; this is often caused by a graphic presentation that is too demanding on the connection speed; this may discourage the visitors and the company may lose a prospective client. Trying to save the money, companies sometimes place their pages on public servers that are free of charge, however, this increases the risk of inaccessibility, slow download speed, loss of data or appearance of improper advertisement.

Webpages can be run on an own server place either in the company or in a data centre, on a rented server or through a webhosting. In the case the company decides to outsource the running of its information system (use a hosting), it should ensure that it hires a trustworthy and capable provider. [1]. The provider may use a virtual server, when the server fulfills the function of web and/or e-mail server for multiple client companies.

SEM – Search engine marketing

SEM is relatively young discipline of on-line marketing that deals with advertisement of web pages through Internet search engines. It does not address a passive customer, but an active user trying to find a company, a service or a product. SEM is composed of two parts:

- directly paid advertisement
- Search Engine Optimization (SEO)

In the case of the directly paid advertisement, the owner of the website is paying to the search engine for its prominent placement in the search results. Nowadays, more and more search results of the directly paid advertisement can be observed.

The PPC (pay per click) system of paid advertisement also exists; in this case, the company does not pay for publishing the hyperlink, but for the number of clicks on it, i.e. for the number of potential customers that decided to click on the link and download the company's website.

SEO – Search Engine Optimization

SEO is an aggregate of methods and tools to achieve a prominent placement in the search engine results, leading to increased website visits and increased number of customers. Today's Internet user is impatient and looks only at a few first search results. So, if the link is to be found lower on the list of results, it is likely to get overlooked. According to the statistics published at www.iprospect.com, 68% of users only read the first page of results, 17% of users read also the second page and only 8% of users read three or more pages.

Unlike the directly paid advertisement, the SEO requires highly professional skills and knowledge from the field of informatics; this is why the SEO is usually outsourced.

Companies offering SEO outsourcing usually offer complex services, starting with detailed input analysis of the web site – a Web Presence Audit. The website is analysed from different perspectives: content, source code with key words, hyperlinks, accessibility, speed, visibility. This serves to identify the steps necessary to long-term improvement of its position, improvement of the online visibility, creation of the so called back links and sometimes also to increase the activities on blog and social networks. A strategy of complex optimization is prepared; this can last a couple of months based on the clients' preferences and its results are measurable. [4], [5].

In Slovakia, SEO is offered by multiple companies, for example:

- Pizza SEO (www.pizzaseo.com)
- H1 Slovakia (www.h1slovakia.sk)
- Seocentrum www.seocentrum.sk
- Internet Partners (www.internetpartners.sk)

Some companies also deal with the creation and management of social network pages and e-shops.

![Search Engine Optimization](image1)

**Fig. 1** Part of the services offered by PizzaSEO on its website [4]

![Search Engine Optimization](image2)

**Fig. 2** Services offered by H1 Slovakia, as offered on its webpage - 4

What factors influence the Google search?

Looking for answer to the question which factors mostly influence the final search results in Google, multiple quantitative and qualitative characteristics were followed. (6 quantitative and 8 qualitative) [2], [3].

The analysis shows that creation of own local webprofile on the Google map that can be viewed in the contact section by a potential customer, has the greatest impact on the improvement of the company's website in the order of search results.

The second factor is having the key word in the name of the profile. The companies that have the searched key word in its name achieve better results in the search.

The only quantitative factor that influences the search results is the number of references of the company in the Google search engine, i.e. the number of search results with the same data on the company, such as the phone number and address. [2], [3].
We have verified the results of this research on the case of key words "road cargo transportation" and "cargo transportation" in the Google search engine. In both cases the results were comparable. In searching for "road cargo transportation", the search engine offered mostly websites of offices and institutions, or, more precisely, documents published by them dealing with road transport (ministries, district offices, laws, regulations). This is why we examined the search results for companies offering road cargo transportation with the seat in Žilina or Žilina region. The search was carried out in three consecutive days on different computers, but the differences in results were negligible, that is why average results are presented below.

Google offered 91 600 results while searching for "cargo transportation Žilina" ("A" from now on) and 312 000 results while searching for "cargo transportation" ("B" from now on). The prominent results offered directly paid advertisement of companies located close to the city of Žilina, even without searching for "Žilina". First five pages of results of each search were examined. In the "A" case, the paid advertisements were to be found on the first page 11 times on average. On the next pages it was 7, 3, 1, and 1 times. In the "B" case, the paid advertisements were to be found 9, 6, 3, 3 and 3 times respectively. The advertisements were used mostly by larger freighters and transportation databases, e.g. LKW Walter or Timocom.

We identified 4 companies that always placed on the prominent positions (apart from the advertisement). They all had their own local profile on the web on Google maps.

![Transport firms searched on the Google map](Image)

Three of them had the object of their activity (i.e. the searched key word) in their name. The fourth one did not have the searched key word in the title, but unlike the others, it had the search word in the website source code key words:

```html
<title>STAVEBNÁ MECHANIZÁCIA, s.r.o. Žilina</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-2" />
<meta name="KEYWORDS" content="STAVEBNÁ MECHANIZÁCIA, Medzinárodná cestná nakladná doprava, zemné práce a terénné úpravy, uskutočňovanie stavieb, pripravné práce pre stavbu, uskutočňovanie jednoduchých stavieb" />
```

While examining the websites, we also found that one of the companies did not have its own website, only Google+ and other local servers profiles, which brought it surprisingly advantageous positions. Other companies have nice, well-arranged and comprehensible websites, in all cases created by professional companies dealing with website creation and SEO.

We were interested to know why some companies from the transportation area we know did not place on prominent positions. We found out that none of these relatively well-known companies have a profile on Google+ and less than a half of them have their own website created by a professional company. Their websites are static and not updated for a long time. It suggests that these companies do not pay enough attention to the use of online communication. This could be the reason for a worse search engine position.

The parameter "number of company references" was not examined, but our previous research does not suggest that it has such and effect as the above-mentioned qualitative parameters.

**Conclusions**

The results of our enquiry show that if a company wants to improve it Google search results, it should create its own local profile on Google maps and it should include the object of its activity in its title or in the keywords on its website. Investment devoted in the creation, management and updating of websites, preferably in cooperation with a company specializing in complex internet marketing, covering search engine optimization, design and management of pay-per-click campaigns, usability and accessibility services, as well as social network marketing and reputation management, brings benefits in the form of increased number of customers and improved economic results.

**References:**


CARPOOLING AS A MEASURE FOR ACHIEVING SUSTAINABLE URBAN MOBILITY: EUROPEAN GOOD PRACTICE EXAMPLES

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Abstract: Growing problems of transportation in urban areas in terms of congestion, air pollution, reduced safety and comfort, occupation of the space, are creating the need for innovative mobility strategies and exchanging good practices. One of the measures that can help resolving these issues is urban carpooling that decreases the number of private cars traveling to/from a desired destination site. This paper focuses on good practice examples of carpooling in Europe and potentials for transferring knowledge and experience. Several implemented concepts of carpooling are discussed in terms of resources and implementation effects. The paper concludes with recommendations for stepwise implementation of carpooling concept.

Keywords: CARPOOLING, SUSTAINABILITY, URBAN MOBILITY, GOOD PRACTICE, IMPLEMENTATION

1. Introduction

Urbanization and rapid expansion of the cities produce pressures on urban transport systems that tend to affect the quality of life of urban population more than ever. Reduced mobility options and inadequate transport infrastructure, increasing congestion, pollution and traffic safety problems are some of the major problems that require a systematic approach to be resolved. An increasing number of European cities are faced with the problem of growing transport demand and insufficient capacity of the transport network to support them. This is particularly evident in cities that were not sufficiently committed to strategic plan for sustainable mobility. In the last decades these cities were faced with high motorization rate and modal shift in favor of passenger cars.

To achieve effective functioning of urban transport system, it is very important to provide different modes of travel, which would have a positive impact on the mobility of citizens. Accordingly, sustainable urban mobility in cities is a major challenge and complex task for traffic engineers, urban planners and other professionals, as well as to the population that need to acquire new behavior and travel patterns. Mobility management or transport demand management includes measures of various types and nature whereby they have a common aim to reduce the use of passenger cars. One of these measures is carpooling – the concept that does not preclude the use of passenger cars but makes its use more efficient. In that sense it can be regarded as equally attractive to transport policy makers and users/citizens themselves.

The subject and the aim of this paper is to indicate the potential and contribution of carpooling in pursuit sustainable mobility based on the experience of application within the CIVITAS (City-Vitality-Sustainability) Initiative. The paper deals with the opportunities to spread carpooling based on lessons learned and experiences of previous applications as well as CIVITAS guidelines.

The paper is organized in the following way: in the next section the explanation and types of carpooling are given. Section 3 presents evidence of performance. Thereafter, section 4 highlights the potentials of implementing carpooling in the city of Belgrade as well as some obstacles. Section 5 concludes the paper.

2. Carpooling concept

Carpooling is the transport concept/measure based on a shared use of private cars in order to reduce the number of single occupant vehicle users. The idea of carpooling was born in the 1970s in the USA, when shortage of oil and rise of fuel costs motivated people to share their rides with neighbours or colleagues. So far, there is no single definition of carpooling. According to the most commonly adopted definition carpooling is “the agreement of joining the use of a private car by several individuals frequently commuting along the same journey at jointly compatible times” [1]. Hence, carpooling is usually associated with very simple idea: two or more persons sharing a whole trip, or a part of it, with the passengers contributing to the driver’s expenses. Based on this, it can highlights two main characteristics of carpooling. First, a group of people voluntarily joins together for sharing the costs of some particular journey. Second, one person from the car decides to offer his own vehicle to be driven to the common journey.

The term carpooling is sometimes referred as ride-sharing. However, ridesharing is a broader concept because it includes not only carpooling system, but also other sharing systems like taxi or bike trip. Besides, carpooling rather refers to commuters and regular rides, while ridesharing is commonly used for single ride on long distances.

The advantages of carpooling are discussed in many studies. Besides positive effects that arise from reduced car travel, like decreasing pollution, traffic congestion and the need for parking space, an important advantage of carpooling is the reducing of individual travel costs [1],[2],[3]. According to evidence from practice, the uptake of carpooling can induce significant mode shift. It can even replace the use of public transport for commuting [1]. However, this is not consistent with mobility management principles. Namely, although carpooling can be considered as a more preferable than solo-driving, it is still less desirable and efficient than non-motorized or collective, public transport. Therefore, it is recommended to avoid the competition between public transport and carpooling. It is even necessary to be cautious in granting subsidies to carpooling because its excessive favouring can outperform more sustainable urban transport modes [2].

There are several forms of carpooling, mainly differing according to their formal character and the way of matching [4]:

- Informal carpooling (slugging, casual carpooling): practiced in areas that have HOV (high occupancy vehicle) lanes1. Drivers pick up commuters near a HOV lane, at a bus stop or a parking lot and take them to central area. Passengers typically do not share costs with drivers, whose main advantage of carpooling is a shorter travel time by using a HOV lane.
- Pre-arranged carpooling: most common form of carpooling. Systems and services offering this form of carpooling rely on internet based databases that match drivers and passengers and arrange a meeting point in advance. Passengers usually share costs with the driver or they pay the carpooling service some fee for membership or for successful matching.

1 High Occupancy Vehicle lanes – reserved for vehicles with a driver and one or more passengers
• Real time carpooling (instant, ad-hoc or dynamic carpooling): emerged from the flexibilisation of working times. Service providers offer real-time matching: commuter’s demand is instantly matched with a compatible offer in order to keep waiting times as short as possible.

Generally, carpooling can happen in a spontaneous way, as is the case with common household members trips or friends and colleagues travelling together. Accordingly, carpooling can be differentiate as internal or external [2], whereby the internal one appears in the above described situations. It is characterized by a high degree of confidence between carpoolers. On the other hand, the external carpooling happens when there are no specific relation or previous communication between carpooling members. This kind of carpooling is therefore more demanding in terms of organization. This is not only because of possible resistance and mistrust, but also because of the need to determine the location of the carpooling checkpoints. Additionally, the origins and destinations of driver and carpoolers or carpoolers themselves may be different, which implies the need for complex organization from external sources.

Table 1 summarizes some forms of travel arrangements within a carpooling concept.

Table 1: Some characteristics of carpooling

<table>
<thead>
<tr>
<th>Degree of connection</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>household membes</td>
<td>friends, colleagues, neighbours, etc.</td>
<td>unrelated people</td>
</tr>
<tr>
<td>Origin/destination (O/D)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>matching</td>
<td>non-matching</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>matching</td>
<td>non-matching</td>
<td></td>
</tr>
</tbody>
</table>

Travel organising
- spontaneous
- pre-arranged
- dynamic

Financial aspects
- household budget savings
- individual travel costs savings

3. Carpooling in Europe – good practice examples

A number of studies and initiatives promote the concept of sustainable mobility. One of them is the CIVITAS initiative whose aim is to support financing sustainable mobility projects and provide the platform for knowledge exchange. The CIVITAS initiative put emphasize on measures that favour efficient and environmentally less harmful transport.

Together with other initiatives that promote sustainable mobility like EPOMM² (European Platform on Mobility Management) or KonSult³ (Knowledgebase on Sustainable Urban Land use and Transport), CIVITAS project eventually became important knowledge database in this area. Based on practical application, the policy makers have gained valuable insight and evidence on performance for many soft policy measures whose potentials are often questionable. By now, more than 200 cities across Europe joined CIVITAS. They are committed to test innovative urban mobility measures and exchange good practice. Since 2002, CIVITAS initiative has realized a number of carpooling measures in many different cities. A brief overview of some of them is presented below [5].

² www.epomm.eu
³ http://www.konsult.leeds.ac.uk/

In Debrecen (Hungary), one of the largest university towns in Hungary, carpooling was an innovative solution. With the participation of university student organizations and the use of their intranet, a service for pairing driving was created. The service was promoted by local television and radio stations, leaflets and the university intranet. After completion of the implementation of this system in 2008, there were 100 registered users and 204 ads placed - information about sharing rides. Given that it was a completely new project, the efficacy is obvious.

As well as in Debrecen, the city of Krakow in Poland, began with the implementation of this system primarily for the needs of universities and students, but the ultimate goal was the inclusion of all residents of Krakow. During the first year of implementation, the project under the name Let’s ride together attracted 700 users, while the number of registered monthly trip varied from 30 to 50. However, two key barriers in the application of carpooling were detected - the fear for personal safety and the unwillingness of sharing rides with strangers.

In the city of Rome, the primary objective of carpooling system was reducing congestion in the central city area, as well as promoting more efficient ways of using the car. In order to determine the characteristics of travel in the project area, the extensive research with about 100 000 questionnaires was conducted. A simulation model designed to manage carpooling services was developed and installed. The results of the application of these measures were encouraging: a total of 1 180 carpooling users were registered, while the occupancy vehicles raised to 75%.

The concept of carpooling in Perugia (Italy), was primarily intended for students and staff at the University of Perugia. During the implementation the specific prototype-gate was developed. It was able to verify the number of people in the vehicle before entering the parking space designed for carpoolers, by reading occupant’s smart cards (prepaid cards for carpooling). Vehicles with three or more passengers were allowed to access the parking lot. Thus, car owners were enforced to increase the occupancy of their vehicles.

In Toulouse (France) carpooling Association Covoitual operated within the existing mobility center established by the operators of public transport Tisséo who granted it official status. Within two years (2005-2007), the number of registered users increased from 194 to 1 866, where as many as 17% of users shared drive on a daily basis. For this period, about 1 600 000 kilometers were avoided, with a saving of 340 000 kg of carbon dioxide equivalents.

Within CIVITAS II project in the German city of Stuttgart, carpooling application is tested for the purpose of major sporting and other events in the city, or in cases where there is a high demand for transport to the same place at the same time. Existing system-portal for registration and booking driving Pendelnetz Stuttgart was adapted to travel for the purpose of attending sport events, concert, etc. The promotion of this system in particular has contributed to the football club Stuttgart and VfB Stuttgart, for example through the club newsletter and stadium display screens. Also, more than 45 major companies in Stuttgart participated in the organization of promotional campaigns, creating presentations, posters and flyers to their employees presented this new system. As a result of the measure, the demand for carpooling system increased: the number of hits rides on the carpooling portal increased from around 200 000 in 2005 to more than 800 000 in 2008. The fact that more than 120 companies and about 40 municipalities in the region promote the link Stuttgart Pendelnetz Portal confirms the growth of public awareness.

In many other cities across Europe the idea of avoiding solo driving is appearing. For example, the carpooling system in Belgrade still does not exists in the way it is intended to be - for commuters and regular daily rides. Instead, there are recently introduced systems of sharing rides mainly across country and for one-time purpose, which can accordingly be rather considered as...
ridesharing concept. The information about them is available on the web platforms, www.blablacar.rs and srbija.timskavoznja.com.

However, there is no evidence about the share of carpooling traveling within the city of Belgrade. Anyhow, the carpooling concept still has no media attention and the citizens are generally poorly informed about it.

4. Obstacles and potentials for implementation of carpooling

An efficient use of carpooling system requires the involvement of all stakeholders: government, the ministries, local authorities, state institutions, big and small-size companies, employers, all citizens. For the introduction of carpooling, it is necessary to define the basic parameters affecting the proposed system. The starting point for the application of this concept would be the research about the attitudes and knowledge of the carpooling benefits, thereafter the survey on willingness to accept it.

At the same time, it is necessary to collect traffic data before and after the application of carpooling. These include the average number of daily motorized travel, the motorization rate, modal split, travel distribution by purpose, total volume of traffic during the day, desire lines, etc. In this way the efficiency and effectiveness can be monitored and perceived. Larger companies would be expected to be main holders of the application by encouraging employees who enforce carpooling in different ways - through awards, days off, secured parking spaces, etc.

It is also necessary to design a unique mode of travel pairing and reservations aimed at automating these processes in real time or booking in advance through modern information and communication technologies (creation of forums, web sites, portals, and mobile applications for on-line booking rides). In this regard, it is necessary to define the location of terminals according to the requirements of potential users (commuting).

Knowing that the application of carpooling affects the reduction of passenger cars usage and thus improves sustainable mobility, the city authorities should provide additional requirements for the use of carpooling on the existing transport infrastructure. It may include giving priority to vehicles with a large number of passengers, marking lanes for vehicles with high occupancy lanes (so called HOV lanes), integration of carpoolers with public transport, as well as policy instruments for stimulation of carpooling in the transport market.

Given that carpooling is a measure that affects the independence and convenience of travel, it is very important to provide as strategic plan for the additional user’s motivation. For this purpose it is necessary to organize campaigns, education and promotion of sustainable modes of transport for all stakeholders. It is also necessary to raise awareness of the general public about the importance and possible contribution of carpooling aiming to enhance public acceptability of this and similar measures.

For a comprehensive understanding and differentiation of barriers a research conducted for the city of Zagreb can be useful. They distinguished four types of barriers – technical, organizational, financial and political [6]. Some of the listed barriers are universal by nature and should be considered elsewhere. The major challenges are infrastructure problems, organization of communication among users, building adequate information systems and dispatcher activities. The lack of clear concept of financial and/or other stimulations for drivers and costs compensation for cars has a negative impact on motivation for becoming drivers in the carpooling system.

It seems that one of the key preconditions in the successful implementation of carpooling is to draw up ride-matching schemes. This implies availability of service at a time when users need it. For that purpose, harmonized work schedules are required, which is not always easy to achieve, and which is also the subject of change. That is why large companies should be active participants in the implementation of the concept. In order to encourage companies and enhance their interest to act proactively carpooling should be considered as a part of their overall environmental performance. If the environmental benefits are attributed to the company that has introduced carpooling, it will be one way to enhance their motivation.

Based on these observations and evidence from practice, the SWOT analysis (Figure 1) of carpooling can be a useful tool for policy makers and other stakeholders.

This kind of analysis provide the answers on the advantages of the concept, its potential for improvement, opportunities to disseminate and obstacles for implementation.

5. Concluding remarks

Carpooling is gaining importance as a mean to expand travel options. However, as summarized in the paper there are many challenges ahead. Existing practice examples show that there are various levels of implementation:

- Cities with significant number of carpoolers among whole citizens and with existing intuitional support for this concept;
- Cities implementing pilot-projects for a limited period and for particular user- group;
- Cities where carpooling is not organized in original form but as ride-sharing scheme at the regional level;
- Cities without any form of carpooling.

Moving towards carpooling implementation implies several key issues to be considered by policy makers. These include:

- Learning from good practice examples/sharing knowledge and experiences from cities that successfully implemented carpooling;
- Providing detailed travel plans that cover the highest possible percentage of population;
- Finding suitable pick-up points for carpoolers;
- Marketing activities to encourage citizens to accept carpooling;
- Encouraging big companies to be main holders of the implementation by including carpooling scheme in their overall environmental performance.

In addition, although more preferable than solo-driving, carpooling should not be designed as competitor to more efficient urban transport modes (public transit, non-motorized modes) but...
rather to be planned as a part of joint effort to achieve sustainable urban mobility.

6. References


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ACTUAL ACCELERATION, VELOCITY AND TRAVELED DISTANCE PROFILES OF VEHICLES IN URBAN ENVIRONMENT AS DOMINANT MICROSCOPIC TRAFFIC FLOW PARAMETERS

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Abstract: In this paper we have presented a methodology used to determine actual acceleration, velocity and traveled distance profiles of vehicles of different categories in urban environment, as dominant microscopic traffic flow parameters. The tests have been done on representative arterial road in the city of Skopje. Within a period of one month, we have been observing the traffic on the subject arterial road and have determined the average traffic flow during different day periods. The structure of the traffic flow has also been analyzed. In the experiment we have used a probe vehicle equipped with adequate measuring system to follow more than 130 vehicles of different categories on the observed arterial road, imitating i.e. reproducing their behavior as much as possible. The final goal to determine the domains of these microscopic traffic flow parameters in specific velocity intervals, regarding different vehicle categories was reached. These results have shown to be very useful as input parameters in the single lane urban traffic flow simulator that we have developed.

Keywords: TRAFFIC FLOW, MICROSCOPIC TRAFFIC FLOW PARAMETERS, ACCELERATION PROFILES, VELOCITY PROFILES, TRAVELED DISTANCE PROFILES

1. Introduction

The propulsive idea of the performed research was to obtain knowledge about the real traffic conditions in urban environment through relevant traffic flow parameters [5, 7]. The reason for that is the need to parameterize actual daily traffic as a start for analysis of its weaknesses in an effort to improve it by engineering methods as introduction of components of Intelligent Transportation Systems. Afterwards the results could be used as input parameters in microscopic traffic flow simulators [3, 4]. Having in mind the complexity of the task, there is an obvious need to perform experimental research under appropriate methodology, with a goal to determine the structure of the traffic and dynamical behavior of representative vehicles of each category. This should be done without interaction of experimental procedure with the real traffic, and therefore no direct measurement of vehicles in traffic is acceptable. First off all we have selected a representative arterial road in the city of Skopje for observation, based on several factors like traffic flow, density, position in the city, etc. Then, within a period of one month, we have been observing the traffic on the subject arterial road and have determined the average traffic flow during the pick hours. Furthermore we have analyzed and defined the structure of the traffic flow regarding the presence rates of different vehicle categories, vehicle brands and models [2]. Based on these information we have selected those vehicle brands and models with the highest presence rates in the traffic flow to be used as measuring objects in the experimental research. In the experiment we have used a probe vehicle equipped with adequate measuring system. With the probe vehicle we have followed more than 130 vehicles of different categories on the observed arterial road, imitating i.e. reproducing their behavior as much as possible. Each measurement has started at the beginning of the observed arterial road and has ended when the vehicle has left the road. As a result we have obtained actual acceleration, velocity and traveled distance profiles of the observed vehicles. The final goal was to determine the domains of these microscopic traffic flow parameters in specific velocity intervals, regarding different vehicle categories [1].

2. Description of the measuring system used in the conducted experimental research

The dominant microscopic traffic flow parameters, i.e. vehicles actual acceleration, velocity and traveled distance, are obtained with a probe vehicle equipped with adequate measuring system. The system contains sensors, measuring amplifier and data registration and acquisition device. The schematic layout of the measuring system is shown on Fig.1.

For the acceleration measurement, we have used a fifth wheel with an inductive sensor BALLUFF, type BES M12MI-NSC40B-BV03. The sensor has an operating frequency of 300Hz, working distance of 4mm and a guaranteed working distance between 0 and 3.2mm. The error is less than 5%. The fifth wheel with the sensor, within the designed measuring system, is shown on Fig. 3.
Besides the velocity measurement, the signal from the sensor is also used to measure the travelled distance. With an appropriate adaptation of the electric scheme of the velocity sensor we have split (doubled) its output signal. In this way, one signal was used for velocity measurement and the other was used for travelled distance measurement.

The calibration process of the measuring system is performed with known physical properties which are applied on the sensors in the system. The accelerometers are calibrated according the ±g method, regarding their orientation in vertical direction. The velocity sensor is calibrated according to the frequency that corresponds to fifth wheel's angular velocity of $2\pi$ rad/s, and its rolling radius.

The above described sensors are passive sensors. Therefore, we have used a HBM measuring amplifier, type SPIDER-8, for their power supply and amplification of their output signals (Fig. 4). For data registration and acquisition we have used a PC and the data acquisition software HMB CATMAN 4.0.

![Fig. 4 Measuring amplifier HBM - SPIDER-8](image)

**3. Program of the experimental research**

In the conducted experimental research we have followed 131 vehicles of different categories along the selected arterial road. During the following process with the probe vehicle, we have measured their acceleration, velocity and travelled distance. Of the total number of vehicles that were followed, 93 were M1 category, 15 were M3 category, 17 were N1 category, 2 were M2 category, 2 were N2 category, and 2 were N3 category [6]. The selection of a vehicle as a measuring object was done primarily according to the presence rate of the vehicle's model in the inlet traffic flow on the observed arterial road. The following process of each vehicle (measuring object) has started at the beginning of the observed arterial road. The following process of each vehicle presence rate of the vehicle's model in the inlet traffic flow on the vehicle as a measuring object was done primarily according to the proportion of vehicles of different categories along the selected arterial road. The total number of vehicles that were followed, 93 were M1 category, 15 were M3 category, 17 were N1 category, 2 were M2 category, 2 were N2 category, and 2 were N3 category [6]. The selection of a vehicle as a measuring object was done primarily according to the presence rate of the vehicle's model in the inlet traffic flow on the observed arterial road. The following process of each vehicle (measuring object) has started at the beginning of the observed arterial road. The following process of each vehicle presence rate of the vehicle's model in the inlet traffic flow on the vehicle as a measuring object was done primarily according to the proportion of vehicles of different categories along the selected arterial road.

![Fig. 5 Acceleration of followed vehicle (Astra-G)](image)

**4. Presentation and analysis of the experimental testing results**

Fig. 5, Fig. 6 and Fig. 7 show the acceleration, velocity, and distance travelled by one vehicle from M1 category which has been followed within the frames of the experimental research.

![Fig. 6 Velocity of followed vehicle (Astra-G)](image)

![Fig. 7 Distance travelled of followed vehicle (Astra-G)](image)

The acceleration profile is expected and normal during driving of vehicle in urban environment. Its characteristics are frequent accelerations and decelerations as a result of starting and stopping, or due to adopting the speed to the other traffic participants. It is obvious that acceleration and deceleration make pairs. Fig. 8(a) shows acceleration profile which is characteristic for starting and stopping. Fig. 8(b) shows the acceleration profile in the phase of adopting the speed.

![Fig. 8 Characteristic profiles acceleration](image)

Characteristic acceleration profiles show that the vehicle after start reaches its maximum acceleration in a very short period of time. In this period the influence of vehicle inertia is noticeable. After reaching its maximum value, the acceleration decreases. The intensity of such decreasing depends of the driving style of the driver. During stopping phase three characteristic cases are noticeable: gradually increasing of the deceleration until the vehicle stops; gradually increasing of the deceleration to its maximum value and its maintaining until the vehicle stops, and fast increasing of the deceleration and then its relaxation until the vehicle stops. The last case relates to the phase of adopting of the vehicle speed where main characteristic is frequent switching between acceleration and deceleration.
The velocity and distance traveled profiles of the vehicle are in line with the acceleration profile. Parallel analysis shows whether the acceleration happens in the phase of start, stop, or during adopting of the speed of the vehicle. This analysis shows also the actual location of the vehicle on the arterial road.

Fig. 9 shows phase diagram for the vehicle followed. It describes the correlation between the vehicle acceleration and its velocity. This diagram is the basis to define maximum acceleration and deceleration of the vehicle in different intervals of its velocity (Fig. 10).

![Fig. 9 Phase diagram of followed vehicle (Astra-G)](image)

**Fig. 9 Phase diagram of followed vehicle (Astra-G)**

This analysis has been done for each of 131 vehicles being tested. In order to draw generalized conclusions, the results received by described measurements are systematically processed in the categories the vehicles belong. In some categories this has been done in groups of vehicles. The category M1 has been divided in four groups depending of their dimensions and performances. First group is formed by vehicle models Yugo, Koral, Tempo, 101, 128, Tico, Spark, Matiz, Felicia and Samara. Second group is formed from vehicle models Punto, Corsa, Fiesta, Kalos, 206 and Polo. Third group includes vehicle models Astra, Golf, Escort, and Focus, and the fourth group takes the vehicle models Mondeo, Passat, Vectra, Ostavia and E class.

The maximum accelerations and decelerations of the vehicles of M1 category systematized in described groups are shown on Fig. 11 and Fig. 12.

![Fig. 10 Maximum values of acceleration and deceleration of followed vehicle (Astra-G) in different velocity intervals](image)

**Fig. 10 Maximum values of acceleration and deceleration of followed vehicle (Astra-G) in different velocity intervals**

The vehicles of N1 category are divided in two groups based on their total mass. First group includes vehicle models Doblo, Berlingo, Partner, Kangoo and Express. The second group is composed of the following vehicle models: Transit, Transporter, Sprinter, Ducato, Rival, Boxer, Jumper, 35-8H, Vito and Ceres.

The maximum accelerations and decelerations of the vehicles of N1 category systematized in described groups are shown on Fig. 13 and Fig. 14.

![Fig. 11 Maximum accelerations of the vehicles of M1 category systematized in groups](image)

**Fig. 11 Maximum accelerations of the vehicles of M1 category systematized in groups**

![Fig. 12 Maximum decelerations of the vehicles of M1 category systematized in groups](image)

**Fig. 12 Maximum decelerations of the vehicles of M1 category systematized in groups**

![Fig. 13 Figure 13 Maximum accelerations of the vehicles of N1 category systematized in groups](image)

**Fig. 13 Figure 13 Maximum accelerations of the vehicles of N1 category systematized in groups**

![Fig. 14 Maximum decelerations of the vehicles of N1 category systematized in groups](image)

**Fig. 14 Maximum decelerations of the vehicles of N1 category systematized in groups**

Systematic processing of the results led to the range of the maximum accelerations and decelerations in different speed intervals. In order to make results more precise, the vehicle velocity is divided into intervals with relatively small size. First interval is between 0 and 5 m/s. Other intervals are with a size of 2 m/s. The interval between 13 and 15 m/s has been additionally divided into two subintervals: from 13 to 13.9 m/s, and from 13.9 to 15 m/s. This is done on the basis of the maximum functional speed of low speed following systems (13.9 m/s), as defined in the standard ISO22178.

Fig. 15, Fig. 16, Fig. 17, Fig. 18, Fig. 19, Fig. 20, Fig. 21, Fig. 22, Fig. 23, Fig. 24, Fig. 25 and Fig. 26 show the range of maximum accelerations and decelerations related to the speed intervals measured on followed vehicles, representatives of the actual vehicle category.

![Fig. 15 Range of the maximum acceleration of the vehicles of the category M1 related to the interval of the speed](image)

**Fig. 15 Range of the maximum acceleration of the vehicles of the category M1 related to the interval of the speed**
Fig. 16 Range of the maximum deceleration of the vehicles of the category M1 related to the interval of the speed

Fig. 17 Range of the maximum acceleration of the vehicles of the category M2 related to the interval of the speed

Fig. 18 Range of the maximum deceleration of the vehicles of the category M2 related to the interval of the speed

Fig. 19 Range of the maximum acceleration of the vehicles of the category M3 related to the interval of the speed

Fig. 20 Range of the maximum deceleration of the vehicles of the category M3 related to the interval of the speed

Fig. 21 Range of the maximum acceleration of the vehicles of the category N1 related to the interval of the speed

Fig. 22 Range of the maximum deceleration of the vehicles of the category N1 related to the interval of the speed

Fig. 23 Range of the maximum acceleration of the vehicles of the category N2 related to the interval of the speed

Fig. 24 Range of the maximum deceleration of the vehicles of the category N2 related to the interval of the speed

Fig. 25 Range of the maximum acceleration of the vehicles of the category N3 related to the interval of the speed
Presented diagrams show high consistency of results achieved in different vehicle categories. At the same time the differences between such categories are noticeable. In addition, a number of analytical checks have been done in order to compare the experimental results with theoretical maximum performances of tested vehicles. The results confirmed validity of experimental results. These analyses are not presented here due to room issue.

5. Conclusion

Having on mind that vehicles in the real traffic are driven by drivers with diverse (different) driving styles, and at the same time the vehicles could also have significant differences in performances, the research that is performed relies on a methodology which comprises wide experimental testing and appropriate processing of the results. It provides a possibility for systematic presentation of the results for groups of vehicles and categories according to the international categorization in power of ECE-EC systems.

The analyses of the obtained results showed that the developed experimental testing methodology has capacity to cope with the research goals and to be used as a method for measuring dynamical behavior of different vehicles in real traffic without a burden of their equipping with measuring instruments and deterioration of their normal rhythm of driving in the traffic.

Actual acceleration, velocity and traveled distance profiles that we have measured reflect a vehicle behavior in urban environment.

The obtained domains of the maximum accelerations and decelerations of vehicles of different categories, in relation to the velocity intervals, are consistent within a vehicle category and note the differences between vehicle categories.

Large number of the achieved results is useful in different purposes. They could be used as input parameters for development of urban traffic flow simulators. At the same time, they could serve as a basis for analysis and modeling of the behavior of different driver profiles (males, females, ordinary drivers, professionals, etc.)
HOW IS THE ARTIFICIAL INTELLIGENCE USED IN APPLICATIONS FOR TRAFFIC MANAGEMENT

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Abstract: There are described in the article current applications with the artificial intelligence and value of using it for the road transport efficiency. This paper deals with concept of artificial intelligence, main reasons for successful growing of AI at present and main areas of AI using in transportation. One part of the article aims to define the artificial neural networks and basic elements of them. The article describes the reason of use them in transportation problems solving, the possibility of using neural networks in the road transport, examples of tasks solvable by neural nets, the advantages and disadvantages of using neural networks.

Keywords: PERCEPTRON, ARTIFICIAL INTELLIGENCE, NEURAL NETS, FEED FORWARD NEURAL NET, UNMANNED

1. Introduction

Intelligent technologies which are penetrating to different parts of human life don't ignore transportation. As an example we can take intelligent transport systems and automated transport systems which use information, transportation and communication technologies implemented to vehicles or to infrastructure. These systems aim to increase people or goods mobility along with increasing road safety and transportation comfort, reduction of transport collisions and impacts on environment.

Information technologies usage became inherent component of “human” development. Ability to effectively process and use information and knowledge became one of the most important parts of economic growth and prosperity. In transportation, the still changing environment of many participants, special attention should be paid to artificial intelligence – progressive information technology.

2. What Artificial intelligence is and main areas of its utilization in transportation

There are a lot of definitions of Artificial intelligence (AI), for better imagination what AI is I choose following two from Marvin Minsky and John L. Gordon:

Marvin Minsky: Artificial intelligence is the science of making machines or systems do things that would require intelligence if done by men:

John L. Gordon: The aim of Artificial Intelligence is to create intelligent machines and through this, to understand the principles of intelligence. At the moment, we can settle for creating less stupid machines.

According to these definitions we can say that AI systems are characterized by:

They think like people
They act like people
They think reasonably (rational)
For their implementation is the necessary to get information and knowledge and using information and knowledge to achieve the goal or solution.

2.1. Main reasons for successful growing of AI at present

However AI theory is developing some decade years already its using had to wait for progress in IT technologies area. Including AI in transport machines or systems requires:

- The huge development of IT technologies.
- The development of computer components – mainly speedy processors, high capacity memory devices etc.
- Digitalization of sound and image – for inputs.
- Computer networks creation and growth as wireless nets, logistic systems, Internet are.
- Satellite and mobile nets.
- Progress in transport devices area.

Thanks to this current technical progress Artificial Intelligence contains ways and means to be used in transportation such as neural nets, AI planning, evolution algorithms, knowing and expert systems, fuzzy logic, multi-agent systems, vector regression, data mining, optimizing techniques, etc.

2.2. Main areas of AI using in transportation

AI at present provides instruments and allows solving problems in each kind of transport and their interaction (air, road, railway and water transport) and is used in areas such as:

- Real time transport managing
- Design, operation, time schedule and administration of logistical systems and freight transport
- Transport policy, planning, projecting and managing
- Questions related to environment, toll – roads, reliability and safety
- Transport systems operation
- Usage and administration of new technologies
- Travel demands analysis, predictions and transport organization
- Travel information systems and services
- Transport and surroundings intelligence technologies
- Pedestrian and herd behaviour analysis and simulations
- City planning of sustainable mobility
- Service oriented architecture of vehicles and vehicles in communication infrastructure
- Transport technology review and evaluation
- Artificial transport systems and simulations

AI techniques allow using applications for entire transport system managing – vehicle, driver, infrastructure and the way in which these components dynamically offer transport services. All-purpose AI instruments and their power are suitable for complicated and diversified transport systems.

3. Artificial neural nets using in transportation

According to diversity of AI and to its growing usage I am only able to describe in this article neural networks use in some areas of road transport.

Nowadays IT era force us to handle more and more information in very short time. That is why it is inevitable to construct and use such technical devices which are able to sort out important information from quantity and according to its design suitable solution for current situation, perhaps even predict following situation. These complicated problems are partially solved by neural networks utilizing knowledge about data organizing and administration in human brain.

3.1. Artificial neural nets definition

Artificial neural nets can be defined as massive parallel computing system open to saving and following execution of information while simulating human brain in collecting data during learning process and saving of these data using inter-neural connections.

Artificial neural nets are one of the options in situations where there are no strict rules according to which it is possible to simulate result of the situation or where these rules are too complex or incomplete. Statistical methods, multi-agent systems or adaptive computing systems are further alternatives. It is suitable to use standard AI methods when rules are known.

3.2. Basic elements of neural nets

Perceptron is a neural model which receives input signals \( X = (x_1,x_2,\ldots, x_{n+1}) \) through synaptic weights (in neurobiology synapse is connection between two neural and a power acting in synapse is a synaptic weight) creating weight vector \( W = (w_1,w_2,\ldots,w_{n+1}) \). Input vector is called sample or pattern. Components of input vector can gain real or binary values.

Perceptron output is defined as:

\[
o = f(\text{net}) = f(W^X) = f(\sum_{j=1}^{n+1} w_j x_j - \Theta)
\]

where variable net assigns weight sum of inputs – dot product of weight and input vector. Function \( f \) is called activation function of perceptron. \( \Theta \) is excitation threshold value of perceptron, \( o \) is perceptron output.

![Fig. 1 Perceptron](image)

Perceptron at picture 1 has \( n+1 \) inputs. \( (N+1) \) input value is always -1 and \( W_{n+1} = \Theta \) which is excitation threshold value of perceptron.

If there are only feedforward connections between neural these nets are called feedforward neural nets. Each neural of each layer send signals to each neural of following layer. Backward connections don’t exist.

It is not necessary to know solved problem model when using artificial neural nets. Suitable training set and suitable net architecture offer enough information to train designed neural net and together with backward error spread set parameters (weights and thresholds) of net to receive acceptable result. Solution can be also obtained by simulations or experiments instead of rigorous and formal problem solving.

4. Examples of tasks solvable by neural nets

Neural networks (NN) applicability comes from some basic features of NN. The most important one is that NN are universal function approximator. According to the fact that many problems cannot be described with known functions, NN usage would grow in short time. The only decelerator is very high computing technique requests which on the other hand change rapidly with high performing computing systems development.

Neural networks generally can be used in following areas:

- Function approximation problem
Category classification, situation classification
Prediction problem solving
Signal transformation
Association problems, memory simulation

4.1. Advantages of using neural nets in transportation
Following advantages and disadvantages of using neural nets applies broadly as well as in road transport. For this reason I am mentioning them in this article:

Neural nets allow parallel data processing and by using appropriate hardware it is possible to allocate calculations on more parallel processors.

This capability of NN is essential for example to construct unmanned vehicle due to a processing a huge number of inputs from surroundings during driving the vehicle.

Neural net doesn’t need any information about process structure to which it is implicated, it learns and does not to be reprogrammed.

Instead of it is possible use just suitably chosen training set and appropriate network architecture. Train with back propagation of errors set the parameters (weights and thresholds) of network so that we get acceptable solution. The solution can be finalized by simulations and experimentation rather than rigorous and formal approach to the problem.

If neural net is used with learning algorithm it can be adapted to changes in parameters.

Neural nets are suitable for identification, classification and sorting of models – using in recognition of road signs, registration plates, driving licenses, people faces and others.

If neural nets are implemented without learning algorithm they are quite fast.

Learning algorithm is a huge programme process that can significantly slow the NN.

NN allows abstracting managing rules for different regulators (such as human being or regulator with long computing time) and replace them.

Very important in unmanned vehicles – human solutions in the cars are relatively slow that cause most of road accidents. A decisions of NN system is disproportionately faster.

NN allows data reduction to smaller dimension.

NN are universal approximator – they allow approximation of any function with any accuracy.

4.2. Disadvantages of using neural nets in transportation
Artificial intelligence and NN also need a huge hardware support.

There is no methodology for neural net architecture and functions for neural description. Implementation is done by experiments and mistakes what increase time demand on solution.

The architecture of a neural network is different from the architecture of microprocessors therefore needs to be emulated.

Learning process can take very long time.

During the learning process can became the situation when neurons reach the state of saturation consequently their outputs lead to extreme values for example sensible error signals.

5. Some neural nets application description in road transport
The following section describes some important and interesting applications of neural networks in a road transport and explains NN using in these solutions.

5.1. Driving of unmanned vehicles or computer controlled cars
One of the most valid successes at present is using artificial neural nets in the road transport. When appeared vehicles on the road without steering wheels of a man for the first time they aroused a wave of interest. Simply because it is amazing to see how the car passes several thousand kilometres without a driver and no crash.

Currently is their development in full drift and they have already driven more than a half million kilometres. In one US state there is a law allowing unmanned vehicles on the roads. Unmanned vehicles controlled by computer covered many different transport situations without an incident.

Unmanned vehicles development is related to development of Automatic Transport Systems ATS. These systems use only electric vehicles and different transport organization as usual. Main feature is using only unmanned vehicles and eliminating other drivers from limited ATS area what will bring more discipline and less accidents in the transport. Only electric vehicles are planned in this project to clear away exhaust fumes and to enrich environment. Such projects are currently realized in some countries, in others is its development financed.

5.2. Driver behaviour modelling
Sometimes using GPS or other navigation doesn’t have to be the best solution. Driver has to decide about by-pass road or using highroad etc. There are models allowing designing such transport systems which consider safety and effectiveness of human mobility. Feed forward neural nets are used in analysing desirable road from interactive simulators.

Such system was created as following:

Neural net was designed with volunteers providing trial journeys. During the journey they were deciding about the most effective and the most suitable way from many different criterions. According to the actions of volunteers neural net training set was created. This neural net learned same decisions as volunteering drivers and was able to choose journey from unknown data.

5.3. Creation of models which can forecast following of traffic signs by driver
There are algorithms created to solve this problem. Current models use fuzzy logic and neural nets combination to overcome limitations of existing algorithms. Using neural nets to solve such problems is preferable due to their ability to solve nonlinear relations and because they are immune against mistakes obtained from imperfect inputs. NN are suitable for reactive behaviour modelling which is often described as rules connecting perceived situation with attributable measures.

Models which can forecast following of traffic signs by driver can be used as a part in Intelligent transport system (ITS) or ATS.

5.4. Systems for advising maintenance and repair of paths and roads can foresee problems on the roads caused by weather or abrasion
ITS and ATS need to have such parts which offer overall view of roads and paths state for either road participants or transport companies which are in charge of road conditions.

Systems for advising maintenance and repair of paths and roads can be divided to two subsystems – diagnostic and prognostic.

Diagnostic subsystem can be classified as pattern detecting problem. Neural nets are used here to process road surface snapshots and assigning them to different defect categories.
Diagnostic subsystem also automatically detects bypass roads or damaged roads.

**Prognostic** subsystem is complex according to its conformity – road repair actions are not only dependant on actual road condition but also on traffic intensity and on financial needs required for road repair. Data collection for all potential situations is extremely difficult. Suitable solution might be connecting more neural nets to one system.

5.5. **Systems for classification and registering of passing vehicles**

NN are in this case used to process input data from signalers built beside the roads (video cam with high performing snapshot processing, sensors, etc.). Their main contribution is noticeable during bad external conditions. These systems were successfully run in licensed trademark reading.

5.6. **Traffic net analysis and Journey planning and optimizing**

These systems use neural nets to diagnose traffic jams and analyse season changes in the traffic and can plan the most effective route what can shorten journeys, lower accidents and finally save environment. The most difficult part is setting parameters for the problem which is nonlinear.

5.7. **Traffic streaming forecast**

Very important parts of ATS or ITS are systems to recognize and predict congestions to inform all road users about actual situation.

The benefit of a neural network to solve this problem is that it absorbs patterns in data and so can learn to generalize. The main features of a neural network approach are trials of its application to a congestion recognition problem to short term and long term forecasting of flows. Models to recognize and predict congestions include:

- Short term forecast – forecasting few minutes, can be part of transport managing system
- Long term forecast – forecasting months or years, important in planning and building roads

5.8. **Transport economics**

Neural nets can also be used in solving problems in the area no one would expect – impact of noise on real estate price close to transport arteries. Used neural net consisted of instrument which could analyse many variables – real estate condition, age, largeness and of course noise factor of vehicles.

5.9. **Traffic sign recognition**

There are devices that can detect, recognise and follow traffic signs from moving vehicle. Recognition is done by colour segmentation and neural nets classification. Existing systems can not only recognize traffic signs but also locate and gather them. Locating is realised by approximating location from GPS device and location of traffic sign acquired from video cam or video file. Traffic signs gathering help to build traffic sign database which in the same time composes training data set.

Traffic signs are characterized by features from which the most important for detecting and recognising are colour and shape. Detection is done by classical methods based on tresholding and colour segmentation using different colour models or shape models (in black and white images) or their combination. 3D modelling is also often used.

There are more methods which use machine learning algorithms for classification and detection.

6. **Conclusion**

Artificial Intelligence and Neural nets included in there have broad utilization in every area of transport. Their applications can be found in all systems involving road transport management, such as

- Automatic transport systems using electric computer managed vehicles
- Intelligent road systems
- Intelligent highway systems
- Traffic road logistics and many other.

Nowadays all rich developed countries involve in development of these systems which costs high financial means.

**References**

TRANSIT ROUTES FOR TRANSPORTATION OF DANGEROUS GOODS IN THE CITY OF BRATISLAVA

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Abstract: National and international transport of dangerous goods in Slovakia is exercised by the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR). All shipments covered by this agreement remain subject to national and international road traffic regulations, international road transport and international trade.

Keywords: DANGEROUS GOODS, ADR, TRANSIT WAY FOR CITY BRATISLAVA,

1. Introduction

Bratislava with a strategic location near the border with Austria and Hungary is a transport junction to or from these countries (significant border crossings are listed in Table 1), as well as to Czech Republic and farther to the east. Within the capital of the Slovak Republic there are two major traffic arteries, highways D1 and D2, allowing transit through the territory of the city. Subject to certain cases of entry ban and mandatory transport direction for vehicles carrying dangerous goods or carrying substances that may pollute water sources, located just on these two highways in Bratislava, it is necessary to analyze transit road network of the city for the transport of dangerous cargo. As a result of such prohibitions and entry bans for trucks it is necessary to look for alternating tracks in the process of route planning, as these tracks are often channeled through via lower class roads, for which the probability of accidents is higher, also through the city center or even through the densely populated areas.

Table 1: Border crossings in Bratislava.

<table>
<thead>
<tr>
<th>with weight limit up to 3.5 tons</th>
<th>Slovakia – Austria</th>
<th>Petřžalka</th>
<th>Kittsee</th>
<th>Road (MK)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Petřžalka</td>
<td>Berg</td>
<td>Road (I/61)</td>
<td></td>
</tr>
<tr>
<td>Slovakia – Hungary</td>
<td>Rusovce</td>
<td>Rajka</td>
<td>Road (I/2)</td>
<td></td>
</tr>
<tr>
<td>Slovakia – Austria</td>
<td>Jarovce</td>
<td>Kittsee</td>
<td>Highway (D4)</td>
<td></td>
</tr>
<tr>
<td>Slovakia – Hungary</td>
<td>Čunovo</td>
<td>Rajka</td>
<td>Highway (D2)</td>
<td></td>
</tr>
</tbody>
</table>

No weight limits are two motorways crossings, located to the south of Bratislava and leading to Austria and Hungary. Therefore, where dangerous goods are being carried to this countries through the territory of Bratislava, the route will be scheduled just this way.

In the city of Bratislava there are plenty of road signs to direct the possible routes of trucks, especially those carrying dangerous goods in the area, therefore it was necessary to investigate their location. Analysis of road signs was carried out on roads suitable for such transit routes in the directions D2-D4-Austria, D2-Hungary and D1-D2-D4-Austria and D1-D2-Hungary.

Road signs B21, B22 and C19 prevent entrance of vehicles carrying dangerous goods on a section of motorway D2 regarding to the tunnel Sitina, and vehicles carrying substances that may pollute water sources on a section of motorways D1 and D2 regarding to existing water sources placed in this area.

The sign B 21 – No entry for vehicles carrying dangerous cargo – prohibits any entry for vehicles transporting explosives, high flammable or otherwise hazardous cargo. In the case of prohibition of passage for these vehicles through the tunnel this sign will be supplemented by additional table N. E 14 (category tunnel).

The sign B 22 – No entry for vehicles carrying loads that may pollute water sources – prohibits any entry for vehicles carrying substances that may pollute water sources, e.g. vehicles transporting crude oil, petroleum materials or other pollutants. The quantity as well as type of cargo can be marked on supplementary tables.

![Fig. 1 Red zone, where it is not possible to transport dangerous cargo, and blue zone, where it is not possible to transport substances that may pollute water sources. Source: Authors](image)

Energy of the laser beam locally melts the metal powder only in contour of the cut which is defined by the intersection of the plane (layer) of the product body (3D CAD model). A correct position of the part is very important during a fabrication. The supporting structure (anchored on the base steel platform) is used to ensure the correct part position. Metal powder is thoroughly melted by the laser and ensures a perfect close coupling of deposited layers. Powerful 200 Ytterbium (Yb)-fiber “dual-spot” laser is able to produce even small construction features in fine resolution, fabrication of the physical model is faster thanks to the higher energy density of the laser beam. The laser beam is precisely driven in the X and Y coordinates, Z-axis is controlled by shifting of the platform layer when the layer is created. This system allows accordance with geometrical tolerances of shape in the range of ± 0.1 mm. Workspace of 3D printer EOSINT M270 is 250 x 250 x 215 mm.
It is essential to protect these resources, and therefore transportation of goods that may cause water pollution should be diverted as much as possible from their protection zones. The large capacity sources Sihot, Pečniansky les and Sedláčkov ostrov are protected by entry bans. The road I/2 passes around the protection zone II, degree Rusovce – Ostrovne lúčky – Mokrđ, and large capacity sources Rusovce. Although the border crossing Rusovce – Rajka is restricted to vehicles with maximum weight of 3.5 tonnes, it is not suitable to keep following the route to Hungary along this road, but to divert it to the highway ahead of the village Rusovce. Water resources Šamorín is far enough from the road I/63 passing from Bratislava to Šamorín.

3. Transit routes for transportation of dangerous goods within the territory of Bratislava

After reflecting this situation alternate routes for vehicles transporting were incorporated into the map. In Figure 3 recommended routes for dangerous goods are marked green. Orange is the alternate route when driving from the direction of Pezinok towards Račianska, Pražská and Lamačská cesta (II/502, II/572, I/2). Yellow is for alternate routes for vehicles with maximum weight of 3.5 tonnes towards the border crossing points Petržalka-Berg (I/61), Petržalka-Kitse (local road) and Rusovce-Rajka (I/2). Pink is for alternate routes Rožňavská, Dolnozemská cesta in the direction to Austria/Hungary (I/61, I/2). More detailed information are provided in the table N.2

<table>
<thead>
<tr>
<th>From – To</th>
<th>Recommended routes for the transport of dangerous goods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senec - CZ</td>
<td>D1 from the direction Senec ↔ Prístavny most (D1) ↔ Einsteinova (D1) ↔ a feeder D2 ↔ D2 - Lafranconi Bridge ↔ Road nr. I/2 (Mlynská dolina) ↔ Crossroad Patrónka ↔ Lamačská cesta (road nr. I/2) ↔ D2 (direction CZ)</td>
</tr>
<tr>
<td>Senec - A</td>
<td>D1 from the direction Senec ↔ Prístavny most (D1) ↔ Continued D1 (Einsteinova) ↔ a feeder D2 ↔ D2 ↔ a feeder D4 ↔ D4 – Highway border crossing to AT</td>
</tr>
<tr>
<td>Senec - HU</td>
<td>D1 from the direction Senec ↔ Prístavny most (D1) ↔ Continued D1 (Einsteinova) ↔ a feeder D2 ↔ D2 ↔ D2 – Highway border crossing to HU</td>
</tr>
<tr>
<td>Senec - A up to 3.5 t</td>
<td>Prístavny most (D1) ↔ Cesta I/61 (Einsteinova) ↔ Road nr. I/61 (Viedenská cesta) ↔ Road border crossing to AT (up to 3.5 t)</td>
</tr>
<tr>
<td>Senec - HU up to 3.5 t</td>
<td>D1 from the direction Senec ↔ Prístavny most (D1) ↔ Road nr. I/2 (Dolnozemská cesta) ↔ Continued Rusovce Road nr. I/2 ↔ Road border crossing to HU (up to 3.5 t)</td>
</tr>
<tr>
<td>CZ-A</td>
<td>D2 from the direction Malacky ↔ Lamačská cesta (Road nr. I/2) ↔ Crossroad Patrónka ↔ Road nr. I/2 (Mlynská dolina) ↔ D2 - Lafranconi Bridge ↔ a feeder D4 ↔ D4 – Highway border crossing to A</td>
</tr>
<tr>
<td>CZ-HU</td>
<td>D2 from the direction Malacky ↔ Lamačská cesta (Road nr. I/2) ↔ Crossroad Patrónka ↔ Road nr. I/2 (Mlynská dolina) ↔ D2 - Lafranconi Bridge ↔ a feeder D4 ↔ D4 – Highway border crossing to A</td>
</tr>
</tbody>
</table>

| Table 2: The recommended alternate route guidance through the city Bratislava for vehicles transporting dangerous goods. Source: Authors |

Based on placing of „No entry” signs on the highway D1 and D2, the colour-coded zones have been marked in the picture. The red zone is no entry zone for vehicles carrying any dangerous cargo. This zone represents the area of the tunnel Sitina on the highway D2, where no entry zone begins for the vehicles transporting dangerous goods. From the tunnel to the south begins the zone of no entry for vehicles carrying substances that may pollute water sources (this zone is marked blue). The connection of the highways D1 and D2 is located in the area Pečniansky les where there are sources of drinking water.

2. Areas with water sources protection within the city of Bratislava

Under the law N. 364/2004 Collection of Acts on water resources, the water sources means the waters in surface water bodies and groundwater bodies used for the supplies of water for drinking water or usable to provide the population for more than 50 people, or allowing the use of water for this purpose, on average greater than 10 m³ per day, either fresh or treated. To guarantee the health safety and quality of water that are used, public authorities have specified protection zones. Protection zones may be intended for usable water sources and sources intended for drinking water with a capacity of less than defined water sources. Protection zones are divided into zones by degrees of protection (I., II., III. degree). It is essential that Slovakia protected, maintained and preserved its water as a precious and strategic resource. Thanks to the national conditions Slovakia has currently sufficient resources covering present and perspective needs of public and private sector. The quality of drinking water sources around Bratislava is excellent, sanitary control meets the requirements of Decree no.151 Collection of Acts on requirements for drinking water. The city of Bratislava is supplied with water drawn from large capacity sources Sihot, Pečniansky les, Rusovce – Ostrovne lúčky – Mokrđ, Sedláčkov ostrov and Šamorín. Water resources Rusovce and Čunovo were shut because of construction in the protection zone II. Degree in 2013. Water resources Čunovo was shut because of construction in the protection zone II, degree in 2013. Water resources Kalinkovo is connected to city water system, but since 1999 it is no more used to supply this district.

As a result of acts of the Slovak parliament (eg. No. 274/2013 Collection of Acts or The law N. 82/2013 Collection of Acts on water resources), the Bratislava region is divided into zones by degrees of protection (I., II., III. degree). It is essential that Slovakia protected, maintained and preserved its water as a precious and strategic resource. Thanks to the national conditions Slovakia has currently sufficient resources covering present and perspective needs of public and private sector. The quality of drinking water sources around Bratislava is excellent, sanitary control meets the requirements of Decree no.151 Collection of Acts on requirements for drinking water. The city of Bratislava is supplied with water drawn from large capacity sources Sihot, Pečniansky les and Sedláčkov ostrov are protected by entry bans. The road I/2 passes around the protection zone II, degree in 2013. Water resources Kalinkovo is connected to city water system, but since 1999 it is no more used to supply this district.

Sources of drinking water. D1 and D2 is located in the area Pečniansky les where there are protected, maintained and preserved its water as a precious and strategic resource. Thanks to the national conditions Slovakia has currently sufficient resources covering present and perspective needs of public and private sector. The quality of drinking water sources around Bratislava is excellent, sanitary control meets the requirements of Decree no.151 Collection of Acts on requirements for drinking water. The city of Bratislava is supplied with water drawn from large capacity sources Sihot, Pečniansky les and Sedláčkov ostrov are protected by entry bans. The road I/2 passes around the protection zone II, degree in 2013. Water resources Kalinkovo is connected to city water system, but since 1999 it is no more used to supply this district.

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4. Transit routes for transportation of cargo which may cause water pollution

Transportation of dangerous cargo that may pollute the environment, especially water, is more complicated than transportation of other dangerous goods, as it should be to diverted from highways D1 and D2 because of entry bans into the areas with the possible transport of dangerous goods has shown a large number of vehicle combinations with a maximum permissible weight exceeding 12 000 kg or to pollute water sources, thus respecting this provision would not be possible to transit these substances by vehicles and vehicle sets with a gross weight of over 12 tonnes by the direction from the city Senec to Austria or Hungary because in our opinion, this is contrary to §39, section 4 and 5 of the Law N. 8/2009 Collection of Acts on Road Traffic and on amendments to certain laws and refil where it is defined that driving on the III. class road is prohibited to a vehicle with a maximum permissible weight exceeding 12 000 kg or to vehicle combinations with a maximum permissible weight exceeding 12 000 kg, except of motor vehicles and combinations of vehicles:

a) which ensure loading or unloading of goods or other cargo, repair, maintenance services, municipal services and the like on the III. class road or in a place to which access is possible only by this road,

b) whose drivers or operators are residents or possess a garage or operating structure in a place accessible only by this road

c) whose passage or transport is carried out for repair, servicing, technical inspections, emission checks, originality check of the vehicle or the passing OBU

d) which drive on the III.class road or in a place accessible only by this road as training vehicles for driving schools or due to the aptitude test for participants

The passage of trucks carrying cargo which may cause water pollution on the road III/00246 in the direction from Bratislava to Austria and Hungary.

Given that there is no other possible way for such vehicles to transit, a problem arises when passing the road III/00246 toward Austria and Hungary because in our opinion, this is contrary to §39, section 4 and 5 of the Law N. 8/2009 Collection of Acts on Road Traffic and on amendments to certain laws and refil where it is defined that driving on the III. class road is prohibited to a vehicle with a maximum permissible weight exceeding 12 000 kg or to vehicle combinations with a maximum permissible weight exceeding 12 000 kg, except of motor vehicles and combinations of vehicles:

The analysis of the road network in Bratislava with reference to the possible transport of dangerous goods has shown a large number of higher category roads leading through the populated areas of the city Bratislava to Austria and Hungary.

5. Conclusions
city with a lot of intersections and a high frequency of bus stops. The main transit route is made of highways D1 and D2, which in most cases are optimal for transporting all kinds of goods. In the city of Bratislava, however, both highways are crossing water sources Pečniansky les and therefore can not be used to its full length in the city goods transport that may pollute water. In addition, the D2 highway passes through the tunnel Sitina, which is categorized as E, and therefore is excluded from the transportation of dangerous goods. Trucks should avoid the tunnel on the road I/2. Another factor that complicates planning the transport routes of these cargoes is the fact that in Bratislava is a large number of no entry signs for trucks (especially in the city). Suggested routes are then kept as much as possible on first class roads and motorways. As this was no longer possible for alternate routes, it is appropriate to use these routes in such cases where a shipment can not be carried out on the recommended route.

REFERENCES

[1] ADR European Agreement concerning the International Carriage of Dangerous Goods by Road

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TECHNOLOGICAL STRUCTURE OF OPERATIONAL FILES IN REGIONAL BUS TRANSPORT FOR THE NEEDS OF THE TENDER FOR CARRIERS

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Abstract: In the regional bus transport in the Czech Republic is currently ending a period, in which contracts with the bus carriers have been concluded directly - without a tender, before the effect of European Regulation 1370/2007. Main contractors of public transport are currently solving questions, how to define the structure of operational files in regional bus transport, so that these files were technologically functional, operationally homogeneous and that the price of transport performance in these files was economically viable. This situation requires new and innovative approach in the field of transportation technology.

KEYWORDS: PUBLIC TRAFFIC, TRANSPORT TECHNOLOGY, BUS TRANSPORT, TIMETABLE DESIGNING, TRANSPORT EFFICIENCY, TRANSPORT PLANNING, TENDER FOR CARRIERS, VEHICLE CIRCULATION

1. Introduction

Regional bus services in the Czech Republic are currently ordered by 14 regions. The overall extent totals approximately 300 mil km / year. Total operating compensation payment amounts to approximately 5.5 billion CZK / year. Revenues from fares cover approximately 1/3 of the total cost.

Most of these 14 regions will end directly awarded contracts with carriers in period 2017 - 2019. The exception is the Ústí Region, which all bus services have competed and with new carriers it runs from January 1st 2015.

According to European Directive 1370/2007 it is no longer possible to conclude a public service contract for bus transport directly and therefore will need to be given the full range of transport to compete.

For this reason, the issue is currently in the Czech Republic is highly topical.

In the first half of the 90s was privatized bus state enterprise ČSAD, which ensured all regional bus service. Through purchases of individual operation units by different owners and their transformation the situation has stabilized in the Czech Republic in a state where there are large carriers operating hundreds of buses, both on a national scale (e.g. ICOM, Autobusy Karlovy Vary), as well as in the field of international players, that operate in the Czech Republic (e.g. Arriva). Besides these major carriers there are hundreds of small operators that in regional transport run to tens of buses. In each of the regions it is also a division the performance among of large and small carriers distributed differently.

Because even the preparation and organization of the competition on the carrier requires considerable complexity (time, organizational and financial) on the side of the public service orderer, they are looking to such techniques and methods that are most effective and allow the orderer to profit from the effects of the competition.

2. Influence of structure and configuration of operational file

The authors of this article have participated in the preparation of the technological structure of the operational files in the Ústí and Olomouc Region. Among the key issues defining the structure of the operational file belong three basic areas:

- Operational file size (volume of transport performance)
- Configuration the operational file
- Definition the operational file

These points will be discussed in the following subsections.

2.1. Operational file size

Generally, the larger the number of contracts is associated with a higher demand of administration on the side of the orderer. At the same time, a greater number of smaller contracts mean potentially more competitive environment because of the smaller contracts are achievable to a larger number of entrants. For each contract size is by volume, financial performance generally required bank guarantee corresponding proportional amount of the financial performance for the duration of the contract. The smaller contract, the smaller bank guarantee and vice versa. Large contracts are a way for smaller carriers usually completely unachievable - not only in terms of bank guarantees, but also the opportunities and conditions for obtaining credits for the financing vehicles.

According to the positive results to now realized competitions in the Czech Republic experience shows that the appropriate approach is to define a greater number of smaller areas, respectively medium range transport performance. Such operating systems are of the ideal size around 1-2 million vehicle km traveled per year and cause the need for all-out 10 to 20 buses.

Each operational file is determined primarily by the volume of transport performance, but the investment required for the carrier is determined by the length of contracts and the required age and equipment of buses.
2.2. Configuration the operational file

In the particular regions there is a very heterogeneous structure of transport performance. On one hand, the connection can be found, their peak occupancy amounts typically up to 100 passengers, on the other hand can be found connections whose peak occupation does not exceed the of 20 passengers. These extremes are going in principle across the whole territory of the Czech Republic. In terms of the size of buses required we move from the minimum size of a bus for regional traffic with a length of 8.5 meters to 3-axle 15 m buses or articulated buses.

It is obvious that a larger number of operational files (i.e. the areas defined by one contract) must be each operational file in a certain way homogeneous, graspable, coherent and compact. This homogeneity can be in principle regarded geographically or operationally.

Typical geographical clustering to the operational files would be necessary to copy administrative boundaries, eg. former districts, or there may be cases where the territory is geographically isolated by a natural barrier.

The advantage of the geographical clustering of the territory on operational files is high operational ability of the carrier (on all lines in this area operates just one carrier, any advances and operational vehicles can be concentrated in one “central” point etc.). Geographical clustering would have been 100% successful but only in such theoretical case, that the territorial boundaries were “impenetrable” by the regular public transport, i.e. there would be no lines connecting neighboring regions. This principle was applied in many cases at a time, when organization of regular public transport fell under the district offices (very small regions) - in many places in the Czech Republic can be still on line planes seen, that the lines do not go behind the former district border and “ignore” aims on "other side". In many ways it is so apparent lack of connection quality between medium sized regional centers.

However, because often there are strong linkages between regional centers, is perfect geographic clustering not reachable. There will always interregional connection lines, which must be allocated in one or in the other operational file, and so there will be possible, that more carriers will operate in single areas.

Conversely, operationally perfect clustering of the territory would not be after lines, but after individual links, respectively groups of circulation plans of single vehicle types. Each operational file would have been formed by numerous circulation plans on the same type of vehicle. These circuits would be designed for maximum operating efficiency and maximum operating use of buses and personnel. Clustering into such operational files would be based on the assumption of a single bus-fleet, uniform technical background, identical vehicles and identical traffic backups. The maximum operating efficiency in many cases would be leading to a large spatial overlap between operational files, which would run at maximum driving time for drivers and limits on buses refueling. Strictly operational clustering would have the major advantage, that the vast majority of links would be ensured by such bus, its capacity meets real demand and would minimize excess of offered capacity.

2.3. Definition the operational file

Principle definition of the operational file was at the orderers, who have in bus transport already tendered, or are only preparing the tenders, primarily such, that they were primarily based on the geographical clustering. By the geographic clustering is generally easier to comply with local catchment area, transport links and axes of regular commuting.

When defining the operating files themselves, were in the proposals removed the obvious disadvantages of geographical clustering - i.e. primarily too high demand on the variability of sizes and types of buses. This clustering principle was so extended by two additional factors:

- the maximum allowable size of operation file
- limiting allowable number of vehicle types

In smaller operational files for lower number of vehicles is limiting of allowable number of vehicle types essential, because it reduces the real cost of uptime, maintenance of the fleet of buses and reduces the diversity of necessary technical background. Limiting the number of vehicle types can be solved either by lump sum (strict determination of the type of vehicle, which is required at the busiest link by passenger frequency on strongest line in the operating file), or by using the properties of the elements of operational clustering. The very strict definition of just one type of vehicle would lead to excessive overhangs of offered capacity on most of the connections in the area. The authors of this article recommended to the orderers of public bus services, to balance factors of geographical and operational clustering, by using of two types, as permissible limit of the number and types of buses operating in the file.

The result is a geographical clustering with the very high emphasis on operational efficiencies and with limited spatial overlaps.

3. Technological structure of traffic performance in operational file

The specific content of each operating file are concrete lines, their timetables and the resulting number of vehicles, which is necessary to ensure the required transport performance.

Before assigning single lines to single operational files it is usually appropriate to revise leading of lines, not only for transportation reasons, but also for operational reasons. In the current conditions of Czech Republic, there’s line management in many cases "historic" and in many cases was in regional bus transport not changed eg. 30 years, regardless of economic, socio-economic and demographic trends.

Based on the review of known facts of the various transport relations should be applied methods of line-planning leading to maximizing of the number of direct-travelling passengers, with the following modifications:

- unification lines given to a balanced use of vehicle capacity (some lines were rearranged into another operational areas and vice versa), all busses in the area have newly the same passenger capacity
- with regard to the balanced use of vehicles was necessary to determine the permissibility of carriyng of standing passengers; taking into account the sharpness of the morning peak hour is usually not possible to avoid deterioration of transport (regular standing
to the average daily performance.

The following figure expresses defined operational file.

The aim is to ensure maximum operational efficiency within a number of vehicles, reduction of total working time of drivers (breaks for drivers, refueling buses...).

4) operational optimization and ensuring operational efficiency (breaks for drivers, refueling buses...)

5) adaptation of timetables in the evening hours (to minimize the number of vehicles, reduction of total working time of drivers)

The aim is to ensure maximum operational efficiency within a defined operational file.

The following figure expresses the fixed costs of the bus relative to the average daily performance.

Approach to the timetable creating is as follows:

1) defining IPT nodes and intervals, calculate the number of vehicles for "basic periodical operation"

2) defining a specific operation in the morning peak hours and minimizing the number of vehicles in this period; ideally for the number required in previous point 1

3) after the arrival of school busses, as soon as possible "timetable transition" to defined structure of periodical timetable

4) operational optimization and ensuring operational efficiency (breaks for drivers, refueling buses...)

5) adaptation of timetables in the evening hours (to minimize the number of vehicles, reduction of total working time of drivers)

The author's team new approach is, that already when the timetable proposal is created, combines the operational concept with cycles of vehicles, in mutual repeating iteration steps.

After designing of the line-network and basic structure of the periodic timetable and IPT-junctions were made minor changes in the ruster of periodic timetable. In the morning peak hours were separately taken into account the requirements of the local time (starting times by significant employers, beginning of school hours) and the structure of IPT was often partially deflected. At the same time, during the morning peak hours was usually a structure of IPT preserved primarily in the main transport directions and main change linkages, while in the opposite direction (contrary to a major transport streams) were used differing routes, atypical crossings between the lines, as well as pragmatic time positions, which led to the minimization of the number of vehicles in the morning peak hour of the workday. It is just a morning peak hour of the working day, which determines the number of vehicles.

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The aim is to ensure maximum operational efficiency within a defined operational file.

The following figure expresses the fixed costs of the bus relative to the average daily performance.

Currently, the regional bus services in the Czech Republic has held daily vehicle mileage normally about 60-130 km. From the above figure it is apparent, that the cost curve is broken in the space daily performance of 200-300 km, which corresponds to an annual mileage of a vehicle about 70 000 to 100 000 km.

In no operational file are these limit values reached in the beginning. It is natural, since the beginning sort of performance into operational files is usually made by current timetables, which has been usually no optimized before. It is certainly not without interest, that for example in Region Ústí nad Labem, where they are generally the most experience with tenders in regular public bus transport, there are always in all operational files reached values from 70 to 100 thousand vehicle-km annual mileage. The main subject of rationalization it is usually the maximum reduction of the number of vehicles necessary to ensure the demanded transport performance, and only after this step, at the optimized number of vehicles can be considered a possible rise in transport performance.

Currently, in conditions in the Czech Republic in the field of bus prices, fuel prices and the drivers' cost, we can very simply state, that if an operational optimization saves 1 bus in operational file, it is a cost equivalent of 60-70 kilometers daily transport performance, of which we can improve transport services.

In relation to how the orderers are increasingly understand the relationship between structure and scope of the transport performance in relation to its cost, there are requirements for structuring the prices of transport performance into fixed and variable components. By changing the traffic performance during the execution of the contract remains fixed component fixed and variable component reflects truly realized extent of the traffic performance.

Application of these principles is fully reflected in the operation costs. For example, in the Region Ústí nad Labem, in the operational file "Dolní Poohří", have the authors of this article achieved continuously optimizing condition, that the number of vehicles has been reduced from 30 to 25 and the annual mileage of one bus currently amounts 90 000 km yearly mileage.
4. Conclusion

The necessity of holding tenders for the bus carrier in a regular public transport in the Czech environment, fundamentally changes the relationship between the orderer and the carrier in public transport.

The first major change is, that in the regional bus services the public orderer can not conclude a contract with a carrier directly, although this orderer is satisfied with carriers’ services and pays the normal und usual price of transport performance, and under normal circumstances there would be not any reason to change the carrier.

The second, more fundamental change is the fact, that the public orderer by preparing a tender for the carrier, has to ensure a wide range of activities, previously carried out by the carrier. While the direct award of traffic performance rises in the interaction orderer - carrier, and the carrier himself watches operational productivity of the negotiated services, so at the competition is the situation different. The orderer of public services defines the operational concept and all requirements. Any technological error concerning in the tender documentation can not be removed in consultation with any carrier who wants to participate in the tender. Such error or hidden unproductivity increases the cost of transport performance, and orderer will it subsequently pay. Full operational optimization - timetables, cycles of vehicles, personnel demands etc. must be well thought out by the orderer already in the formulation of the operational file and operating requirements in the tender. In the Czech Republic, this situation ordering parties generally chew very slowly, and often have a tendency to underestimate the situation.

The situation is in many ways even for new by bus operators participating in the tenders too, because the demands on the operational concept and quality are predetermined from the orderer. The carrier has already no possibility to optimize (or partially) operational concepts according to its operational needs. The role of carriers in this regard is already seemingly passive - however numerous carriers orient already in the new circumstances and focus their activities on the rationalization measures that allow them to cope with the prescribed requirements at the lowest cost. After the carriers have no opportunity to enter timetable preparation and requirements during the tender, they are focusing on typical operating area (suitable dislocation vehicles and personnel for contract performance, minimizing of empty rides, placement of technical and technological background, optimal mode of refueling buses, reduction of personnel time losses etc.)

This current situation is a great challenge for us - academics - too, as we are by the orderers increasingly asked to perform a variety of operational and technological optimization of operational concepts in preparation of the structure of operational files, in order to achieve the lowest cost of transport performance by fixed transportation requirements

On the example of the Region Ústí nad Labem shows, that a good and thorough preparation of a tender in public regional bus transport can reduce the unit cost of transport performance by up to 20%, with a further price reduction due to a competitive environment. From the original average price of the transport performance of about 35, - CZK / km came the orderer after tender to an average value of about 28, - CZK / km transport performance. The Region Ústí nad Labem, as the orderer of public services, so could significantly extend the range of connections and improve the quality of public transport services - while preserving and no increasing of the original level of operating compensation from public money.

REFERENCES

Abstract: A number of agricultural, land reclamation and road construction machinery bearings (wheels, rollers, skis, etc.) are located behind the working bodies and move across the surface generated by their working bodies during the execution of processes. These machines and mechanisms relating to machines and mechanisms with delayed feedback.

We were first investigated by transient planar and spatial models of machines and mechanisms with delayed feedback, a feedback coefficient is greater than one, when exposed to a single step of the relief support surface. When the model coefficient \( k > 1 \) (this machines and tools to the schemes similar to the bulldozer) transition process from a single push - \( h_0 \) has the form of a circle with radius \( r \).

KEYWORDS: MECHANISM, LONG WHEELBASE PLANNER, MODEL TOOLS, SUPPORTS, WORKING BODY

1. Introduction

World and domestic practice of agriculture proved that the layout or the alignment of the earth's surface is the main reclamation measures designed to eliminate existing irregularities on the field in a variety of increases and decreases. Most clearly manifest the effectiveness of planning, in paddy fields, from micro relief which depends primarily on the yield of rice and other crops of rice crop rotation.

Among tillage, sowing and other machines, tools and separate mechanisms for agricultural purposes, as well as land reclamation and road construction. Excavation works are those in which various types of support (wheels, rollers, skis, etc.) are located behind the working bodies and move on surfaces created by these working bodies during the execution of processes.

Such mechanisms and machines have in their kinematic schemes closed contours transmission effects: Yaw bearings located behind the working body is transmitted through the frame to the working body, and from the latter through the surface formed by them to support the motion. Pass-by-frame support chain-working body forms a direct connection, and from the working body through the surface of the newly formed by them to the support - the reverse. In this case, the feedback of these machines is delayed: as deviations supports located behind the working body causes displacement of the latter, but in relation to them occur with a lag time [1,2,3].

After leveling land in the capital section remain inconspicuous irregularities. Some irregularities remain on the cutting sites and mounds of substandard processing sites Earthmovers, others due to the fact that they were not included in the draft plan. All microscopic irregularities must be addressed by long-base planner. Long-base planners eliminate unevenness of up to 10-12 cm and a length in the range of leveling base machine, that is to 18-20m [5,6,7].

2. Physical models of machines and mechanisms with delayed feedback, machines for planning field surface

The effectiveness of planning of irrigated land in the first place depends on the quality of performance. Deviations from the marks on the planned project area should not exceed \( \pm 0.05 \) m [4,5]. Aged single natural slope should not lead to soil erosion. When planning should be kept fertile layer thickness of not less than 0.15 m and for a number of crops at least 0.18-0.20 m [6,7].

The planning capacity planner monotonic grows with increasing length \( L \) of the machine base and decrease distance (Figure 1). However, for small values (approximation of the knife to the rear wheel), the influence of disturbances by the rear wheels, and a reduced ability to follow planners midline profile. With the increase of the same base \( L \) increases dramatically reduced metal consumption and maneuverability, which is a serious obstacle in the way of improving the ability of planning long-base trailer planners.

\[ K = \frac{L}{L - k}; \quad h_2 = h_1 + k; \]

When lifting \( A_{\text{AC}} = \frac{L}{L - k} = k; \)

The height of the first step is:

\[ h_1 = h_0 \]

The height of the second step is:

\[ h_2 = h_1 + k = h_0 + k^2; \]

The height of the n-th step is:

![Figure 1 - The structural layout of long-base scheduler](image-url)
\[ h_n = h_n \ast (1 - k) = h_nk(1-k)^n, \quad (2) \]

**Figure 2 - Model guns feedback with a single push**

Transients are counting on the assumption that the model (Figure 2) inertial less, the deviation point linkage \( O_1 \) and support \( C \) with small compared with the length \( OC \) of the operating system frame, \( OOC \leq CC \), the speed \( v = \text{const} \) and support \( OOC \) is given by a rigid stand [1.2].

Consider the behavior of the model at running about support on the step height \( h_0 \) deviation point \( D \) of the working body of the value of \( h_i \) as a single push. Due to the rotation of the model with respect to the pivot point \( C \) on a working body forms a first step. Changes in the depth of processing height where \( \Delta Y_i \)

\[ \Delta Y_1 = h_0 \ast k \]

When

\[ k = \frac{l}{L} \]

At copy the support \( C \) from the first stage of the turning point \( O_1 \) of the model with respect to the working body forms the next step with height \( \Delta Y_2 \).

\[ \Delta Y_2 = h_1(1 - k) \]

**Figure 3 - Transients**

With the formation of the step have changed to the value:

\[ Y_2 = \Delta Y_1 + \Delta Y_2 = h_0k + h_1(1 - k), \quad (3) \]

Height third step is:

\[ \Delta Y_3 = k \ast \Delta Y_2 = k^2 \ast h_0 + kh_1(1 - k), \quad (4) \]

The height of the fourth step is:

\[ \Delta Y_4 = k \ast \Delta Y_3 = k^3 \ast h_0 + k^2h_1(1 - k), \quad (5) \]

and so on. The height of the \( n \)-th step

\[ \Delta Y_n = k \ast \Delta Y_{n-1} = k \ast h_0 + k^{n-1}(1 - k)h_1, \quad (6) \]

In the formation of \( n \)-th step change aligned the same site

\[ Y_n = \Delta Y_1 + \Delta Y_2 + \Delta Y_3 + \Delta Y_4 + \cdots + \Delta Y_n, \quad (7) \]

Substituting in (7) value \( \Delta Y_1, \Delta Y_2, \Delta Y_3, \Delta Y_4, \cdots, \Delta Y_n \) we obtain the following expression changes aligned site

\[ Y_n = h_0k + h_1(1 - k) + k^2h_0 + kh_1(1 - k) + k^3h_0 + k^2h_1(1 - k) + \cdots + k^{n-1}h_0 + k^{n-1}h_1(1 - k) \]

Equation (8) is the sum of a geometric progression with ratio \( k \). That is Why

\[ Y_n = h_0 \sum_{i=0}^{n-1} k^i + (1 - k)h_1 \sum_{i=0}^{n-1} k^i = h_0 \frac{k^n}{1 - k} + (1 - k)h_1 \frac{(1 - k^n)}{1 - k} = h_0 + h_1(1 - k^n), \quad (9) \]

The transition process, calculated according to the equation (9) is shown in Figure 2.

The final change aligned sites determined from (9) by setting \( n \to \infty \), and considering that \( 0 < k < 1 \)

\[ Y = \lim_{n \to \infty}[h_0 + h_1(1 - k^n)] = h_0 + h_1; \quad (10) \]

From (10) it follows that the final change aligned digging equal to the deflection point linkage.

Consider the behavior of the model with the modified surface of the field formed a support \( C \) to a constant value \( h_2 \) as a single push

**Figure 4 - Model guns feedback to the front working body**

When leveling the field surface changes due to the rotation of the model relative to the point hitch \( 0 \) working body forms a step height in \( \Delta Y_1 = k \ast h_2 + h_2 \). When you copy a mainstay of the first step working body forms a second step, the height of \( \Delta Y_2 = k \ast \Delta Y_1 = k^2 \ast h_2 + k \ast h_1 \) and so on.

The height of the \( n \)-th step is

\[ \Delta Y_n = k^n \ast h_2 + k^{n-1} \ast h_1, \quad (11) \]

The amount of change aligned site \( Y_n \) the formation of \( n \)-th step is the sum of the heights of all the steps.

\[ Y_n = \Delta Y_1 + \Delta Y_2 + \Delta Y_3 + \Delta Y_4 + \cdots + \Delta Y_n, \quad (12) \]

From Where

\[ Y_n = \frac{k^{n-1}(1 - k^n)}{k(1-k)}k \ast h_2 + h_1 = \frac{k^{n-1}(1 - k^n)}{1-k}h_2 + h_1, \quad (13) \]

The final amount of change aligned area determined from the equation (13) by putting \( n \to \infty \).

\[ Y = \lim_{n \to \infty}(h_2 + h_1) \frac{k^{n-1}(1 - k^n)}{1-k} = \frac{k^{n-1}}{1-k}(h_2 + h_1), \quad (14) \]

From (14) it follows that in the depth of the treated section \( \Delta V \) times greater than the change in \( \frac{k^{n-1}}{1-k} \) the depth of ruts formed support.
For example, when \( k = 1.05 \)

\[ Y = 1.05(h_2 + h_1) \]

That is, the amount of change in the treated area 1.05 times the value of the ruts formed a support C. Calculate the duration of the transients. Since the theoretical processes are long, then we assume that the real transition process ends when leveling the field surface in the (100 - a)% of the total of its theoretical value [2]:

\[ Y_i = \frac{(100-a)}{100} Y, \quad (15) \]

where \( Y_i \) - change leveling the field surface, above which the real transition process is considered or \( Y \) - the final theoretical change of the surface of the field, \( a \) - a percentage that depends on the required accuracy of determining the duration of the transition process:

\[ a = \left(1 - \frac{Y_i}{Y}\right)100\% \]

Substitute in the formula \( Y_i \) change leveling the field surface (9), and in place \( Y \) - the final theoretical change of the surface field (10):

\[ h_0 + h_1(1-k^i) = \frac{100-a}{100}(h_0 + h_1). \]

After conversion, the following relation

\[ 1 + k(1-k^i) = \frac{100-a}{100}(1-k)or k^i = \frac{2a}{100} = \frac{a}{50}, \quad (16) \]

Hence we define the number \( i = n \) of anew copied passes required to complete a real transition.

\[ i = \frac{\log a - 2}{\log k}. \quad (17) \]

The path \( S_i \) of transition determined by multiplying (17) by the distance \( CA = l \) between the working and the support body (Figure 4)

\[ S_i = l \frac{\log a - 2}{\log k}. \quad (18) \]

(18) that the path of the transition process is directly proportional to the distance between the working body and the support and inversely proportional to the logarithm \( k \) of feedback tools. When \( a = 5\% \) is equal to the duration of the transition process

\[ S_i = l \frac{\log 5 - 2}{\log k}. \quad (19) \]

Similarly, the transient path changing surface define the field values \( Y_i \) and \( Y \) by substituting (13) and (14) to (15):

\[ \frac{k^{i-1}(1-k^i)}{1-k}h_2 + h_i = \frac{100-a}{100} \left[ \frac{k^{i-1}}{1-k}(h_2 + h_1) \right] \]

Hence, for \( h_2 = h_1k \)

\[ 1-k^i = 1 + \frac{2a}{100} \quad or \quad k = \frac{a}{50}. \quad (20) \]

Since (20) is similar to equation (16), the transition path also exists from the equation (18).

The analysis is valid for support in the form of a rigid stand up and instant support \( B \) in the vertical front steps. In the real world in the course of transients are various deviations due to the influence of various kinds of factors.

3 Results Discussion

Were first investigated by transient planar and spatial patterns of machines with a delayed feedback, a feedback coefficient is greater than one, when subjected to a single step bearing surface topography. For example, if the model coefficient \( k > 1 \) (this machines and tools to the schemes similar to the bulldozer) transition process from a single push - \( h_0 \) has the form of a circle with radius \( r \).

The proposed methods of theoretical research model of machinery allows us to study their properties and the impact of design parameters and operating modes. The foundations of the theory of the study of mechanisms and machines different from the existing approaches to the study of the problem and the application of this theory in the calculations make it possible to justify the optimal parameters and modes of operation of real machines and tools with delayed feedback.

4 Conclusions

Finishing area rice fields produced long-base scheduler. Planning work can be carried out with the following limits of soil moisture,% absolutely dry soil: clay soils of 20-24%; loamy 19-22%; loamy 13-15%; sand and silt 10-14%. Before you start the scheduler on a flat plot surface correctly set knife height. On the loose soil at the first track layout knife set at 3-5 cm above the base plane wheels. After the first trace of the knife assembly is lowered to the reference plane of the wheels.

After a major leveling land in the area remain subtle irregularities. Some irregularities remain on the cutting sites and embankments due to defective processing sites Earthmovers, others due to the fact that they were not included in the draft plan.

All microscopic irregularities must be addressed long-base scheduler.

5 Literature

2 Ksendzov VA Introduction to the mechanics of machines and mechanisms with delayed feedback. Moscow: Sputnik, 2005.
EVALUATION OF AIRCRAFT PASSENGER CABIN FIRE SAFETY AND MEASURES FOR IMPROVEMENT

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ABSTRACT: This research has been carried out on aircraft passenger cabin fire safety problem. The pathways of decreasing the fire danger are considered. The algorithm of fire safety implementation was presented. Risk management would decrease the state of danger in the cabin as the subject of the research, therefore, increase the safety to the maximum level available today.

KEYWORDS: Aviation incident and/or accident, fireproof structural and decoration materials, fire safety, fire risk, fire dangerous stress/load, passenger cabin fire danger decrease.

1. General
Ensuring safety of any object requires ability to employ methods and practices of protection against dangers in force. Hence why analysing fire safety problems it is necessary to evaluate two terms: Danger and Safety. Both of them are interconnected by the term of Risk. Thus a linkage between interconnected events Danger - Risk - Safety is established, where the most questionable term is the Risk. Here is the most popular definition: Risk – a probable danger of any failure caused by actions undertaken, also, the actions as they are if leading to failure of the results anticipated. From the middle of the XX century one of the risks on air transport had become the fire risk. It is often possible to make forced landing after fire is emerged on board yet the conditions for passengers in the cabin remain sustained at safe levels. However such cases have collateral victims who lose their lives after landing because of flame and smoke penetrated into cabin. The fires in cabins and under their floors generate extreme stress factors and along the delay of the crew actions may lead to a catastrophe. Forecasted by ICAO yearly world increase of pax transportation volume by 4-7% meanwhile the safety remaining at the same level will lead to yearly 4% increase of deaths caused by fires.[1] According to statistics around 75% of air accidents happen at take-off, landing and approach stages of flight, i.e. within airport vicinity and one of the major causes of human deaths is emergency aftermath fires.

2. Aircraft passenger cabin fire risk levels
The epicentres of fire in an aircraft might be:
- Aero engine
- Fuel system
- Electric power network
- Passenger cabin
- Crew cockpit
- Service compartments - cargo/baggage, technical/crew

Fires inside cabins are related to fires in confined spaces. They feature high density smokes, small burning spots, great gradient of temperatures along the cabin height, low temperature of fire (comparing with external fires), also, great concentration of highly toxic substances in burning products. Burning may start as a result of reckless care to fires, short cuts in electrical wiring of an aircraft, carrying flammable substances and materials by passengers and other causes.

In the table below are shares of fires on aircraft structural elements.

<table>
<thead>
<tr>
<th>Nr</th>
<th>Types of fires on aircrafts</th>
<th>Share of totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fires on fuel spills/leaks located on one and both sides of a/c</td>
<td>55%</td>
</tr>
<tr>
<td>2</td>
<td>Fires and burnings on power plants</td>
<td>25%</td>
</tr>
<tr>
<td>3</td>
<td>Fires and burnings inside passenger cabins</td>
<td>12%</td>
</tr>
<tr>
<td>4</td>
<td>Fires and burnings on landing gears</td>
<td>5-6%</td>
</tr>
<tr>
<td>5</td>
<td>Other fires and burnings</td>
<td>2-3%</td>
</tr>
</tbody>
</table>

The results of a series of fire tests prove that one of the major causes of heavy injuries made to human beings in passenger cabin fires of aircrafts [3] are intoxications with fully or partially burned fire products. The results of analysis made on air samples taken during fire tests indicated that after 2-3 minutes from the start of a flamed burning lethal concentration levels reached:
- Carbon oxide
- Hydrocyanic/Prussic Acid
- Acronitril
- other toxic substances.

By the 3rd minute of burning the oxygen concentration decreased to 6%, and the carbon concentration rose up to 12% per volume. Concentration like that is lethal to human beings. Up to 40% of passengers’ deaths happen due to their intoxication by toxic products of burning decoration materials in cabins, thermal traumas and evacuation procedure problems. The heavy consequences concerned (including those with losses of humans) determine the problem actuality and therefore require effective measures to enhance fire safety of passengers on air transport.

The major fac5-tors of danger during fires inside passenger cabins are:
- great speed of fire propagation and high temperature of flame;
- quick accumulation of burning toxic products and loss of visibility;
- situational panic.

At fires inside cabins the temperature along height rises rapidly. The tests showed the temperature at floor level may remain at 50°C while can reach 250°C at 1.30.1.50 metres above the floor. The burning occurs on the surfaces of walls, ceiling, passenger armchairs, however may also take place in the cabins’ volume due to burning drops of molten plastics flowing down from passenger cabin and cockpit decorations and structures. When fire gets through the cabin walls to the core structures (stringers, bulkheads and the skin) the temperature in the cabin top rapidly increases (up to 900°C and open flames spread. Very high temperature can melt and start burning of some types of passenger armchairs made with magnesium alloys. That would hinder and compromise killing the fire.
As soon as at fires inside passenger cabins the factors of danger increase rapidly and the conditions become ultimately fatal it is utterly vital to evacuate human beings in a fast and safe manner.

Taking into account the safety of evacuation process as the major condition the evaluation of fire risk is verified. The factors of fire danger inside the passenger cabins are the following:

- presence of fire sources;
- massive fire load;
- limitations of evacuation feasibility;
- absence of smoke removal system;
- high concentration of human bodies across the volume.

At present various polymer materials are widely used in decoration of cockpits, passenger cabins and cargo compartments of modern aircraft designs. At start of a fire all of them burn easily and produce great amount of heat and noxious fumes. These are the main reasons of deaths there.

The amount of fire load in structural and decorative polymer materials in passenger cabins may comprise about 2 to 3.5 metric tons, which in case of a fire would become not only a source of air contamination, but also the carriers of toxic volatile compounds.[4]

Great volumes of fire prone polymer materials used for decoration and trim in modern aircraft designs are determining to the fire risks, thus creating the requirement to apply thermally stabile compounds.[5-6]

Introduction of fire safe materials to aircraft interiors should extend the time period of the so called “safe” evacuation of humans from 2...4 minutes at present till 10 minutes.

3 Aircraft passenger cabin fire safety improvement directions.

Evaluation of aircraft passenger cabin fire safety level greatly depends on calculation of the fire risk. This is a process of complex calculation which is based on accounting of the evacuation time, floorplan, dangers and fire risks, protective equipment available.

The risk determining methodical approaches are the following:

- direct assessment based on data processing;
- model analysis, setting various events’ probabilities’ interconnection;
- technical analysis.

In order to perform the fire risk analysis the collection of aircraft specification data is required. It would encompass:

- specific design features;
- thermo-physical characteristics of the materials used for furnishes, structures, equipment mountings;
- types, quantities and disposition of fire prone substances and materials;
- number and probable locations of humans;
- fire protection, aural warning systems and evacuation control.

At the same time into account are being taken the below mentioned factors:

- possible fire progression dynamics;
- composition and characteristics of the fire protection system;
- possible effect of the fire on human beings and structures.

The frequency of actual fire situations equals the number of fires happened on the protected facility during a yearly period. The evaluation of frequency parameters of possible fire events could be performed upon statistical data.[8]

A fire risk calculated value could be found as a maximum value of the fire scenarios considered:

\[ Q_B^{\text{c}} = \max \{ Q_{B,1}, Q_{B,2}, ..., Q_{B,n} \} \]

where \( Q_{B,i}^{\text{c}} \) – a possible effect of the fire on human beings and structures.

A fire risk calculated value could be found as a maximum value of the fire scenarios considered:

\[ Q_B = \text{max} \{ Q_{B,1}, Q_{B,2}, ..., Q_{B,n} \} \]

where \( Q_{B,i} \) – calculated value of a fire risk for the \( i^{\text{th}} \) scenario, \( N \) – number of fire scenarios considered.

The fire scenario is deemed as a variant of a fire progression taking into account the place of it’s start and character of it’s development, when the worst conditions for human beings take place.[10]

A fire risk calculated value for the \( i^{\text{th}} \) scenario is found in accordance with the formula:

\[ Q_{B,i} = Q_{A,i} \cdot (1 - K_{an,i}) \cdot P_{pr} \cdot (1 - K_{pr,e}) \cdot (1 - K_{pr,f}), \]

where \( Q_{A,i} \) – a fire events’ frequency per year period is found using statistical data. When statistics are not available it is allowed to use as \( Q_B = 4 \cdot 10^{-6} \).

\( K_{an,i} \) – a coefficient for automatic fire extinguishing equipment. It is allowed as \( K_{an}=0.9 \) because in this particular case it is not necessary;

\( P_{pr} \) – a probability of human presence in the aircraft, found from the proportion \( P_{pr,e} = t_{pr,0} \cdot 24 \), where \( t_{pr,0} \) – a time period of human presence in the aircraft, in minutes;

\( K_{pr,e} \) – a probability of evacuation for passengers;

\( K_{pr,f} \) – a coefficient for automatic fire protection equipment which is used for safe evacuation of humans at fire is in accordance with legal requirements.

The probability of evacuation is calculated as per following formula [9]:

\[
\begin{align*}
    \text{if } t < 0.8t_{pr,0} \text{ and } t \geq 6 \text{ min}, & \quad \text{then } P = 0.8t_{pr,0} - \frac{\text{t}}{t_{pr,0}}, \\
    \text{if } t = 0.8t_{pr,0} \text{ and } t \leq 6 \text{ min}, & \quad \text{then } P = 0.999, \\
    \text{if } t > 6 \text{ min}, & \quad \text{then } P = 0.000,
\end{align*}
\]

where \( t_{pr} \) – calculated time for evacuation, in minutes;

\( t_{pr,0} \) – time period of evacuation since the beginning of the fire, in minutes;

\( t_{pr,1} \) – time period since the beginning of the fire till the exits become blocked due to fire dangerous factors with the ultimate tolerable values come into force, in minutes

\( t_{pr,2} \) – time period when humans are blocking the evacuation paths (human flow density in the evacuation paths is above 0.5 value), in minutes;

Blocked exits time period \( t_{pr} \) is found by calculating the time till fire dangerous factors reach the ultimate tolerable values in the paths of evacuation at different moments of time.

The coefficient for automatic fire protection equipment which is used for safe evacuation of humans at fire is in accordance with legal requirements \( K_{an} \), can be found by the following formula:

\[
K_{an} = \frac{1 - (1 - K_{an} \cdot K_{COV}) \cdot (1 - K_{an} \cdot K_{EDE}) \cdot (1 - K_{an} \cdot K_{COV}) \cdot (1 - K_{an} \cdot K_{PDE})}{1 + (1 - K_{an} \cdot K_{COV}) \cdot (1 - K_{an} \cdot K_{EDE}) \cdot (1 - K_{an} \cdot K_{COV}) \cdot (1 - K_{an} \cdot K_{PDE})}
\]

where \( K_{an} \) – a coefficient for automatic fire protection equipment which is used for safe evacuation of humans at fire is in accordance with legal requirements;

\( K_{COV} \) - a coefficient for fire warning and evacuation control systems are in accordance with legal requirements;

\( K_{PDE} \) - a coefficient for smoke expelling system is in accordance with legal requirements. [9]

Conclusions

The analysis accomplished here has shown that the average value of a fire risk could be calculated if based on the fire scenario modelling. The risk of a fire is calculated for the specific aircraft design, either existing or proposed, and also for the specific conditions of the accident followed by a fire. The risk of a fire is as required and is not higher than one of a million per year period even while a human being is located as far as possible from the cabin exit point.
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