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**TRANSPORT. INTELLIGENT TRANSPORT SYSTEMS. LOGISTICS AND
MANAGEMENT.**

RAILWAY ENGINEERING AND TRANSPORT.

**INFORMATION TECHNOLOGIES. TRAINING, EDUCATION AND
SCIENTIFIC RESEARCH.**

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RUMOBIL – PUBLIC TRANSPORT SOLUTIONS IN SPARSELY POPULATED REGIONS



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Abstract: Demographic change is one of main problems in the rural areas of the Central Europe region. Young and active people are moving to bigger towns and cities due to the lack of attractive opportunities and older and less educated people usually remain at the countryside. To attract economically active group of people to rural areas, appropriate public services must be offered there. Public transport offer is of high importance, since its high quality can improve quality of life, better reachability and can also attract more tourists to visit area. The European project RUMOBIL funded by Program Interreg Central Europe (Project number CE55) deals with various options for solving the problem of public transport service in the countryside.

KEYWORDS: RURAL AREAS, PILOT PROJECT, DEMOGRAPHIC CHANGE, PUBLIC TRANSPORT.

1 Introduction

RUMOBIL is based on transnational cooperation between public authorities and their transport entities who are confronted with a similar challenge to respond to pressures on regional public transport systems caused by demographic change in peripheral areas. Working together in RUMOBIL provide them a platform to exchange their knowledge, to generate learning through launching pilot applications of state-of-the-art tools and solutions and revise their regional transport policies to better suit changing mobility needs. Main outputs of RUMOBIL are therefore pilot actions, the elaboration of a RUMOBIL Strategy and policy-decisions to implement it in the eight partner regions through an improvement of their transport plans. Pilot actions have allowed testing a number of innovative applications during a period of years 2017-2018, how sparsely populated peripheral areas can be better linked to a primary, secondary or tertiary transport node (access to European and national passenger transport networks). The transnational RUMOBIL Strategy indicates to CE regions innovative and transferable public transport approaches - based on jointly analyzed good practices, the combined knowledge of the partners and involved stakeholders, learning from the pilots, and fresh ideas put forward through a transnational social media-based competition. All outcomes are jointly assessed in site-visits, transnational workshops and a coordinated evaluation under the hospices of research institutions participating in RUMOBIL.

2 Demographic changes

The substantial problem in rural regions within Europe is demographic change and its repercussion to a population. In many regions, there is a displacement especially of the younger generation migrating to cities. Some areas were also affected by the violent removal of the indigenous population, for example, from the borderland of the Czech Republic, where, after the World War Second, many people, especially Sudeten German, were deported to Germany. Nowadays, these regions are not so popular for living especially among young families, who are leaving this area. Good quality of public services including transport ones could stop this trend, and the number of inhabitants in rural areas could increase.

3 Contributions of JIKORD to the RUMOBIL project

JIKORD (South Bohemian coordinator of public transport), an organization established by the South Bohemian Region, is responsible for planning regional transport (bus and rail in public service obligation) operation and expansion of the integrated transport system, and preparation of tenders for the provision of public transport. JIKORD, has implemented pilot action in the low

density populated rural area of South Bohemia. Pilot action of JIKORD is introducing bus line, which connects rural region around Kaplice village, with the main TEN-T line of international express trains Praha – Linz, or semi-fast trains České Budějovice – Linz, which have stop in Kaplice railway station. People got fast and comfortable connection with regional capital, city of České Budějovice and interchange possibilities to long-distance and regional trains in České Budějovice to other destinations. Second benefit of this bus line is enhancement of tourism. New connection leads through an attractive tourist area with possibility to visit old castle ruins, or to hike in hills – Slepíčí hory.

Pilot activity – implementation phases

- 1) *Selection of suitable area* – Based on the requirements of municipalities with insufficient transport services, the Kaplice region was selected in autumn 2017 for pilot project. This region met all requirements - low population density, negative demographic developments, and access to TEN-T network.
- 2) *Collecting of indicators before pilot implementation* – Before pilot operation data about the area (no. of inhabitants, usage of public transport service, traffic volumes,...) were collected.
- 3) *Planning of the operation and informing local stakeholders* – Based on the needs of municipalities timetable of new bus line was prepared. Line connects area with main-line trains (all categories, from regional to long distance).
- 4) *Tender procedure* for bus operating company was finished.
- 5) *Advertising campaign* to inform citizens was performed.
- 6) *Operation of bus line started in April 2018.*
- 7) *Collecting and evaluating of indicators.* The bus line success will be evaluated in August 2018 with the aim to optimize service and decide on further operation, or replication.

4 Pilot projects of the other partners

Focus of the all pilots is on innovative approaches and modern public transport solutions. These started to be tested in the participating partner regions through experimentations since spring 2017. Eight different measures have been implemented. Pilots concern three main objectives:

- 1) introducing new transport services (buses, minibuses and trains in rural areas),
- 2) developing IT applications for passengers and transport operating companies,
- 3) renovating/modernization of transport infrastructure for passengers at transport terminals/stops.

Ministry of Regional Development and Transport of Saxony-Anhalt – MLV (Lead partner)

Pilot project of lead partner is introducing a new bus service to connect towns of Osterburg and Möser and their surroundings operated by volunteering drivers driving a local microbus in their free time. The concept of the project consists of deploying buses for 8 people (optimum size for sparsely populated areas). Drivers are organized in an association and their voluntary work is supported and framed by local PT operators and regional authorities. Residents who are not able to use conventional forms of transport or do not have access to them can stay independent and active in their local communities. In this manner the project raises the residents' awareness for local public transport offers and encourage them to participate in it. The concept will be tested for 1,5 year.

HŽ putnički prijevoz d.o.o. - Croatian railways

New thematic trains, connecting Croatian capital, City of Zagreb and rural region Ozajl, were introduced by Croatian railways. The principle is to introduce tourist trains on the main line to the city of Karlovac, alongside the regional and underused rail line to the town of Ozajl, especially on weekends and public holidays. Each ride is promoted and is always associated with another program (such as a tour of the castle, city festivals, or local events). Trains within the RUMOBIL project offer fast connections from the capital, support tourism and regional development and economy. Thanks to a good information campaign, the region is more frequently visited and visitors are using public transport instead of car.

Vysočina Region

The ambition of Vysočina Region was introducing new bus service, especially in the weekends, connecting rural areas with bigger towns in the regions and tourist destinations, as a castle of Lipnice nad Sázavou.

Mazowieckie voivodeship

Polish region, Mazowieckie voivodeship equipped regional trains with GPS sets providing real time information on location and delay of regional trains. The mobile application was developed, enabling to get information about train operation. Also digital interactive kiosks were introduced on the stations.

Modena Region

Public transport service Prontobus is operated in the town of Castelfranco Emilia and its surroundings. It is based on dial-a-ride transit with no fixed lines. Operating of such a system is usually complicated. To simplify it the new software system was developed consisting of:

- web portal (www.rumobil-modena.eu) for the users of the Prontobus service with information about the service and the situation of reservations updated in real time with the possibility to register in order to receive mails or SMS about interesting services recognized for the day after;
- web site dedicated to the management of reservations for the call center;
- app for users of the Prontobus service to view reservations updated in real time and with the ability to book an existing trips directly from the app;
- app for drivers of the Prontobus service to get information about reservation in real time and the trips to be made.

The increase of travelers registered after the activation of the RUMOBIL project was significant and exceeded expectations providing valuable information to be used for the definition of the RUMOBIL strategy (Fig. 1).

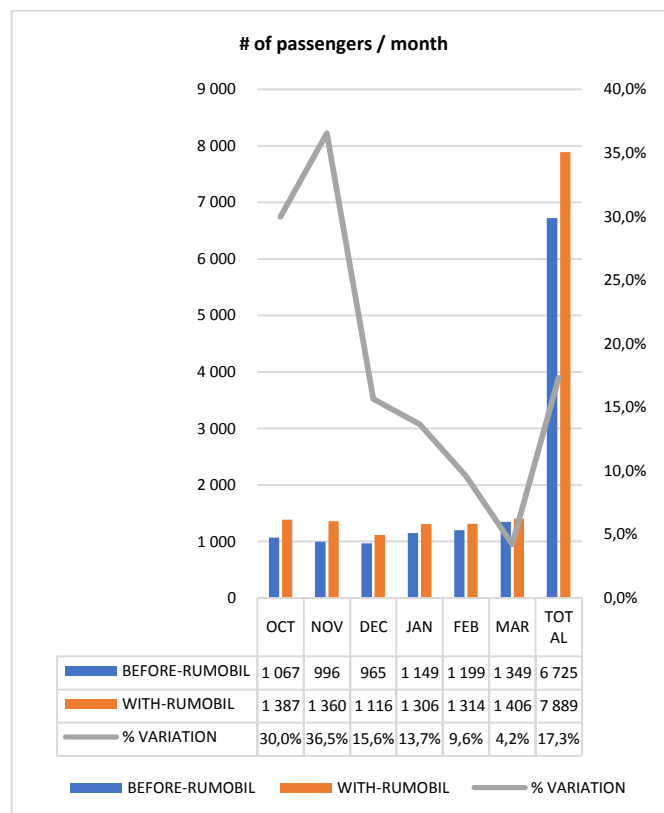


Fig. 1 Number of passengers per month before and after RUMOBIL in Modena Region

Positive feedback came also from the primary stakeholder, the users of the Prontobus service, that in contacts with call center reported appreciation in particular for having real-time reservations available. Another good result is for the call center that has improved the management of reservations. Through a reporting tool it is now possible to elaborate detailed statistics that was not available before. This information is indispensable in order to be able to intervene in the services for a better tuning in future. The drivers also expressed satisfaction, as they now receive the information faster and safely and are no longer distracted from driving by the calls received from the call center if there are any changes to the bookings.

Hungarian towns of Nagyálló and Nyíregyháza and Žilina region in Slovakia have started modernisation of bus stops and rebuilding and intermodal rural transport hub. Main benefit of these projects is better information for passengers in real time, more comfort at waiting area, support of inter-modality and better access to disabled people.

5 Conclusions

All pilot projects have ambitions to support public transport in the rural areas. The pilot projects are still in operation and final evaluation will be done in the second half of the year 2018. First outputs show, that pilot projects are successful and can be replicated in other European rural regions. For more information visit <http://www.interreg-central.eu/Content.Node/rumobil.html>.

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APPLICATION OF GEOGRAPHICAL INFORMATION SYSTEMS TO EVALUATION A CONCENTRATION OF CHLORINE RELEASED INTO AN ATMOSPHERE IN THE CASE OF ROAD ACCIDENT

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Abstract: Modelling propagation of hazardous substances released in road accidents is important issue from the point of view of safety in road transport. The paper presents use of the Geographic Information Systems to analyse the impact of the emissions of hazardous compounds in the built-up area. In the paper dispersion of pollutants released in a road accident, involving a chlorine tanker truck, followed by chlorine spillage has been analysed. It is assumed that the accident took place in a mountainous area on a bypass within a built-up area. Concentrations of pollutant have been calculated in the own program. The calculation of field of wind speed was taking into account the terrain elevation and type of land cover. The package Idrisi Taiga has been applied in the pre-processing stage. It was used to generate a site map with buildings and aerodynamic roughness map. Meteorological conditions were also taken into account: wind speed and direction, temperature, atmospheric pressure and atmospheric stability class. The computer program consist two basic modules: diagnostic model of air velocity field and Lagrangian model of particles, being the original implementation of the Lagrange model of particles. In both models, some elements of mathematical modelling were applied. The models have been successfully validated and verified. The results of the calculations of concentrations of chlorine have been analysed in the Geographic Information System. The following analyses have been made, among others: designation of hazardous zones AEGL 1-3, determination spatial size of built-up areas within the zone, analysis of changes in pollution concentrations over time. The proposed analyses allows to determine areas exposed to deadly and highly dangerous concentration of chlorine.

Keywords: COMPUTER MODELLING, ROAD SAFETY, ROAD TRANSPORT, POLLUTION DISPERSION, HAZARD MATERIALS, GIS ANALYSIS

1. Introduction

Modelling the propagation of hazardous substances released as a result of a road accident is an important element in the assessment of hazards resulting from the use of transport means to transport chemical substances. Determining the probable effects of a tanker collision that results in leakage into the air is possible due to the use of computer programs such as ALOCHA or HPAC, but they do not take into account many elements, such as the complexity of the topography of the terrain. These elements can be taken into account thanks to the use of proprietary computer models and programs.

Computer simulations for the case analyzed in this paper regarding a sudden road accident with the participation of a chlorine tanker were carried out in proprietary programs based on the diagnostic model of the air velocity field and the Lagrange model of particles. In both models, elements of mathematical modelling were applied. These models were validated and verified (Brzozowska, 2013; Brzozowska, 2014a).

An analysis of the spread of pollutants as a result of a road accident involving a tank carrying chlorine is presented, accompanied by a leak of substance into the air. The occurrence was simulated in the city of Bielsko-Biala (Poland), on the bypass road in the built-up area.

At the stage of pre- and post-processing, the GIS Idrisi Andes Spatial Information System was used.

2. Modelling the effects of releases of hazardous substances in transport

2.1. Serious accidents in road transport

According to data provided on the European Commission's Eurostat websites, in the years 2012-2016, in the European Union, road transport carried from 74 billion t km to 84 billion t km of hazardous goods. Also in Poland, the transport of hazardous goods from year to year is growing (according to the same commission) and in 2012 it amounted to 6 801, in 2015 already 9 174 million t km, and in 2016 8 444 million t km, which was ca. 3% of the total amount of goods transported by road (Transport, 2016).

The safety of road transport is regulated, among others, by the provisions of the European Agreement for the International Road Transport of Dangerous Goods (ADR). It is a widely used standard, subject to constant amendments in the forum of the United Nations Economic Commission for Europe. In Poland, there is also the Act of 19 August 2011 on the transport of dangerous goods (Journal of Laws 2011 No. 227 item 1367), which defines the rules for the transport of dangerous goods.

According to the analyzes carried out by the Supreme Audit Office (NIK, 2012), irregularities were detected in about 5% of the vehicles inspected, most of them related to incorrect security in the event of a fire.

The subject of the problem of transport of dangerous substances is taken by many authors. At work (Oggero et al., 2006), an analysis of 1,932 cases has been made, which occurred during road and rail transport of hazardous substances from the beginning of the 20th century to July 2004 in Great Britain. The obtained results indicate an increase in the frequency of major accidents (incidents) over the time. Over half of the accidents happened on roads (63%). The most common accidents were related to the releases - 78%, then with fires - 28%, explosions - 14% and gas clouds - 6%. The causes of accidents were analyzed, the type of substances and the consequences for the population (number of people killed, injured or evacuated).

In the United States (Erkut et al., 2007) the most cases concerned flammable materials - over 42%, caustic materials - 37.5%, poisonous - more than 5%, oxidants - 3% and mixed - almost 4%. Other accidents - more than 8% related to other hazardous substances. About 40% of accidents involving hazardous materials were caused by human error and also as a result of road accidents, and almost 20% were related to the failure of containers.

Welles et al. (2004), based on research carried out in New York, states that: 21% of accidents related to hazardous substances occur in relation to transport, 39% due to faulty equipment and 33% due to human error.

The assessment of the effects of this type of events is a considerable task and requires the use of appropriate tools.

2.2. Modelling the effects of major accidents in road transport

The impact of accidental releases of toxic chemicals can be minimized by providing accurate information and organizing the work of the team to prevent the effects of major accidents. This is possible thanks to the use of programs and computer systems that allow to estimate the effects in real time. They are a key tool to support decision-makers in the planning of pre-trial and rescue proceedings in case of an accident (Alhajraf et al., 2005, Quaranta et al., 2002, Zhao et al., 2012). An example of such a system may be ARAC (Atmospheric Release and Advisory Capability) developed by Lawrence Livermore National Laboratory (LLNL) (Ermak et al., 2002). In these systems, one of the necessary modules is the dispersion module. Spatial information systems are also used, among others to estimate the number of people in the range of danger (Chakraborty and Armstrong, 1995, Fisher et al., 2006).

A variety of computer programs are used to model the effects of releases of hazardous substances. In the programs used in Poland by the State Fire Service to assess the toxic zones of vapours hazardous to health and life arising during chemical spills, the direction and speed of the wind, the class of atmosphere stability and air temperature are usually taken into account. The most frequently used programs include: ALOHA (Areal Locations of Hazardous Atmospheres), a program for estimating hazardous areas in the event of emergency release of hazardous substances (NOAA, 2013); ALOFT-FT (A Large Outdoor Fire Plume Trajectory Model - Flat Terrain - McGrattan (2003)); FDS (Fire Dynamics Simulator - McGrattan et al. (2007)); CFAST (Consolidated Model of Fire Growth and Smoke Transport - Peacock et al. (2013)). The ALOHA program is mainly used because of its ease of use. The results are presented in the form of graphic zones whose boundaries can be defined individually. In the program, indirect construction can also be taken into account by selecting one of three possible types of aerodynamic roughness of the ground.

In this work, we used our own computer program based on independently operating models: air velocity field and dispersion of pollutants. The first of them belongs to the group of diagnostic models, the second is the original implementation of the Lagrange model of particles. The flow chart is shown in Fig.1.

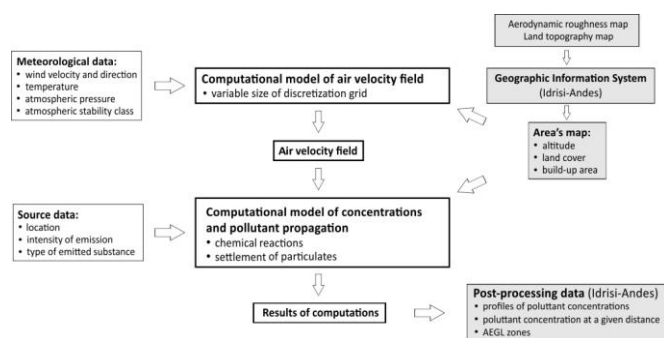


Fig.2. Stages of proceedings in the custom program

The description of mathematical models is presented in Brzozowska L., (2013) and Brzozowska L., (2014a), and their implementation and application to the simulation of the effects of dangerous substances, among others, in: Brzozowska L., (2014b) and Brzozowska L. (2016).

3. Analysis of the effects of the sudden release of chlorine resulting from a road incident

This chapter presents the use of the Spatial Information System to analyze the effects of the sudden release of a dangerous substance resulting from a road accident involving a tanker carrying chlorine (Brzozowska L., 2016). Analysis and visualization of results was carried out in the Idrisi Andes program.

3.1. Chlorine as a hazardous substance

On the one hand, chlorine, used for the production of industrial and consumer products, helps improve the quality of everyday life (Clugg, 2012, Dandrieux et al., 2006), on the other is also very toxic and considered one of the most dangerous materials from the hazardous materials group. Classified as Toxic Inhalation Hazard (TIH) and Poison Inhalation Hazard (PIH). Gaseous chlorine becomes particularly dangerous when released into the air. The risk of exposure depends on how close the source of release is to a given person. Chlorine is easily dispersed in atmospheric air and can therefore be a threat to a large population. Ultimately, the consequences of the release depend on the intensity of the emission, the location of the source, the shape and type of surrounding terrain and meteorological conditions. Any unintentional release that is not associated with an accident is called 'Non-Accident Releases' (NARs) (Clugg, 2012).

One of the major disasters associated with the transport of chlorine was the train accident on January 6, 2005, in Graniteville, South Carolina, which resulted in the car bursting and the release of 54 tons of chlorine (Railroad Accident Report, 2005). Over 5,000 people were evacuated in a sparsely populated area; over 500 people required treatment; nine people died. Both this accident and others caused that urban planners and emergency, transport and chemical industries had to deal with the issue of the sudden release of chlorine. In addition, the transport of dangerous substances may become the target of terrorist attacks in the urban area (Bauer, 2013, Buckley et al., 2012).

The simulations of spreading in several prognostic models carried out by Hanna et al. (2008) suggest that lethal concentration from large chlorine releases (50+ tons) will be maintained in a toxic cloud more than 10 km long in the wind.

3.2. The analyzed case

In the calculations, it was assumed that the accident occurred on the Bielsko-Biala bypass, on the S69 road (Fig. 2). There is a sharp turn here. As Fabiano et al. (2005) points out, the areas where traffic accidents most frequently occur are curves as well as tunnels, uphill slopes and high downhill slopes.

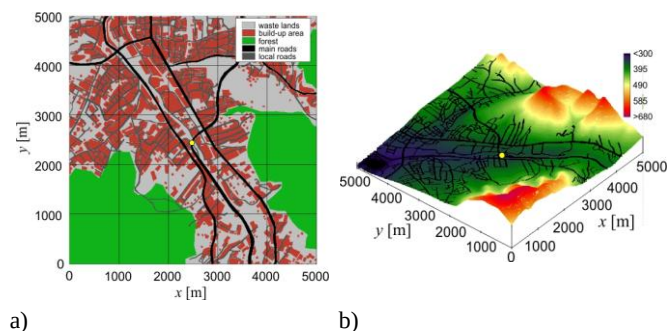


Fig.2. Modelled area with buildings - a) and terrain - b) the place of the collision and the route of the bypass road were marked

As a result of the collision of a tanker carrying 20 tons of chlorine, chlorine leaked into the air in the amount of 10 tons. It was assumed that the leak had a Gaussian curve, and most of the substance was extracted within the first hour of simulation (70%), the duration of the simulation was set to two hours. The maximum leakage is 4500 g/s.

The emission took place at a height of 1.5 m above the ground surface - roadway, in a place with coordinates $x^{(1)} = 2500$ m and $x^{(2)} = 2250$ m (this place is marked in figure 2), in built-up area. The wind direction at the time of chlorine leakage is the eastern direction, the wind velocity taken as input to the diagnostic model (when calculating the initial air velocity field) is $u = 2$ m/s. Atmospheric condition, air temperature 20°C . Two wind directions were considered: Case 1: east - E ($u^{(1)} = -2$ m/s, $u^{(2)} = 0$ m/s) and Case 2: south-east - SE ($u^{(1)} = -1.5$ m/s, $u^{(2)} = 1.5$ m/s).

3.3. Assessment of the effects of chlorine emission as a result of an sudden road accident

A series of analyzes of the simulation results obtained in the custom computer program were carried out. The analyzes were performed in the spatial information system Idrisi Andes.

Chlorine threshold values compliant with the 30-minute chlorine exposure standards - AEGL, as well as the value of 0.1 mg/m^3 , as the maximum permissible 30-minute concentration specified in Polish law, were adopted for the analysis. The limit values for AEGL are: AEGL-3 – 81 mg/m^3 , AEGL-2 – 8.1 mg/m^3 , AEGL-1 – 1.5 mg/m^3 .

Figure 3 shows the simulation area where the concentrations reached values above 0.1 mg/m^3 . Profiles selected for further analysis were also marked. In contrast, Figure 4 presents the results of modelling with marked built-up areas under the influence of AEGL-1 ... 3 concentrations.

Both wind directions were considered.

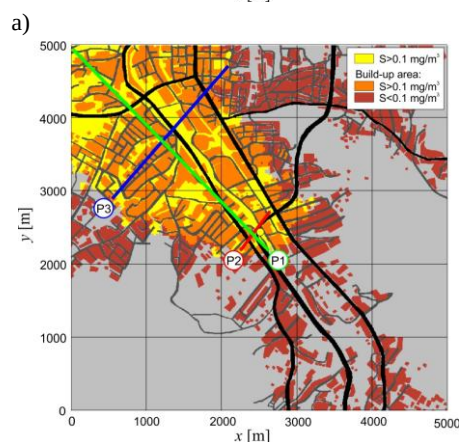
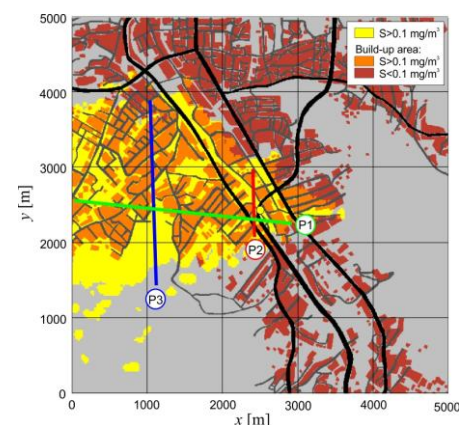
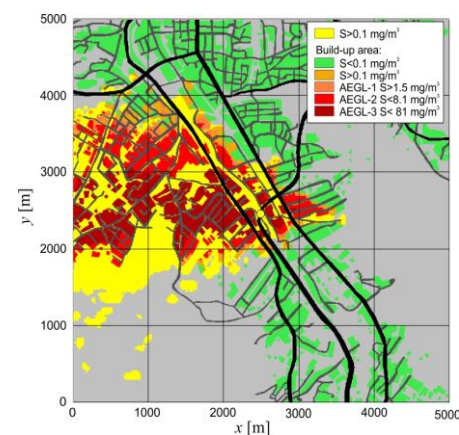
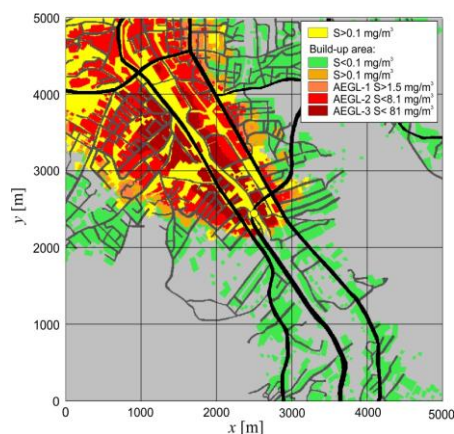


Fig.3. The modelled area under the influence of the pollution cloud and the analyzed profiles for two wind directions: a) case 1, b) case 2.



a)



b)

Fig.4. The modelled area under the influence of pollutant concentrations with different values, for two wind directions: a) case 1, b) case 2.

Table 1 shows the percentage of the risk of sudden release of chlorine as a result of a traffic accident.

Table 1. The area under the influence of pollutant concentrations above the threshold values for both wind directions

AEGL zones	Build-up area [%]	
	Case 1	Case 2
AEGL-1	2.8	3.2
AEGL-2	11.9	23.2
AEGL-3	15	10.1

The following figures (Fig. 5) present simulation results for selected profiles. The profile of building and pollution concentrations is presented.

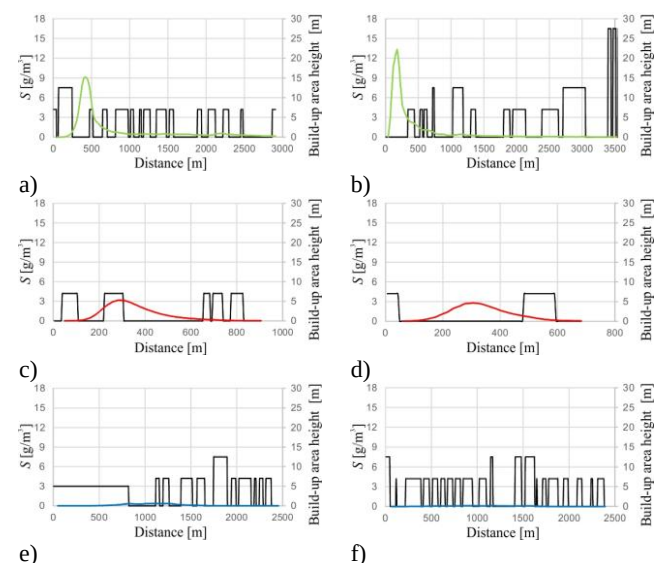


Fig.5. Elevation and pollution profiles: a) P1, case 1, b) P1, case 2, c) P2, case 1, d) P2, case 2, e) P3, case 1, f) P3, case 2.

Figure 6 shows the values of average concentrations in the building area depending on the distance from the emission source.

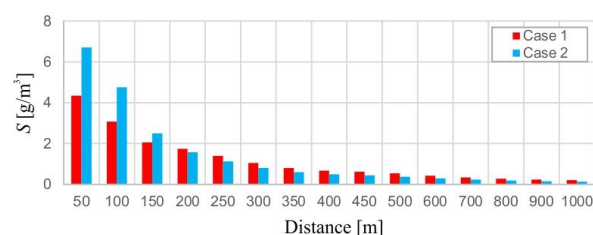


Fig.6. Pollution concentrations at a distance from the source for both analyzed cases.

4. Summary

Import of simulation results into the spatial information system enables to perform a series of spatial analyzes of calculated distribution of pollution concentration in it. The GIS software has built-in modules that are used during the development of charts and maps presenting information relevant to the surface of the earth. The maps developed as part of the work illustrate areas exposed by the occurrence of above-normative concentration levels (endangered areas). They can be used for taking action during the crisis (unsealing of the tank in which the toxic substance is transported).

After the computer simulation, it was found that the chlorine pollution cloud, in which the concentration of pollution exceeds 0.1 mg/m^3 , covers 24.3% and 24.9% of the entire area. Built-up areas under the influence of this concentration constitute 33.8% and 42% of the building area, respectively for case 1 and case 2.

Detailed analysis of the concentration of contamination in the streak axis (profile 1) and across the streak (profiles: 2 and 3) shown in Figure 5 indicates that the highest values of the pollutant are emitted in the immediate vicinity of the emission source. The maximum value of pollutant concentration for profile P1 in both cases exceeds 9 g/m^3 . Also, large concentration values are observed in the graphs for P2 profiles ($S > 3 \text{ g/m}^3$). Only at a considerable distance from the source (P3 profiles) the concentration of contamination is clearly smaller. The maximum concentration then does not exceed 360 mg/m^3 . But it is more than 4 times the threshold value of AEGL-3.

In both analyzed cases, about 3% of the development area is within the pollution concentration range in the AEGL-1 zone. Built-up areas with a concentration threatening the health of living organisms (AEGL-3) constitute 15% (case 1) and 10.1% (case 2) of the whole area of buildings. Rescue operations (zone AEGL-2) can be taken at 11.9% and 23.2% of the area.

The analysis of average values of concentration of pollution in the area of buildings at a given distance from the source of emission testifies to the occurrence of high chlorine concentrations over 1 km (207 mg/m^3 - case 1; 134 mg/m^3 - case 2) from the place of unsealing the tank. Therefore, from the point of view of health care for residents, using the discussed software one should develop a map of the threatened areas, draw up maps of evacuation plans and indicate places of road blockade.

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QUALIMETRIC FORECASTING OF AVIATION PERSONNEL'S PROFESSIONAL DEVELOPMENT LEVEL WHILE SOLVING AIRPORT'S AVIATION SECURITY PROVISION ISSUES

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Abstract: The paper relates to the field of research of "human factor" in civil aviation. It concerns the influence of human factor on the procedures aimed at aviation security provision in airports. The work continues a series of the author's articles on the problem of "human factor" in Russian civil aviation. In this paper, special attention is devoted to the methodology of qualimetric forecasting professional development level of aviation personnel who is involved into aviation security provision in airports. Confidence that at this time the aviation personnel is certainly ready to perform professional functions is obligatory. Appropriate certificate must confirm it. In this case, the problem of forecasting the level of aviation personnel's readiness for some perspective becomes important and practically meaningful.

KEYWORDS: AVIATION SECURITY, HUMAN FACTOR, AVIATION PERSONNEL'S PROFESSIONAL DEVELOPMENT LEVEL, FORECASTING, QUALIMETRIC FORECASTING.

ВВЕДЕНИЕ

Учитывая те особенности, которые возникают при решении задачи прогнозирования уровня мобилизационной готовности (УМГ) персонала служб авиационной безопасности (САБ) статистическими методами, целесообразно еще раз проанализировать смысловую постановку этой задачи, поставив цель максимально возможного ее упрощения.

Исходным пунктом такого анализа следует считать то, что в практической деятельности САБ маловероятно использование сложных, громоздких методов компьютерного исследования, которого требуют статистические методы. Упрощенные методы, при условии обеспечения заданной точности, вполне могут удовлетворить современные требования к решению указанной проблемы. Кроме того, следует помнить об экономической эффективности внедрения разрабатываемых методов, которая, вероятно, невозможна при статистическом подходе [1,2,3].

В таком случае предлагается решать задачу прогнозирования уровня профессиональной подготовки или УМГ авиационного персонала на основе квалиметрического подхода, для чего предлагается метод экспресс-прогнозирования.

ПОСТАНОВКА ЗАДАЧИ И МЕТОДЫ ИССЛЕДОВАНИЯ

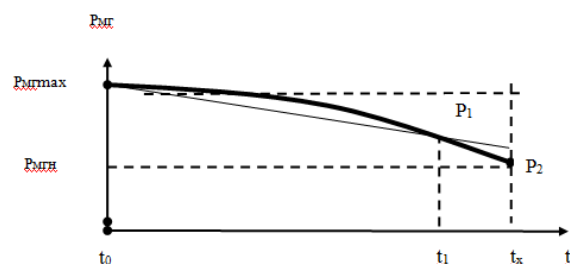


Рисунок 1. Динамика изменения УМГ (кривая выпукла)

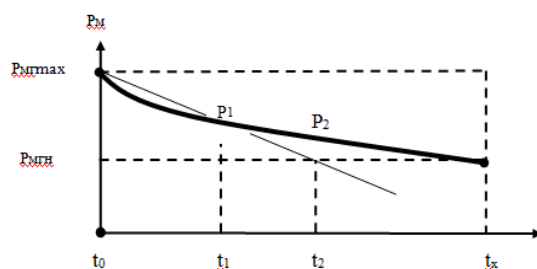


Рисунок 2. Динамика изменения УМГ (кривая вогнута)

Предположим, что кривая изменения P_{mg} от времени аппроксимируется прямой $P_1 - P_x$ так, как показано на рисунке 3. Начало отсчета для прогнозирования находится в t_1 , что соответствует максимальному уровню P_{mg} в данных реальных условиях и приближается к P_{mgmax} . Оценка уровня P_{mg} проведена в t_1 . Вторая оценка P_{mg} проводится в t_2 через интервал времени $(t_1 - t_2)$, определенный соответствующими нормативными документами.

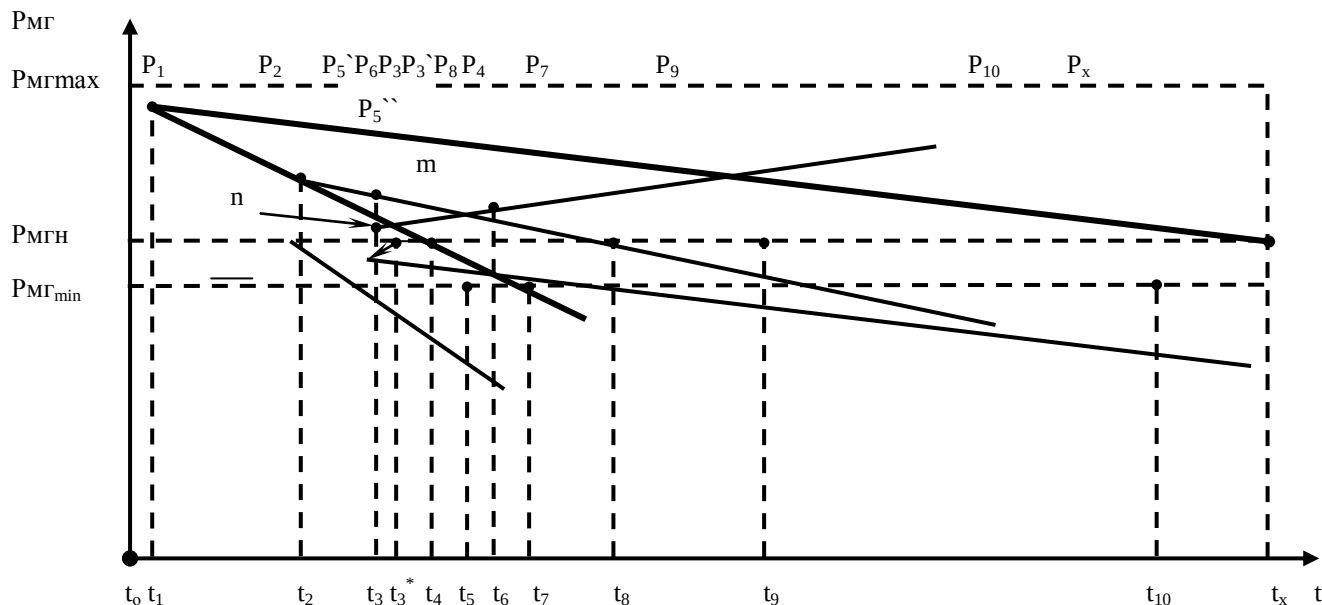


Рисунок 3. Задача квалитетического прогнозирования УМГ персонала САБ

Тогда аппроксимирующая прямая, прогнозная, пройдет через P_1, P_2, P_3, P_4 . При этом критический уровень $P_{МГ}$ ($P_{МГн}$) достигается в момент времени t_3 , а минимально допустимый – в t_4 . Это значит, что корректирующие мероприятия по ликвидации опасного снижения уровня $P_{МГ}$ в соответствии с этим прогнозом необходимо провести до наступления момента времени t_3 . Однако, из рисунка следует, что аппроксимирующая прямая P_1P_x пересекает $P_{МГн}$ только в t_x , т.е. значительно позднее. Отсюда возникает задача проверки точности прогноза, для чего необходимо очередное измерение $P_{МГ}$ до наступления t_3 . Предположим, что такое измерение было проведено в t_5 . При этом возможны два варианта: $P_{МГ}$ соответствует t_x («п») (P_5') и $P_{МГ}$ соответствует t_x («м») (P_5'').

В первом варианте прогнозная прямая проходит через точки P_2, P_5', P_6, P_3 (нижняя). В этом случае прогноз становится более критическим и корректирующие мероприятия необходимы до наступления момента времени t_6 .

Во втором варианте прогнозная прямая проходит через точки P_2, P_5'', P_7 . В этом случае момент введения корректирующих мероприятий отодвигается до времени t_7 .

Следующий этап прогнозирования начинается в момент времени t_5 , при этом возможны два варианта: $t_x(p_5')$ и $t_x(m_5'')$. Предположим, что очередное измерение $P_{МГ}$ проведено в t_8 , т.е. раньше t_7 , что соответствует требованиям первого прогноза.

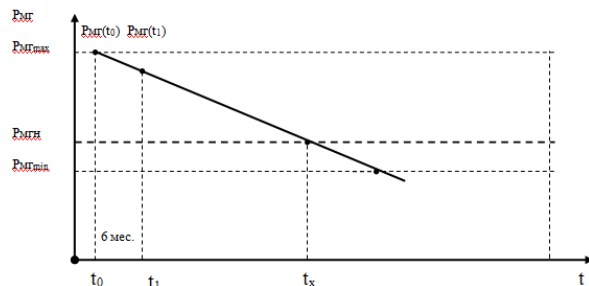


Рисунок 4. Прогнозирование – этап 1

В первом варианте прогнозная прямая P_5', P_8 резко меняет свой наклон и никогда не пересечется с линией $P_{МГн}$. Это говорит о том, что прогноз невозможен. В этом случае использование для прогноза t_x («п») исключается и необходимо, как минимум, еще одно измерение $P_{МГ}$ в промежутке времени ($t_8 - t_4$).

Во втором варианте за начало прогноза берется t_x («м»). Тогда прогнозная прямая проходит через точки P_5'', P_8, P_9, P_{10} . В этом случае прогноз вполне удовлетворителен, а критическая точка отодвигается до точки t_9 .

Рассмотрим некоторые конкретные проблемы, которые возникают в реальной производственной деятельности сотрудников САБ и охраны, и покажем как они учитываются при прогнозировании уровня мобилизационной готовности. При этом, предполагаем, что оценочные процедуры УМГ используют квалитетические методы или тестирование.

Предположим, что уровень мобилизационной готовности (УМГ) в начальный момент времени t_0 будет максимальным для данного сотрудника. Через шесть месяцев определим УМГ в точке t_1 . С помощью двух точек $P_{МГ}(t_0)$ и $P_{МГ}(t_1)$ проведем прямую через эти точки (Рисунок 4). В момент времени t_x она пересечет критический уровень мобилизационной готовности. Под пересечением следует понимать только те случаи, когда t_x лежит в области прогноза, т.е. текущее значение УМГ должно быть меньше предыдущего значения.

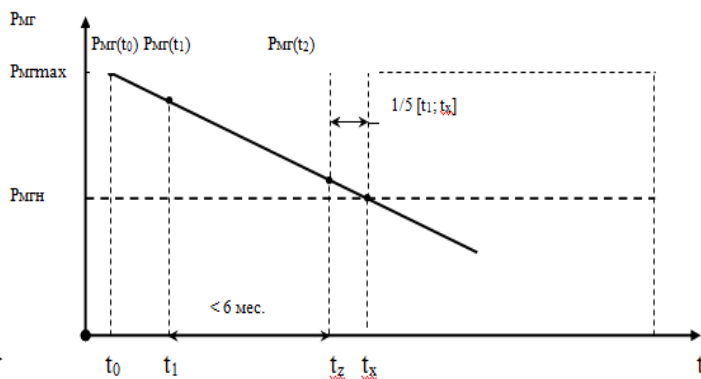


Рисунок 5. Прогнозирование – этап 2

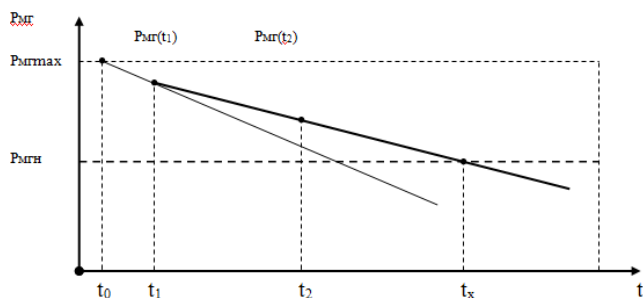


Рисунок 6. Прогнозирование – этап 3

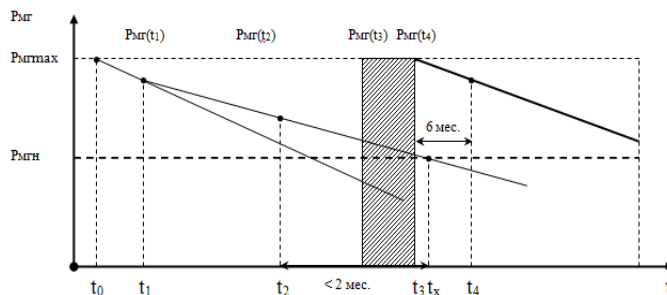


Рисунок 7. Прогнозирование – этап 4.

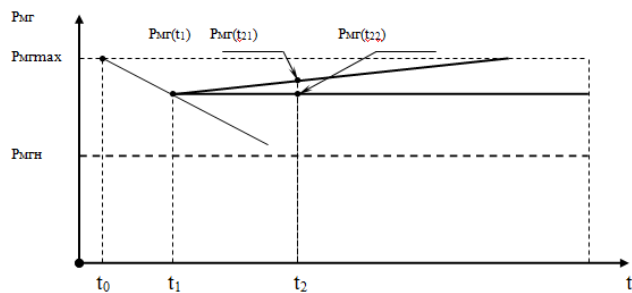


Рисунок 8. Прогнозирование – этап 5

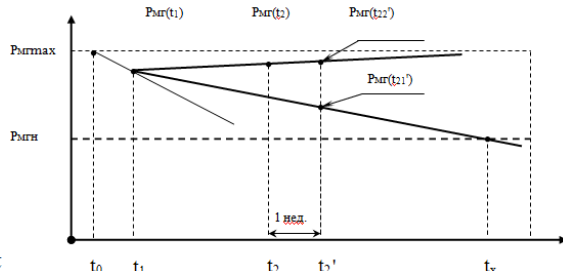


Рисунок 9. Прогнозирование – этап 6

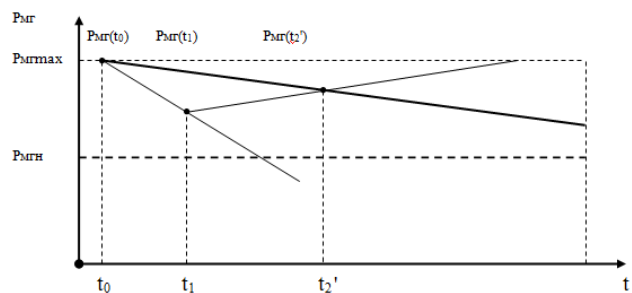


Рисунок 10. Прогнозирование – этап 7

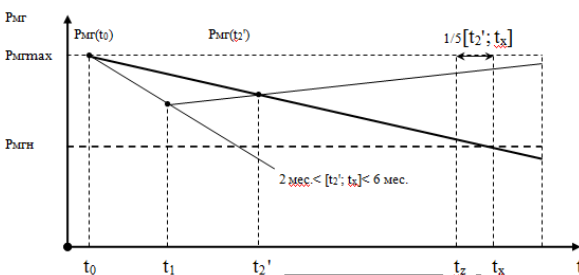


Рисунок 11. Прогнозирование – этап 8

Существует минимальный уровень мобилизационной готовности ($P_{\text{мгmin}}$) при достижении которого сотрудник авиационной безопасности не должен допускаться к работе. Но возможны ситуации, когда общий УМГ сотрудника ниже, чем в момент измерения, т.е. произошло его локальное повышение (эмоциональный всплеск). На этом основании сотрудник допускается к работе, но его реальный УМГ (тренд) приближается к минимуму и, возможно, что следующее тестирование сотрудник пройдет уже в момент, когда его УМГ будет ниже минимума, поэтому, введем нормальный уровень мобилизационной готовности ($P_{\text{мгн}}$), который будет расположен выше минимального уровня, а разность между $P_{\text{мгн}}$ и $P_{\text{мгmin}}$ является запасом. В дальнейшем будем рассматривать только $P_{\text{мгн}}$. Чтобы определить момент времени, когда сотруднику необходимо пройти тестирование, возьмем пятую часть от отрезка времени $[t_1; t_x]$ и отмерим ее от момента времени t_x . Это и будет временем, когда нужно провести следующее тестирование – t_2 (Рисунок 5). Возможны случаи, когда прямая прогноза будет пологой и пересечение прямых произойдет через несколько лет. В таком случае следующее тестирование следует проводить через 6 месяцев, это и будет t_2 .

В момент времени t_2 сотрудник проходит тестирование, т.е. появляется точка $P_{\text{мг}}(t_2)$. Будем рассматривать точки $P_{\text{мг}}(t_1)$ и $P_{\text{мг}}(t_2)$, откуда возможны две ситуации: УМГ в момент времени t_1 выше УМГ в момент времени t_2 (то есть $P_{\text{мг}}(t_1) > P_{\text{мг}}(t_2)$) и УМГ в момент времени t_1 ниже или равен УМГ в момент времени t_2 (то есть $P_{\text{мг}}(t_1) \leq$

$P_{\text{мг}}(t_2)$). Вторая ситуация маловероятна, но все-таки возможна и в этом случае прямая прогноза не пересечет $P_{\text{мгн}}$. Такой случай рассмотрим позднее, а сейчас остановимся на первом варианте, когда $P_{\text{мг}}(t_1) > P_{\text{мг}}(t_2)$ (Рисунок 6).

Через точки $P_{\text{мг}}(t_1)$ и $P_{\text{мг}}(t_2)$ проведем прямую и найдем ее пересечение с $P_{\text{мгн}}$. Далее необходимо определить временной интервал от t_2 до t_x . Если он больше или равен двум месяцам, значит УМГ сотрудника находится на приемлемом уровне, после чего определяем момент, когда необходимо проводить следующее тестирование, и получаем новые точки и прогнозы. Если интервал от t_2 до t_x меньше двух месяцев, то в ближайшее время необходимо принимать меры по повышению УМГ. Для того, чтобы не отстранять сотрудника от работы, необходимо все мероприятия по повышению УМГ провести до наступления момента t_x , т.е. необходимо, чтобы УМГ сотрудника не опустился ниже минимума до окончания проводимых мероприятий. После чего можно строить прогноз сначала (Рисунок 7).

Теперь вернемся к той ситуации, когда прямая прогноза не пересечет $P_{\text{мгн}}$ (то есть $P_{\text{мг}}(t_1) \leq P_{\text{мг}}(t_2)$). Если значение $P_{\text{мг}}(t_1)$ будет меньше $P_{\text{мг}}(t_2)$, то прямая, их соединяющая, пойдет вверх и не пересечется с $P_{\text{мгн}}$ никогда (Рисунок 8), точка $P_{\text{мг}}(t_{21})$). Возможен случай, когда значение $P_{\text{мг}}(t_1)$ будет равно $P_{\text{мг}}(t_2)$, тогда прямая пойдет параллельно линии $P_{\text{мгн}}$ и, соответственно, тоже не пересечет ее (точка $P_{\text{мг}}(t_{22})$).

Так как эти ситуации практически одинаковы для прогноза, будем рассматривать только вариант с точкой $P_{мг}(t_{21})$ и обозначим ее как $P_{мг}(t_2)$. При возникновении подобной ситуации с точкой $P_{мг}(t_{22})$, следует поступить так же, как в случае с точкой $P_{мг}(t_{21})$.

Если значение $P_{мг}(t_1)$ меньше $P_{мг}(t_2)$, то одной из этих точек доверять нельзя. Но точку $P_{мг}(t_1)$ мы проверить не можем, так как это уже в прошлом, необходимо проверить точку $P_{мг}(t_2)$. Для этого через неделю после момента времени t_2 проведем дополнительное тестирование и найдем точку $P_{мг}(t_2')$. Проводить повторное тестирование на следующий день не стоит, так как если значение точки $P_{мг}(t_2)$ является завышенным, то это может быть связано с действием на тренд одного или нескольких факторов и их действие может продолжаться и на следующий день. А временной период равный неделе, как период ожидания, не является большим, но вполне достаточен, чтобы быть уверенным в достоверности результата.

Итак, возможны два варианта: значение точки $P_{мг}(t_2')$ будет находиться ниже $P_{мг}(t_1)$ (Рисунок 9, $P_{мг}(t_{21}')$); значение точки $P_{мг}(t_2')$ будет находиться примерно на таком же уровне, как и значение $P_{мг}(t_2)$ [Рисунок 3, $P_{мг}(t_{22}')$]. Это означает, что в точке $P_{мг}(t_2)$ подтверждается прогноз.

В первом случае возникает стандартная ситуация - $P_{мг}(t_1) > P_{мг}(t_{21}')$. Необходимо соединить точки $P_{мг}(t_1)$ и $P_{мг}(t_{21}')$ прямой, найти пересечение с $P_{мгн}$ – момент t_x , определить временной интервал от t_{21}' до t_x . Если он больше или равен двум месяцам, оставляем сотрудника до следующего тестирования. Далее можно строить прогноз согласно рисунку 4. Если интервал от t_{21}' до t_x меньше двух месяцев, то необходимо принимать меры по повышению УМГ данного сотрудника. После чего можно строить прогноз согласно рисунку 7.

Во втором случае ситуация повторяется - $P_{мг}(t_1) \leq P_{мг}(t_{22}')$. Но это является доказательством того, что и точка $P_{мг}(t_2)$ и точка $P_{мг}(t_{22}')$ являются верными, а точка $P_{мг}(t_1)$ – случайная. Так как именно точка $P_{мг}(t_{22}')$ соответствует текущему значению УМГ, в дальнейшем будем рассматривать ее, а не точку $P_{мг}(t_2)$ и изменим ее название на $P_{мг}(t_2')$ (Рисунок 10).

Теперь необходимо искать точку, значение которой будет больше значения точки $P_{мг}(t_2')$. В данном случае, так как прогнозирование начальное, это единственная точка - $P_{мг}(t_0)$. Если бы мы произвели больше замеров и рассматривали бы, например, точки $P_{мг}(t_8)$ и $P_{мг}(t_9')$, то сначала бы мы сравнили точки $P_{мг}(t_7)$ и $P_{мг}(t_9')$. Если бы точка $P_{мг}(t_7)$ была бы ниже точки $P_{мг}(t_9')$, то мы бы рассмотрели точку $P_{мг}(t_6)$ и сравнили бы ее с $P_{мг}(t_9')$. Если бы точка $P_{мг}(t_6)$ была бы ниже точки $P_{мг}(t_9')$, мы бы рассмотрели точки $P_{мг}(t_5)$ и $P_{мг}(t_9')$. И так до тех пор, пока не нашли бы точку, которая была бы выше $P_{мг}(t_9')$. Наиболее вероятно ситуация, когда уже предыдущая точка будет выше текущей, то есть как в нашем случае $P_{мг}(t_0)$ и $P_{мг}(t_2')$.

Таким образом вместо точек $P_{мг}(t_1)$ и $P_{мг}(t_2')$ мы рассматриваем $P_{мг}(t_0)$ и $P_{мг}(t_2')$. Их можно соединить прямой и она точно пересечет уровень $P_{мгн}$. Обозначим этот момент времени как t_x (Рисунок 11).

Остается определить временной интервал $[t_2'; t_x]$ и сравнить его с двумя месяцами. Если он больше или равен двум месяцам, оставляем сотрудника до следующего тестирования. Затем снова находим t_x – пятую часть от интервала $[t_2'; t_x]$ либо промежуток времени равный шести месяцам от t_2' . Если же интервал от t_{21}' до t_x меньше двух месяцев, то необходимо принимать меры по повышению УМГ данного сотрудника. После чего можно строить прогноз согласно рисунку 7.

АНАЛИЗ РЕЗУЛЬТАТОВ

Таким образом, мы рассмотрели возможные ситуации, которые могут возникнуть на начальном этапе прогнозирования УМГ сотрудника САБ. Далее процесс

прогнозирования будет проходить по одному из описанных выше сценариев. Задача прогнозирования уровня $P_{мг}$ с достаточной степенью точности, определяемой выбором времени измерения $P_{мг}$, решается с помощью кусочно-линейной аппроксимации.

При всей видимой сложности реализации предложенного метода задача прогноза решается достаточно просто, если помнить о главной цели квалиметрического прогноза, а именно: оценить степень приближения уровня мобилизационной готовности авиационного персонала к критическому уровню, за пределами которого профессиональная деятельность специалиста САБ недопустима.

Весьма важным остается вопрос о выборе временного интервала для анализа УМГ. Точка отсчета определяется путем исследования достаточно предельного множества факторов, которые следует принимать во внимание. Это могут быть условия реализации производственной деятельности, алгоритм (стандартная эксплуатационная процедура) деятельности, степень ответственности и многие другие, включая сезонные компоненты.

Еще один важный момент связан с точностью оценки УМГ, т.е. со степенью доверия к полученным количественным оценкам. Поскольку указанные оценки могут быть получены только экспертными методами, весьма осторожно следует подходить к выбору доверительных интервалов, включая приемлемые отклонения в диапазон разрешенных результатов [5].

Результаты прогноза следует рассматривать как информационную поддержку для принятия управленческого решения. В любом случае ответственность за расстановку и использование авиационного персонала несет лицо, принимающее решения.

ЗАКЛЮЧЕНИЕ

Практическая применимость разработанной методики определяется следующими факторами.

1. Достаточная простота процедур реализации алгоритма методики, не требующая в качестве исполнителей специалистов высокой квалификации.
2. Приемлемая точность результатов прогнозирования, определяемая экспертными методами получения количественных оценок УМГ, поскольку других методов их получения в данных условиях не существует [6].
3. Разработанная методика предполагает компьютерную реализацию соответствующих алгоритмов, что представляется достаточно простой акцией и не требует сложного математического и программного обеспечения.
- 4.

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PROSPECTS FOR THE TRANSPORTATION OF LIQUEFIED GAS FROM THE CASPIAN REGION TO EUROPE

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Abstract: Georgia proposes to supply Caspian liquefied gas to the European market via the alternative route - by building a terminal for exporting liquefied gas on the Black Sea coast. Compressed gas will be delivered from Georgia to the Romanian port of Constanta on tank vessels.

Kazakhstan regards this route as an option of delivery of liquefied gas to the world market.

Turkmenistan is also studying options for exporting liquefied gas through Azerbaijan and Georgia.

To participate in the project as a vendor, Turkmenistan could supply liquefied gas by the Caspian sea to Azerbaijan for its further transit through Georgia to Europe.

KEY WORDS: KULEVI TERMINAL; BLACK SEA PORTS; MARITIME TRANSPORT.

1.Introduction

The government of Georgia proposes to supply Azerbaijani gas to the European market via the alternative route – through the construction of a terminal on the Black Sea coast for exporting liquefied natural gas.

Azerbaijan and Romania signed an agreement on the exporting liquefied gas to Europe across the Black Sea, and in order to implement this project, it is necessary to construct a plant for the compression of natural gas in Georgia, and Georgia is interested in becoming a part of a new transport corridor. The delivery of natural gas from Azerbaijan for the compression can be carried out through the South Caucasus gas pipeline, through which gas is currently being transported to the north of Georgia. There must be constructed a gas compression plant with an initial capacity of 5-10 billion cubic meters [1].

According to data from the Ministry of Energy of Georgia, compressed gas will be delivered from Georgia to the Romanian port of Constanta by tankers, and the Romgaz company is already working on the creation of a receiving terminal. At present, the project is at the initial stage. Official negotiations and development of a feasibility study still lie ahead. In the future, this route will be used by other suppliers from the Caspian basin, including Turkmenistan, which exports mainly through the territory of Russia. In this case, the capacity of the plant should be brought to 15-20 billion cubic meters. At the same time, liquefied gas can also be exported from Romania to other countries.



Fig.1. A route for the transportation of liquefied natural gas from Azerbaijan to Romania and further.

Azerbaijan is interested in supplying compressed gas to Europe, since it does not require transit costs and SOCAR (the State Oil Company of Azerbaijan) already owns the Kulevi terminal on the Black Sea coast in Georgia. Recently, during a visit of the Azerbaijani delegation to Romania, the Ministry of Industry and Energy of Azerbaijan and the Ministry of Economy, Energy and Tourism of Bulgaria signed a memorandum of cooperation in the field of energy. Some directions were taken as a basis, one of which is transportation of liquefied natural gas from Azerbaijan to the Bulgarian port of Varna.

If this project would be rational, the Azerbaijani side will construct a terminal for liquefied gas in the Georgian port of Kulevi.

2. Preconditions and means for resolving the problem

According to SOCAR, in January 2017, Azerbaijan exported 8,876 tons of liquefied gas - 25.5 times more than in the same period last year. In 2016, Azerbaijan exported 58.843 thousand tons of liquefied gas. Liquefied gas in Azerbaijan is produced at the H. Aliyev Baku Oil Refinery and at the Azerbaijani Gas Processing Plant [2].

Bulgaria confirms its deep interest in the implementation of the Southern Gas Corridor (SGC) project, designed to transport Azerbaijani gas to Europe.

Last year, Ukraine imported 740 tons of propane-butane mixture from Azerbaijan. Prior to this, Azerbaijani liquefied gas was not delivered to Ukraine.

The first importers were the companies "Nadezhda" and SOCAR Energy Ukraine, which contracted respectively 530 and 210 tons of propane-butane mixture.

Liquefied petrol gas (LPG) was imported in Ukraine by rail from the City Gas terminal, which is located in the free economic zone of the Romanian port of Galati. In turn, the propane-butane mixture was delivered to the terminal in Romania by tanker from the Black Sea port of Batumi. According to the latest data, Kazakhstan allowed for the possibility of transit of its liquefied gas through the territory of Azerbaijan. Kazakhstan offered Azerbaijan to explore the idea of creating transit opportunities for the transportation of Kazakhstani liquefied and compressed natural gas through the Caspian and the territory of Azerbaijan and further to the global market.

The Southern Gas Corridor (SGC) is a project designed to expand the South Caucasus Gas Pipeline (Baku-Tbilisi-Erzurum), as well as to construct the TANAP gas pipeline in Turkey and extend it through Europe. The estimated length of the pipeline is 3500 km.

It is expected that the SGC will increase security of gas supply to Europe by reducing the share of Russia as a gas supplier, and by excluding Ukraine as a gas transit State. The declared cost of the project is about \$ 45 billion.

In 2018, the first phase of the Southern Gas Corridor with the final destination in the EU zone will be launched. This event, in addition to Turkmenistan, was very interested for Kazakhstan. At a recent meeting of the intergovernmental commission, the Minister of Energy of Kazakhstan said that Astana is exploring the possibility of supplying its gas through the territories of Azerbaijan and Georgia to the global markets, including shipments of liquefied form by tankers [3].

In 2017, Kazakhstan extracted 50 billion cubic meters of natural gas, and further growth is expected. In connection with plans to increase gas production, Kazakhstan regards Azerbaijan as one of the options for delivering liquefied gas to the world market. Together with Azerbaijan, a working group is being formed on this issue, whose experts will analyze in the next few months how competitive is this project.

As part of the implementation of this idea, Kazakhstan is exploring the possibility of constructing a liquefied gas plant in the west of the country. In the State Oil Company of Azerbaijan, the idea of Kazakhstan on transit of liquefied and compressed natural gas through the territory of Azerbaijan has been accepted for consideration. The SOCAR notes that, at present, they do not have required infrastructure, and it is also necessary to think over the logistical aspects of transit [4].

Turkmenistan is also exploring the possibility of exporting liquefied gas through the territories of Azerbaijan and Georgia. Currently, the issue of supplies of Turkmen liquefied natural gas to Europe through the Romanian port of Constanta (Black Sea region) is being under consideration. It is planned that liquefied natural gas will be delivered in special containers by the ships of maritime merchant fleet of Turkmenistan to the port of Baku, and then - to the ports of Batumi or Poti (Georgia, Black Sea region), by rail (Fig. 2).



Fig. 2. A route for the transportation of liquefied and pressurized natural gas from Kzakhstan and Turkmenistan to Europe.

Further, from the Georgian ports, containers will be delivered by sea to Romania or other countries of the Black Sea basin. The same scheme can be applied to the other Turkmen goods that can be transported by containers.

Earlier, Turkmenistan had expressed interest in the AGRI gas pipeline project (Azerbaijan-Georgia-Romania Interconnector) (AGRI), which provides for Caspian liquefied gas supplies gas through the Black Sea coast of Georgia to Romania. The project is inherently suited under transporting Azerbaijani natural gas through the gas pipelines to the Black Sea coast of Georgia, where this gas will be liquefied at a special terminal, after which tankers will be delivered to the terminal in Romania.

Further, liquefied gas will be brought into the state of natural gas, and using the gas infrastructure existing in the country, it will be directed to the needs of Romania and other European countries. To participate in the project, Turkmenistan as a supplier could supply liquefied gas through the Caspian Sea to Azerbaijan for its further transit to Europe [5].

3. Conclusion

But the most important thing in implementing the idea of transporting gas from Central Asia to the EU, is that infrastructure for exporting the large quantities of Caspian gas to the global markets has already been built on the territory of Azerbaijan. Now we can safely say that starting from 2020, the first Caspian gas will be transported to the European markets, and then the process of stage-by-stage expansion of this gas main line will evolve in the future. That is why the countries having sufficient volumes to supply gas to the external markets, as well as planning to export it in the future, for example, Israel and Iraq, have begun to consider the possibility of joining to "Southern Gas Corridor".

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OPTIMIZATION OF CUSTOMS PROCEDURES IN THE SOUTH CAUCASUS TRANSPORT CORRIDOR

ОПТИМИЗАЦИЯ ТАМОЖЕННЫХ ПРОЦЕДУР В ТРАНСПОРТНОМ КОРИДОРЕ ЮЖНОГО КАВКАЗА

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Abstract. *The rational use of convenient geographical location, the organized transport-communication and customs-logistics infrastructure, is the key for any country's integration into the world economy and the expansion of foreign economic ties.*

The South Caucasus transport corridor connecting the Asian and European markets, has an important strategic role in the trade-economic context of East-West relations.

Today the formation of a common control of customs and signing between the countries of the South Caucasus is one of the priority tasks, which will facilitate harmonization of transit procedures in the region

KEYWORDS: SILK ROAD; TRANSPORT CORRIDOR; CUSTOMS CONTROL OF THE TRANZIT.

1. Introduction

Contemporary globalization is a qualitatively new phenomenon of world development that covers all areas of public life. The reconciliation of national and global-economic relations is exactly what is characteristic to globalization. Due to globalization development, the leading, priority role of international economic relations is increasing – today, it is very important to develop a single rule for the world economic systems and introduce it in the economy of each country, but this process is quite complex, and even the economic systems of powerful countries are hardly adapted to the challenges of the global economy [1].

The sustainable use of the advantageous geographical location, expansion of the frontiers of national markets, well-organized transport-communication and customs-logistics infrastructure, the creation of favorable conditions of export-import and transit operations, are significant factors for any country to integrate into the global economy and expand the international economic relations [1,2].

International transport corridors fulfil at least two tasks: the first, they create the fundamental premise of involving in a single economic and cultural space of large area; the second, under conditions of deepening the globalization processes, for the macroeconomic regions, which are characterized by the fragmented nature of production forces in all fields of production and services, international transport corridors make up the uniform, economically far more efficient transport and logistics systems, for the rational exchange of the means of production and products [2].

2. Preconditions and means for resolving the Problem

The desire to use the transit potential of the South Caucasus Transport Corridor for their own benefit has also Afghanistan, which is deeply interested in opening an alternative corridor of roads leading to Iran and Pakistan. And the railroad line passing through the Central Asia and the South Caucasus, particularly, via Turkmenistan,

The South Caucasus, as an energy-intensive region and transport corridor linking the markets of Asia and Europe, has long played an important strategic role in the trade, economic and political context of East-West relations.

In addition to significant energy load, the corridor's transport-transit function also takes a particular form that makes its content more valuable and more intensive. Accordingly, both its economic and geopolitical significances are increased. These include the Baku-Tbilisi-Kars railway line, whose transport-transit potential is of great interest not only to countries involved in the project and their partner countries in Central Asia and Europe, but also to more distant countries, particularly China and Afghanistan, as well as the United States of America.

Uzbekistan and Turkmenistan, whose future plans are largely related to the implementation of the Navoi-Turkmenbashi-Baku-Tbilisi-Kars transport project, which can provide their products with a much broader access to the European markets, are interested in using the potential of the China-Central Asia-South Caucasus-Turkey transport corridor [3].

The Baku-Tbilisi-Kars new railway transport corridor, which will unify the railway lines of Azerbaijan, Georgia and Turkey, is an important challenge for meeting the growing demand for trade flows existing between Europe, Caspian Region, Central Asia and China, as well as for the formation and improvement of the relevant transport corridor [4].

Azerbaijan, Georgia and Turkey, is what is considered by it to be such a corridor, which will provide it with access to the Black Sea. It is only also natural that this project has a lot of support in the United States. Due to this, in November 2017, in Ashkhabad, there was signed an agreement on the establishment of a new Lapis Lazuli

transport corridor from Afghanistan to Europe crossing the territories of Turkmenistan and South Caucasus. The document was signed by representatives of the countries involved in the project - Afghanistan, Turkmenistan, Azerbaijan, Georgia and Turkey. The Agreement envisages the promotion of transport relations between the countries involved in the project, which involves fostering the smooth movement of goods and passengers, harmonization of administrative issues and customs procedures related to transit movement, and so on. [5].

In 2016, the lifting of sanctions on Iran has created the needs for the launch of the North-South Transport Corridor, which will naturally increase the transit potential of the South Caucasus. The Georgian side is interested in joining the Mumbai-Bandar Abbas Transport Corridor, which implies the rapid shipment of cargo through from the Mumbai port, crossing through the territories of Iran, Azerbaijan and Georgia using the ports of Poti and Batumi.

According to the agreement between Russia and Georgia, the transport corridors passing through the territory of Abkhazia and South Ossetia will be put into operation in the nearest future, which is a part of the North-South Corridor and links countries of South-West Asia (mainly Iran and India) to countries of Northern Europe. This will, in turn, facilitate the increase of cargo traffic flows and improving the capacity of transit traffic.

Trade-economic relations between Europe and Asia and more economic integration contribute significantly to the "Silk Road" direction, which is now considered to be the economic corridor with the greatest potential. Within the framework of the "Silk Road" development, great importance is attached to close cooperation between Georgia, Turkey and Azerbaijan in the field of transport and logistics.

Due to the favorable geopolitical situation and the location between the several major international and regional transport corridors (TRACECA, North-South, Lapis lazuli, a new silk road "One Belt and One Road"), Georgia and other South Caucasus states represent an integrating link between two macroeconomic continents - Europe and Asia, which provides movement of goods by the shortest route with a minimum amount of time [6]

Experts forecast that by 2020, the total volume of transit traffic through the territories of the South Caucasus countries is expected to increase. At the same time, according to experts, only half from the transit potential of the South Caucasus transport corridor is currently utilized.

The main direction of the development of the customs regulation mechanism of Georgia's international trade is, first of all, the improvement of the customs transit procedures and technologies.

Despite the fact that in Georgia has a number of measures have been taken aiming at improving the customs legislation and procedures: the modern customs registration centers – registration economic zones (REZ) have been built and put into operation, the cargo and vehicles registration procedures have been simplified, the prior declaration mechanisms have been introduced, thus reducing considerably the costs and time for registration, there are still a number of barriers that affect the shipping companies.

Recently, the loss of competitiveness of the South Caucasus Transport Corridor has resulted in redirecting transit traffic flows to alternative routes, which is due to a number of reasons, as follows [7]:

- Different tariff policies between the countries of the Caucasus, and high tariffs for transportation.

- Inadequate and ineffective infrastructure. For example, complicated geographical sections, where the road transport infrastructure is characterized by low throughput; sea ports, which that cannot accommodate large vessels.
- Low level of logistics development. Logistics companies cannot ensure improvement of services and provide comprehensive logistics services.
- Different customs legislation in the countries of the South Caucasus, when there is no uniform customs policy for control of goods and vehicles, and the shipping companies encounter different customs regulations when crossing the border.
- The lack of effective information technology, which significantly hinders the exchange of comprehensive information on transit goods between the customs authorities in each country, which negatively affect the time required for customs registration.

The lack of bilateral coordination in this regard, and the policy of ensuring the "sovereignty" of institutional information from regulatory bodies inevitably lead to the the cardinal differences existing in customs transit control systems, complicating their interactions that are required for the establishment of a single economic space, which significantly hinders the effective utilization of a high transit potential of the South Caucasus.

Formulation of common approaches to the customs control and clearance within the framework of the economic cooperation between the countries of the South Caucasus, is one of the priority tasks, which will facilitate the harmonization of transit procedures in the region; in addition, it creates the possibility of the realization of the attributes information technology of customs clearance and control. Full use of the transit potential of the South Caucasus countries based on information and communication technologies is possible through the integration into the electronic information system within the framework of customs cooperation, as well as by organizing information exchange by the customs authorities in each participating country with other countries and allies.

One of the most important directions in the reduction of administrative barriers, while performing transit operations, is the improvement of customs regulatory mechanisms of foreign economic activity. Inadequacy of customs control procedures and technologies, agencies and State interaction in customs checkpoints reduces the transit potential, contributes to an increase in financial expenditure at border crossings.

Effective utilization of the country's transit potential by customs authorities should be carried out within the framework of interconnected and contradictory transformation processes, of which the main ones are:

- Substantial modification of the rules for the functioning of customs authorities in close connection with the creation of a union similar to a customs union of Georgia, Azerbaijan, Turkey and Armenia (if only for promoting the customs transit and transit cargo movement), which will be associated with reduction or cancellation of the certain customs and other types of control procedures, within the borders of this Union.

- Formulation of the development strategy of the South Caucasus economic space, including the creation of an integrated transport, customs and logistics network, and development of the international transport corridor infrastructure crossing through the territories of the countries of the South Caucasus.
- Enhancing the coordination between customs authorities of the bordering states, and providing the

exchange of information on goods and vehicles, control objects and also exchange of information about phyto-veterinarian sanitary products.

- Providing the customs authorities with technical and information equipment, which implies the use of modern technological systems and technical means of customs control.

3. Conclusion

Within the framework of economic cooperation between the states of the Caucasus, the creation of a single automated information system for the customs control of transit is necessary for the exchange of information on goods and vehicles in real time.

The implementation of these approaches will facilitate the effective utilization of transit potential of the South Caucasus

Transport Corridor, integration of the state in the region into the European transit system, as well as the creation of favorable conditions for involving the additional volumes international trade flows.

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SMART CITIES – DEPENDENCE OF INTELLIGENT TRANSPORTATION SYSTEMS ON CLOUD COMPUTING AND TECHNOLOGIES

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Abstract: With the development of Cloud technologies we finally have the tools and the solutions needed to start planning and executing an efficient urban transportation. The paper presents concepts and ideas toward Smart City intelligent transportation and traffic, namely agent-based traffic management systems and vehicular Cloud computing. It discusses their main characteristics, architecture and provides examples where such technologies are already implemented. Lastly, it outlines some challenges that arise from the application of Cloud computing and the change of the city into a Smart City.

Keywords: SMART CITY, BIG DATA, CLOUD COMPUTING AND TECHNOLOGIES, INTELLIGENT TRANSPORTATION SYSTEMS (ITS)

I. Introduction

We live in the era of Big Data, where knowledge lies inside of an unstructured, heterogeneous pool of information. In this regard, the rise of cloud computing makes it possible to build up a frame and infrastructure for analysis, storage and management of data and to unlock its full potential. Furthermore, this pool of resources will be available to everyone on-demand.

Cloud computing holds also great promises to solve global and local issues that are impossible with small-scale data.¹ The concept of smart cities, for instance, relies mainly on using big data for deeper insights about population behaviors and patterns to tackle today's biggest challenges in the urbanized world. According to IBM, it requires further mobile and social technologies to address problems immediately and for better engagement.² It should be, however, noted that there are also considerable number of challenges that should be solved to unleash the potential of this big data, including: managing diverse sources of unstructured data with no common schema, real-time analytics, suitable visualization, etc.

Intelligent infrastructure would improve the capacity, efficiency and quality of life in the city to make it more "livable". It could enhance travel experience, solve traffic and pollution issues and increase safety and security.³ Barcelona is setting out a notable example in this regard. The city has stated that it will use smart technologies to reduce traffic and in addition to that to offer smart parking technologies. It will also setup sensors throughout the whole infrastructure to fight air pollution and noise. In this way, the city government plans to reduce traffic by 21% in the next years. This result only comes to show that cloud computing and big data is used to understand problems and trends related to the city traffic and infrastructure and to properly address them by processing in cloud-enabled large-scale sensor networks for gathering and analyzing relevant data.⁴

The paper presents concepts and ideas toward smart city transportation and traffic, namely agent-based traffic management system and vehicular cloud computing. It discusses their main characteristics, architecture and provides few examples where such technologies are already implemented. Lastly, it outlines few challenges that should arise from the usage of cloud computing and the turning of the city into a smart city.

II. Smart Cities and Cloud Computing

Cisco offers a general definition of the emergence of digitalization, calling it the "Internet of Everything" (IoE). IoE brings together "people, process, data, and things to gather relevant and valuable data and to turn information into action".⁵ In this sense, cities globally have the potential to claim \$1.9 trillion in value from IoE over the next decade, according to Cisco's study. In the smart city, everything will be optimized and improved, from education, health services and government to infrastructure, transport and traffic.

Smart urban transportation systems use secured cloud technologies to produce big data, involving billions of devices that communicate, computes and updates real time all together. By relying on cloud computing to store, manage, modify data, we could find numeral solutions for most of our society's transportation problems such as traffic, pollution inefficiency, etc. These problems would be tackled with service-generated-big-data and big-data-as-a-service that use cloud computing and effectively manages the data with a reduced cost.

In 2013, Zimmerman proposed integration model for service-oriented architecture (SOA) for systematic development, diagnostics and optimization for big data applications. His conceptual framework of urban smart city is based on multilayered Internet of Things (IoT) - vehicular data cloud platform with an intelligent parking cloud service and a vehicular data mining cloud service. Fig 1. describes the whole architecture.⁶

III. Agent Based Traffic Management System Technology

Nowadays, the use of motor vehicles is a widespread practice with people owning several different vehicles. This results in problems in infrastructure and traffic all over the world. Furthermore, traffic leads to environmental issues, financial losses and waste of time and above all, a significant increase in car accidents. Therefore, there is an urgent need to improve traffic

¹ Villars, R. L., Olofson, C. W., Eastwood, M. (2011). Big Data: What It Is and Why You Should Care. IDC, 6, 1–14.

² Harrison, C., B. Eckman, R. Hamilton, P. Hartswick, J. Kalagnanam, J. Paraszczak, and P. Williams. "Foundations for Smarter Cities." IBM Journal of Research and Development 54, no. 4 (2010): 1-16. doi:10.1147/jrd.2010.2048257.

³ Cuzzocrea, A., Fortino, G., Rana, O. (2013). Managing data and processes in cloud-enabled largescale sensor networks: State-of-the-art and future research directions. Proceedings - 13th IEEE/ACM International Symposium on Cluster, Cloud, and Grid Computing, CCGrid 2013, 583–588.

⁴ Cuzzocrea, A., Fortino, G., Rana, O. (2013). Managing data and processes in cloud-enabled largescale sensor networks: State-of-the-art and future research directions. Proceedings - 13th IEEE/ACM International Symposium on Cluster, Cloud, and Grid Computing, CCGrid 2013, 583–588.

⁵ "The Network." Internet of Everything (IoE) | The Network. Accessed April 29, 2018. <https://newsroom.cisco.com/ioe>.

⁶ Zimmermann, A., Pretz, M., Zimmermann, G., Firesmith, D. G., Petrov, I., El-Sheikh, E. (2013). Towards service-oriented enterprise architectures for big data applications in the cloud. Proceedings - IEEE International Enterprise Distributed Object Computing Workshop, EDOC, 130–135.

management and cloud computing provides the chance for intelligent traffic development.

Nowadays, many heterogenous devices are interconnected on the traffic monitoring system using IoT. The major issue of such systems is the transfer of data over different standards, formats, hardware, protocols etc. Another issue is the necessity of an intelligent interface and the ability to access different services and applications. It seems that mobile agents are a convenient tool to handle these issues, provide means for communication among such devices and handle the IoT interoperability. In this regard mobile agents are a great solution for low bandwidth and disconnection, passing messages to undefined destinations and across network.

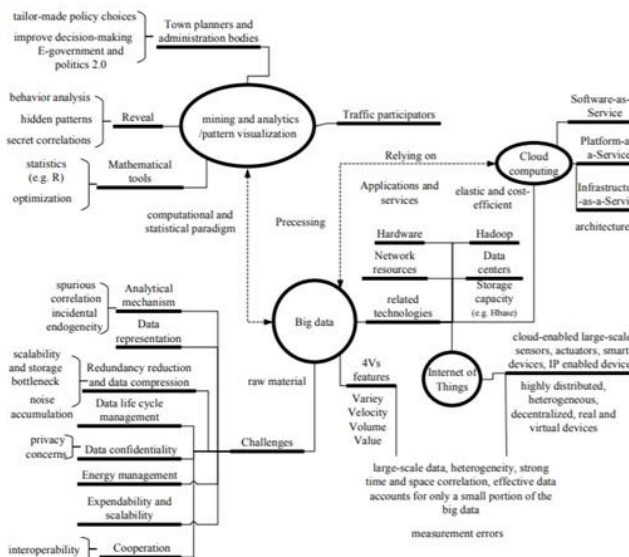


Fig.1 The conceptual framework of urban smart transport based on Cloud and IoT

Agent Technology was used back in 1992 in traffic management systems, however they started to become popular in 2004, especially when it comes to mobile multi-agent traffic system.⁷ The characteristics of mobile agents are autonomy, mobile and adaptive. These features make them suitable to handle problems like inconsistencies and uncertainties. In 2005, the agent-based distributed and adaptive platforms for transportation system (ADAPTS) was proposed as an urban traffic management system. Currently ADAPTS is part of a system which takes advantage of mobile traffic strategy agents to manage and update a road map in real time. The concept of ADAPTS has three layers—organization, coordination and execution.⁸

The organization layer is the core of the system (Fig.2). Its characteristics are four major functions: agent-oriented task decomposition, agent scheduling, encapsulating traffic strategy and agent management. As one traffic strategy has been proposed, a strategy code is saved in the traffic strategy database. Typical traffic scenes, which are stored in typical intersections database, can determine the performance of various agents. If the urban management system cannot deal with a transportation scene with its existing agents, it will send a traffic task to the organization layer for help. The traffic task contains the information about the state of urban transportation. It can be decomposed into a combination of several typical traffic scenes. With the knowledge of the most appropriate traffic strategy agent to deal with any typical traffic scene, the system takes advantage of the strategy agent and manages a road map. The last part is setting up an applicant testing

to test the performance of the urban-traffic management system based on the map showing the distribution of agents.⁹

In addition to what was said before, the urban traffic management system requires traffic control, detection, guidance, monitoring, and emergency subsystems to be completed. As for the performance, the improvements and the implementation of new subsystems, new traffic strategies must be introduced constantly.

So, they must generate, store, manage, test, optimize, and effectively use many mobile agents to support this complex cloud environment (Fig.3). Moreover, they need a comprehensive, powerful decision-

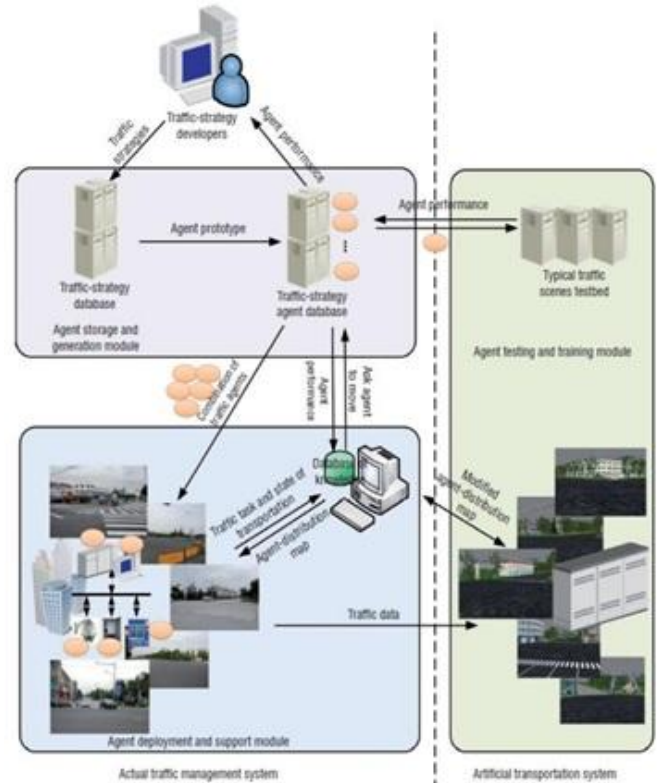


Fig.2. Organizational Layers of Agent Based Distributed Transportation System (Wang, 2005)

support system with a friendly interface to communicate with traffic managers. To achieve this superior performance, however, testing a large amount of typical traffic scenes requires enormous computing resources.¹⁰

As an example, the transport for London (TfL) manages all public transportation in the capital, gathering data across all the city's transit services. Data collection keeps the transport sensitive to issues within the subway system. And in a case of an issue, it deals with the warnings from passengers about the disruptions along their route via their mobile device. This service is found by 83 percent of Londoners to be very useful.

Ridership data could also prevent overcrowding, as real-time updates about ridership and space on public transit could encourage people to re-think their route, clearing up some of the issues caused by volume in the major transit hubs.

⁷ Chen, Bo, and Harry H. Cheng. "A Review of the Applications of Agent Technology in Traffic and Transportation Systems." IEEE Transactions on Intelligent Transportation Systems 11, no. 2 (2010): 485-97. doi:10.1109/tits.2010.2048313.

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⁹ Yu, Xi, Fuquan Sun, and Xu Cheng. "Intelligent Urban Traffic Management System Based on Cloud Computing and Internet of Things." 2012 International Conference on Computer Science and Service System, 2012. doi:10.1109/csss.2012.539.

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Fig.3. Urban-Traffic Management Systems Based On Cloud Computing. (Fuguan, Cheng, 2012)

Architecture

According to the basic structure of cloud computing, an intelligent traffic clouds have four architecture layers: application, platform, unified source, and fabric.¹¹ The application layer contains all applications that run in the clouds, such as agent generation, agent management, agent testing, agent optimization, and traffic decision support (Fig. 4).

The platform layer is made of advanced transportation system, or ATS. It runs a population synthesizer, weather simulator, path planner, 3D game engine, etc. to provide services to upper traffic applications and agent development. The unified source layer administrates the raw hardware resource in the fabric layer and provides infrastructure as a service. It uses virtualization technologies such as virtual machines to hide the physical characteristics of resources, ensuring also safety of data and equipment. Lastly, it provides an access to interface for the upper computing resources.

All those will help solve information silo problems in urban traffic and help gather useful information in the traffic data. Lastly, the fabric layer contains the raw hardware level resources such as computing, storage and network resources. The intelligent traffic clouds use these resources to provide the demand of urban-traffic management systems and testing, storage, and performance.¹²

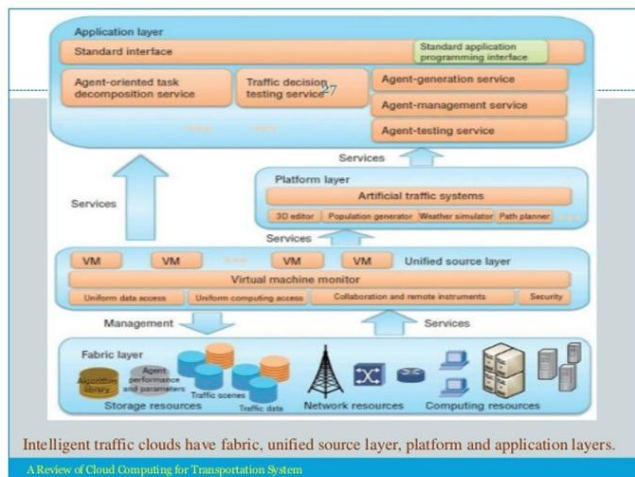


Fig.4. Architecture of Urban-Traffic Management (Fuguan, Cheng, 2012)

IV. Vehicular Cloud Computing

Improvements in city infrastructure, traffic and safety management would also require enhanced design and functionality of vehicles. Therefore, in the past years the concept of Vehicular Ad-Hoc Network (VANET) has gained attention. VANET is a set of moving vehicles in a wireless network that apply the Information and Communication Technology (ICT) to provide an advanced service of traffic management and transportation.¹³

There are a few solutions that have been proposed to tackle the challenges of these networks. Vehicular Cloud Computing (VCC), for instance is one such solution that could have a significant impact on traffic management and road safety by using resources, such as computing, storage and internet for decision making. This solution is an innovative approach that takes advantage of cloud computing to offer the drivers of VANETs in a pay-as-you-go way. VCC aims to minimize traffic as well as accidents travel time, pollution and to ensure energy safety and real time to drivers. Furthermore, VCC provides a technically feasible incorporation with the network for better road safety and secured intelligent urban traffic systems.¹⁴

1. Architecture

The architecture of vehicle cloud computing is based on three levels: in the vehicle, in communication and in the cloud. As shown in Fig. 5, the first layer is the inner layer of the vehicle, which is responsible for monitoring the health and mood of the driver and collecting information in the vehicle, such as pressure and temperature using body sensors, environmental sensors, smartphone sensors, internal vehicle sensors, inertial navigation sensors (INS), and driver behavior to predict the driver's intentions.¹⁵

The information is after that collected through sensors and sent to the cloud for storage or use to software programs in the application layer. Every vehicle has an on-board-unit (OBU) that contains a navigation system integrated with a map. OBUs has also wireless broadband communications to transmit data through 3G or 4G devices, Wi-Fi, WiMAX, wireless access in the vehicle or dedicated short-distance communications.¹⁶

The next layer is the communication layer, which includes the vehicular-to-vehicular (V2V) systems via DSRC Dedicated Short Range Communications, or DSRC. In the case of abnormal behavior on the road, Emergency Warning Messages (EWMs) will be created and forwarded to the cloud storage as well as the vehicles around. The messages will contain all valuable information of "offender", such as the location, speed and moving direction. The second component of the communication layer is vehicle-to-infrastructure (V2I), which enables the exchange of operational data among vehicles, infrastructures and the cloud over wireless networks. The V2I should increase safety level of vehicles on highways and reduce percentage of crashes, for instance.¹⁷

The cloud is the last layer of the VCC architecture, it can calculate massive and complex data in a minimum time. The cloud layer itself consists of three internal layers: application, cloud infrastructure and cloud platform. The application layer considers several applications to which drivers can access remotely, for example fuel feedback, environmental awareness, human activity

¹³ Gu, Lin, Deze Zeng, and Song Guo. "Vehicular Cloud Computing: A Survey." 2013 IEEE Globecom Workshops (GC Wkshps), 2013. doi:10.1109/glocomw.2013.6825021.

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¹⁵ Chung, Tein-Yaw, Yung-Mu Chen, and Chih-Hung Hsu. "Adaptive Momentum-Based Motion Detection Approach and Its Application on Handoff in Wireless Networks." *Sensors* 9, no. 7 (2009): 5715-739. doi:10.3390/s09075715.

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¹⁷ Bordley L, Cherry CR, Stephens D, Zimmer R, Petrolino J. Commercial Motor Vehicle Wireless Roadside Inspection Pilot Test, Part B: Stakeholder Perceptions. Transportation Research Board 91st Annual Meeting 2012.

¹¹ I. Foster et al., "Cloud Computing and Grid Computing 360-Degree Compared," Proc. Grid Computing Environments Workshop, IEEE Press, 2008, pp. 1–10.

¹² Yu, Xi, Fuquan Sun, and Xu Cheng. "Intelligent Urban Traffic Management System Based on Cloud Computing and Internet of Things." 2012 International Conference on Computer Science and Service System, 2012. doi:10.1109/csss.2012.539.

detection, etc. Furthermore, the cloud infrastructure has two components: cloud storage and cloud computation. The data gathered by the inside-vehicle layer will be stored in the geographic information system (GIS), a road traffic control device or a storage system based on the type of applications. The computation part is used to calculate the computational tasks which provides faster performance. Lastly, the sensors, for example, the health recognition sensors will send data to the driver behavior database in the cloud storage.

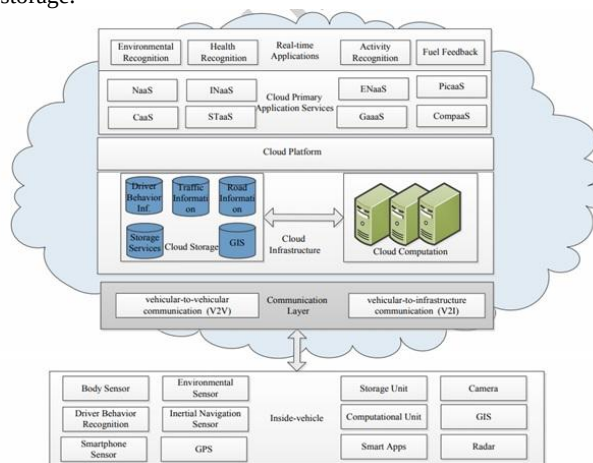


Fig. 5 Architecture of Vehicular Cloud Computing (Lin, Zeng, Guo, 2013)

Vehicular cloud can be deployed by a static infrastructure that is able to provide support and management of various events. In urban areas, such infrastructure contains cameras, traffic lights and utility or street-light poles. In this way, big data is helping for example Tel Aviv to improve and streamline its traffic through sensors, cameras and third-party applications that allow traffic control and the ability to see what is going on across the city. This gives them power to pinpoint and tackle any issues accordingly. One thing that is being done, for example, is to rearrange traffic lights scheme during a traffic jam and in this way to break up the congestion and potential accidents.

Tel Aviv has in general the potential to become a great example for road traffic and infrastructure efficiency. According to the design consultancy Moment, sensors could be placed to form an accessible transit system for those who cannot drive—children, the disabled, and the elderly people. To address coming needs, these sensors would be embedded into the infrastructure of the public transportation and would enable all parties in the public traffic to keep track of any dependents as they use public transit. Once a dependent party uses a public transport and has a device which sends signals to the sensors in the bus, train, or cab and vice versa, the caregiver would be able to know where they are in their journey.¹⁸

V. Challenges of Cloud Computing in Smart Cities

There are some notable challenges associated with cloud computing which might have a significant impact over the implementation of smart transport and traffic. Some of them may even cause a slowdown when delivering services in the cloud or security breaches which might be essentially harmful in the contest of public services and solution. On the other hand, if resolved in the planning stages, they also represent opportunities and could lead to greater technology advancements.¹⁹ Hereby, some of the most

important challenges towards smart city infrastructure will be mentioned:

1. **Security and Privacy** — these are two of the most mentioned issues surrounding cloud computing. The concern is related to storing a well-secured data and monitoring the use of the cloud by the service providers. Breach in security will lead to a slowdown in the deployment of cloud services.

Issues of such kind could be addressed, for example, by storing the information internal to the organization, but allowing it to be used in the cloud. For this to occur, though, the security mechanisms between organization and the cloud need to be strong.

2. **Lack of Standards** — cloud interfaces are well documented, however, no standards are associated with them, so it is unlikely cloud technologies to be compatible to each other. The Open Grid Forum is developing an Open Cloud Computing Interface to resolve this issue and the Open Cloud Consortium is working on cloud computing standards and practices. The findings of these groups will continue to develop over time, but it is unknown whether they will address the needs of the people deploying the services. However, keeping up to date with the latest standards as they evolve will be a step forward in solving the issue.

3. **Continuously Evolving** — user requirements are continuously evolving, as are the requirements for interfaces, networking and storage. This means that a “cloud,” especially a public one, does not remain static and is also continuously evolving.

4. **Compliance Concerns** — the Sarbanes-Oxley Act (SOX) in the US and Data Protection directives in the EU are just two examples of compliance issues affecting cloud computing, based on the type of data and application for which the cloud is being used. The EU has strict laws for data protection across all its members, but in the US data protection is different and can vary from state to state. One possible solution to this challenge is a Hybrid cloud deployment with one cloud storing the data internal to the organization.

VI. Conclusion

In the recent years, society is starting to understand the impact and significance of using data collected for our advantage. Emergent technologies in both big data and cloud storage have the potential to open possibilities in terms of what cities can do for their citizens.

Local authorities have long been aware of the need for integrated land-use transport models to make accurate estimates of travel and transportation demand and to reduce issue such as high traffic, pollution and healthcare problems. With cloud technologies they finally have the tools and the solutions needed to start planning and executing plans for making urban transportation more efficient. This process will involve all participants in the transportation system. Cars, buses, trucks, lights, sensors, infrastructure and even people will be interconnected to form the traffic management system of the future. Everything will be able to send and receive data and this communication will lead to a better transportation, infrastructure and a city. All of these would be possible only with the use of Cloud computing technologies, thus its importance will increase in the years to come.

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BY MANAGING THE REQUIREMENTS AND INTERNAL STANDARDS OF RENOWNED CUSTOMERS TO BETTER BUSINESS RESULTS IN THE MOTORCYCLE INDUSTRY

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Abstract: The effectiveness of the organization depends largely on the ability of managers, employee involvement in clear strategic orientations and its integrated culture. A successful management system of the organization is no longer dependent just on a process approach and continuous improvement. Increasingly, risk and opportunity management is at the forefront, taking into account the requirements of the business environment, particularly the requirements of the largest buyers of the company's products. It is very important for the organization to incorporate risk management into its operations, not only to reduce the negative consequences but also to increase its business opportunities. The paper presents the company's cooperation with one of the largest motorcycle manufacturers in the world - BMW Group, which took place while the company was introducing a new steel frame for the BMW F 800 S motorcycle in global markets. Due to the right approach including a positive risk, compliance with the requirements of the SPQM (Supplied Part of Quality Management) and last but not least our ardent desire to cooperate with BMW, the company has been given the opportunity to become the supplier of complex components for BMW and other large manufacturers in this industry.

Keywords: NOMINATION, FUNCTIONAL PROTOTYPE, SPQM, PFMEA

1. Introduction

The organizations that use their quality management systems to good advantage have a head start over others in the phase of the introduction of new standards, and later the certification and internal and external evaluation processes. Continuous changes require adjustments and new ways of designing and developing products and services. Therefore, the design and development of products and services are of vital importance to each organization as the very existence of the company depends on how successful they are.

In September 2015, the fifth edition of the ISO 9001: 2015 Quality Management System was published, giving a new strategic orientation to the standard by taking into account the fact that more and more quality management systems are used together and integrated with the business processes of the organization, that priority is given to the effectiveness and the results of the management system and that the requirements of the system need to be adapted to current and future business circumstances and requirements. Increasingly, risk management and opportunities are at the forefront, taking into account the requirements of all stakeholders. The quality management system should become a tool for the realization of strategic decisions and the fulfillment of the mission of the organization¹. Among the seven principles of quality management, there is no longer an explicitly stated systemic approach that is covered by the process approach, and the principle of a mutually beneficial supplier relationship has spread to all stakeholders.

A brief summary of the principle of planning and improving could be that preventive measures are no longer there because organizations have to assess and manage risks. Organizations must prevent key risks or at least reduce unwanted impacts in order to ensure that the quality management system achieves the expected results and actualizes the identified opportunities for improvement. The chapter explicitly sets out requirements for quality objectives and planning for achieving them. In addition, organizations are expected to plan and manage change. The principle of improvement deals with inconsistencies, corrective actions and improvements, but no longer speaks of preventive measures, which are now covered by requirements in the planning chapter (risk management). When measuring, the identified risks and opportunities must be taken into account.

Entrepreneurial action is full of uncertainty, which can be the result of changes in the business environment, possible changes in

the company, the perception of opportunities, or the lack of information. Therefore, the goal is to identify the potential effects of the uncertainties and take appropriate action. Contrary to crisis management or problem management, risk management is characterized by a distinct focus on the future. With persistent measures, effective and efficient risk management will contribute to the prevention of crises and problems in line with the motto: "Good managers manage risk, poor managers manage problems."

The paper presents a practical example of opportunity search and project uncertainty in the nomination phase and industrialization of the complex product for BMW.

2. Requirements of the customer BMW

The cooperation between a prominent motorcycle factory, Slovenian company Tomos, and the world-renowned motorcycle manufacturer BMW date back to the late 1990s.

The value of the successful supplier increased when BMW entrusted Tomos the task to enter the competition with other companies in the segment of complex welded components. Project team was entrusted with the management of the project named BMW K71 with a large format drawing containing dimensional and technological requirements. The product is the rear frame of the motorcycle BMW F 800 S/ST made from steel structure, as indicated in the figure 1.

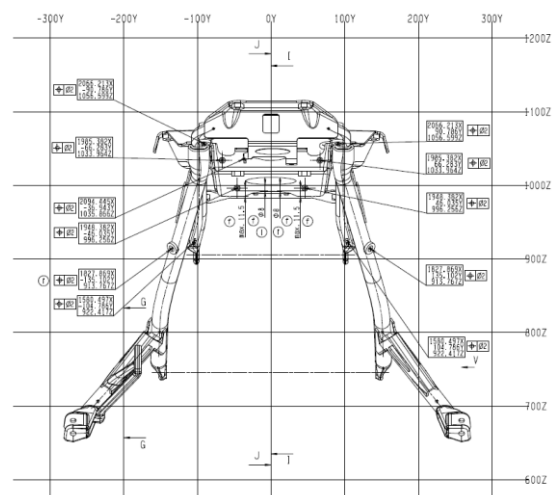


Fig. 1 Drawing of rear frame BMW F 800 S/ST.

With competitiveness in the manufacturing and supply of welded components for BMW, Tomos gained advantage over other companies, which enabled the growth of the company and its new owner Hidria, not only in the segment of welded components but also in the segment of smaller aluminium castings.

With good present cooperation, we entered the nomination process with the rest of other major companies whose aim was similar to ours: to become manufacturers and suppliers of the complex welded product. The deadline for making the calculation was predetermined by BMW. BMW's development department in Munich acceded to our request and soon we acquired a 3D model of the product, made in the program Catia 4.0.

The product was disassembled to single elements and the indicative value for each of them was determined. The calculations of technological processes of welding, painting, inspection and delivery were followed by the final price and its entry into the BMW system. Our manufacturing costs turned out to be interesting to BMW auditors and we came to a shortlist of suppliers.

The project team was given a month to prepare for the visit and assessment by BMW, in the areas of development, industrialization, quality and logistics. Assessment is carried out using SPQM system Supplied Parts Quality Management.

2.1 From the prototype through the challenging SPQM assessment to the winning of the nomination

The BMW engineering and production of quality parts after calculation process, starts with the nomination of suppliers. During the selection process, we must prove that we meet the demanding requirements of BMW Group. The BMW Group Purchasing Division is responsible for the satisfactory completion of all supplier selection and contracting activities. Purchasing is supported by the engineering, parts quality and logistics departments. Supplier selection is performed in different project phases, depending on the type of suppliers and the responsibilities they take.

The relationship between BMW and suppliers is based on partnership and trust. In the supplier selection process, potential BMW suppliers successfully convince our teams that their concepts will meet the requirements in terms of specifications, innovations, quality, and cost. Having signed a contract as a supplier to BMW Group, suppliers together with BMW engineers share responsibility for achieving challenging goals.

SPQM is predestined to develop the questionnaire. At the end of each question assessors appropriately labeled the adequacy of the response to the "traffic lights". Figure 2 shows the initial preparatory form SPQM for carrying out quality management assessment in the field of development, supply, logistics and product quality.

BMW Group Qualitätsmanagement Kaufteile		SPQM Massnahmen pro Umfang				Name: Hans-Jürgen Dülkewitz Datum: 28.08.2004 Postleitzahl: U1-T-13 Telefon: +49-30-3059-2359	
Projekt		K-T1		SE	31.12.2005		Status
Verantwortlicher		Guido Hofbauer - U1-M-1				Freigegeben	
Umfang	Lieferant: 101822-10	Verantwortlicher:	Wolfgang Rentschler - U1-M-2	Modul: 84	NAEL	Risiko: hoch	FIBNRID: 2091021490
Interaktionsplan	Tomos	Verantwortlicher:	Bernhard Kötter - U1-E0-3				
		Hans-Jürgen Dülkewitz - U1-T-13					
		Robert Tappener - U1-T-3488					

Fig. 2 SPQM questionnaire, free form BMW2.

We received the SPQM questionnaire at the same time as other nomination candidates. The group had a month to prepare for the external evaluation of BMW experts according to the SPQM questionnaire. Each individual area of audit consists of a large number of questions, which enable the auditors to provide the criteria for the selection of the best among all candidates at the end of the audit. While waiting for the arrival of the auditors from the company BMW, the project team decided to manufacture the first

prototype of the 3D model, which we had received from the R&D department in Munich.

We decided to take a risk and while preparing for the assessment SPQM, we invested additional effort into the production of the first prototype. We were well aware of the complexity of all the areas of the audit, and the advantages of our business functions as well as our weaknesses. Having enough experts as well as knowledge in the field of rapid prototype technology, we recognized the production of the first prototypes as one of our advantages. Looking back on the then quick decisions, and on today's cooperation with BMW, we can conclude that we acted well.

In its first phase, the future plan included the purchase of the material, all the tubes and sheets of suitable dimensions, and also the material on the basis of the drawing of the frame. Simultaneously with the acquisition of all the materials, from which we had to manually manufacture the individual frame components, we focused on components manufacturing via prototyping technologies.

According to the technologies of rapid prototyping known and available at that time in Slovenia, we decided on the technology of laser sintering, DMLS – direct metal laser sintering, to manufacture both pedals and the exhaust bracket. The device for direct metal sintering of metal powders was owned by the company RTCZ Izlake, which agreed to manufacture all three components. The device enabled a good shape accuracy and mechanical property of the sintered products, which were later welded together. And what was then the most important; we received all three parts three days after sending 3D models to the company RTCZ. The remaining four, production components – pressed parts – were manufactured on a lathe and a milling machine in the tool workshop in Tomos.

A lot of knowledge and experience were invested in the manufacturing of the complex metal sheet components. There are many ways to manufacture a product by reading a drawing. However, due to the time limit, we decided to develop all sheet metal components in 2D shape using the program Catia. This was followed by the cutting of sheet metal with a water-jet technology, which, unlike the technology of laser cutting, maintained the cutting edge without excessive heat load and consolidation of the material. Consolidation of the material could later in the prototype workshop complicate the process of bending and adjusting the products to the requirements of the steel frame drawing.

We managed to purchase and manufacture all the subassemblies needed to build the frame in time. In the prototype workshop a colleague manually shaped all prepared sheet metal parts and other profiles into elements according to the accompanying drawings. Figure 3 shows the process of manufacturing the element, support steel sheet from 3D model to 2D cutting, welding and shaping into the required structure.



Fig. 3 Process of prototyping the complex element.

This was followed by the required phase of adjustment and welding of all components to get the final product. The frame was welded manually using MIG procedure, with 3.5 m of welded joining parts between all the elements. Prototype required a lot of knowledge in the different welding processes between the different materials that we use. Construction of such prototypes is a unique process. Masters of producing such prototypes need a lot of experience, ingenuity and knowledge of modern technologies.

Figure 4 shows the first prototype, successfully and timely implementable with the project team.



Fig. 4 First prototype BMW K71 rear frame.

The first prototype was manufactured in good time just before the arrival of BMW's external auditors. BMW's external auditors' assessment lasted for three days. The supplier selection process aims at appointing the best available suppliers in the world, in terms of product quality, lifetime costs, product innovation, project management and delivery process capability and supply performance. Figure 5 shows the completed SPQM form by the BMW auditors with the decisions shown in the right-hand traffic light of each individual condition of the audit.

BMW Group				SPQM				Name: Stefan Ganten			
Quality management				Variable report				Date: 28.11.2005			
Project:				K71				Posteingang: U1-T-64			
Responsible:				Reno Regen - U1-T-55				Phone: +49-30-3195-2010			
Volume:				module: 84				Project:			
Material:				Material: null				Status:			
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3. FMEA analysis

After the functional prototypes were successfully manufactured, the planning and design of individual processes followed, including the acquisition of materials and sub-assemblies, the complex industrialization of the product, and the shipment of the product to Berlin, where the BMW motorcycle is installed.

The planning and management of implementation processes included the planning of the realization, capacities, resources and materials, and the associated integration of external suppliers and partners. The quality manager at Tomos understood the importance of planning the operation and risk analysis and was well aware and capable of managing the opportunities for creating a product value through the FMEA quality system.

The FMEA Failure Mode and Effects Analysis system, or the analysis of methods of cancellation and consequences, enables the use of specific process methods for managing processes of creating a process network.

Process Failure Mode and Effects Analysis (PFMEA) looks at each process step to identify risks and possible errors from many different sources. The sources most often considered are people, methods, material, machinery, measurement, and environment. All the steps in risk assessment and business impact analysis using the PFMEA method are shown in Figure 8 below.

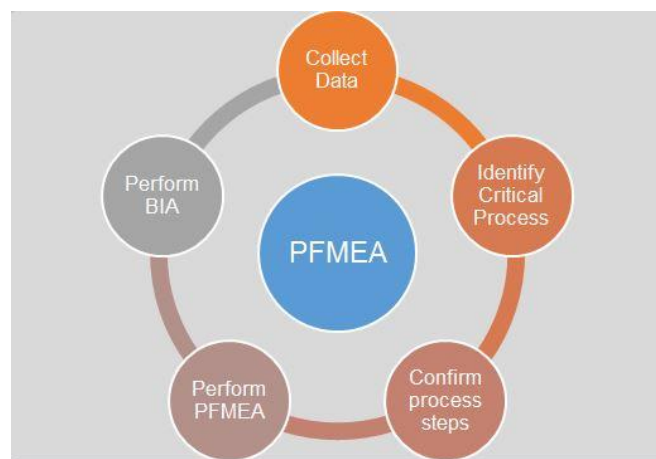


Fig. 8 Steps to conduct Risk assessment and Business Impact Analysis³.

A number of people participated in the PFMEA process, including the coordinator of FMEA - the director of quality, the project leader, the sheet metal processing technologist, the welding and surface protection with varnishing technologist, the quality assurance technologist, the purchasing and logistics technologists and the production manager. When manufacturing the BMW frame, the working group identified possible causes of a possible defect and the corresponding sequence of errors (what could happen?).

Figure 9 shows the form into which we entered identified and collectively received information about the process of manufacturing the BMW frame. For each function, we determined the possible method of failure, the potential consequences of errors, and the probability of detecting the cause of errors.

TOMOS		PROCESS FMEA										Last/First		Datum: 2017-07-07 10:00			
Change	Item	Item Name	Item Description	Item Category	Item Status	Item Priority	Item Risk	Item Impact	Item Action	Item Date	Item Status	Item Priority	Item Risk	Item Impact	Item Action	Item Date	Item Status
1	Change	Item 1	Item 1 Description	Item 1 Category	Item 1 Status	Item 1 Priority	Item 1 Risk	Item 1 Impact	Item 1 Action	Item 1 Date	Item 1 Status	Item 1 Priority	Item 1 Risk	Item 1 Impact	Item 1 Action	Item 1 Date	Item 1 Status
2	Change	Item 2	Item 2 Description	Item 2 Category	Item 2 Status	Item 2 Priority	Item 2 Risk	Item 2 Impact	Item 2 Action	Item 2 Date	Item 2 Status	Item 2 Priority	Item 2 Risk	Item 2 Impact	Item 2 Action	Item 2 Date	Item 2 Status
3	Change	Item 3	Item 3 Description	Item 3 Category	Item 3 Status	Item 3 Priority	Item 3 Risk	Item 3 Impact	Item 3 Action	Item 3 Date	Item 3 Status	Item 3 Priority	Item 3 Risk	Item 3 Impact	Item 3 Action	Item 3 Date	Item 3 Status
4	Change	Item 4	Item 4 Description	Item 4 Category	Item 4 Status	Item 4 Priority	Item 4 Risk	Item 4 Impact	Item 4 Action	Item 4 Date	Item 4 Status	Item 4 Priority	Item 4 Risk	Item 4 Impact	Item 4 Action	Item 4 Date	Item 4 Status
5	Change	Item 5	Item 5 Description	Item 5 Category	Item 5 Status	Item 5 Priority	Item 5 Risk	Item 5 Impact	Item 5 Action	Item 5 Date	Item 5 Status	Item 5 Priority	Item 5 Risk	Item 5 Impact	Item 5 Action	Item 5 Date	Item 5 Status
6	Change	Item 6	Item 6 Description	Item 6 Category	Item 6 Status	Item 6 Priority	Item 6 Risk	Item 6 Impact	Item 6 Action	Item 6 Date	Item 6 Status	Item 6 Priority	Item 6 Risk	Item 6 Impact	Item 6 Action	Item 6 Date	Item 6 Status
7	Change	Item 7	Item 7 Description	Item 7 Category	Item 7 Status	Item 7 Priority	Item 7 Risk	Item 7 Impact	Item 7 Action	Item 7 Date	Item 7 Status	Item 7 Priority	Item 7 Risk	Item 7 Impact	Item 7 Action	Item 7 Date	Item 7 Status
8	Change	Item 8	Item 8 Description	Item 8 Category	Item 8 Status	Item 8 Priority	Item 8 Risk	Item 8 Impact	Item 8 Action	Item 8 Date	Item 8 Status	Item 8 Priority	Item 8 Risk	Item 8 Impact	Item 8 Action	Item 8 Date	Item 8 Status
9	Change	Item 9	Item 9 Description	Item 9 Category	Item 9 Status	Item 9 Priority	Item 9 Risk	Item 9 Impact	Item 9 Action	Item 9 Date	Item 9 Status	Item 9 Priority	Item 9 Risk	Item 9 Impact	Item 9 Action	Item 9 Date	Item 9 Status
10	Change	Item 10	Item 10 Description	Item 10 Category	Item 10 Status	Item 10 Priority	Item 10 Risk	Item 10 Impact	Item 10 Action	Item 10 Date	Item 10 Status	Item 10 Priority	Item 10 Risk	Item 10 Impact	Item 10 Action	Item 10 Date	Item 10 Status
11	Change	Item 11	Item 11 Description	Item 11 Category	Item 11 Status	Item 11 Priority	Item 11 Risk	Item 11 Impact	Item 11 Action	Item 11 Date	Item 11 Status	Item 11 Priority	Item 11 Risk	Item 11 Impact	Item 11 Action	Item 11 Date	Item 11 Status
12	Change	Item 12	Item 12 Description	Item 12 Category	Item 12 Status	Item 12 Priority	Item 12 Risk	Item 12 Impact	Item 12 Action	Item 12 Date	Item 12 Status	Item 12 Priority	Item 12 Risk	Item 12 Impact	Item 12 Action	Item 12 Date	Item 12 Status
13	Change	Item 13	Item 13 Description	Item 13 Category	Item 13 Status	Item 13 Priority	Item 13 Risk	Item 13 Impact	Item 13 Action	Item 13 Date	Item 13 Status	Item 13 Priority	Item 13 Risk	Item 13 Impact	Item 13 Action	Item 13 Date	Item 13 Status
14	Change	Item 14	Item 14 Description	Item 14 Category	Item 14 Status	Item 14 Priority	Item 14 Risk	Item 14 Impact	Item 14 Action	Item 14 Date	Item 14 Status	Item 14 Priority	Item 14 Risk	Item 14 Impact	Item 14 Action	Item 14 Date	Item 14 Status
15	Change	Item 15	Item 15 Description	Item 15 Category	Item 15 Status	Item 15 Priority	Item 15 Risk	Item 15 Impact	Item 15 Action	Item 15 Date	Item 15 Status	Item 15 Priority	Item 15 Risk	Item 15 Impact	Item 15 Action	Item 15 Date	Item 15 Status
16	Change	Item 16	Item 16 Description	Item 16 Category	Item 16 Status	Item 16 Priority	Item 16 Risk	Item 16 Impact	Item 16 Action	Item 16 Date	Item 16 Status	Item 16 Priority	Item 16 Risk	Item 16 Impact	Item 16 Action	Item 16 Date	Item 16 Status
17	Change	Item 17	Item 17 Description	Item 17 Category	Item 17 Status	Item 17 Priority	Item 17 Risk	Item 17 Impact	Item 17 Action	Item 17 Date	Item 17 Status	Item 17 Priority	Item 17 Risk	Item 17 Impact	Item 17 Action	Item 17 Date	Item 17 Status
18	Change	Item 18	Item 18 Description	Item 18 Category	Item 18 Status	Item 18 Priority	Item 18 Risk	Item 18 Impact	Item 18 Action	Item 18 Date	Item 18 Status	Item 18 Priority	Item 18 Risk	Item 18 Impact	Item 18 Action	Item 18 Date	Item 18 Status
19	Change	Item 19	Item 19 Description	Item 19 Category	Item 19 Status	Item 19 Priority	Item 19 Risk	Item 19 Impact	Item 19 Action	Item 19 Date	Item 19 Status	Item 19 Priority	Item 19 Risk	Item 19 Impact	Item 19 Action	Item 19 Date	Item 19 Status
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21	Change	Item 21	Item 21 Description	Item 21 Category	Item 21 Status	Item 21 Priority	Item 21 Risk	Item 21 Impact	Item 21 Action	Item 21 Date	Item 21 Status	Item 21 Priority	Item 21 Risk	Item 21 Impact	Item 21 Action	Item 21 Date	Item 21 Status
22	Change	Item 22	Item 22 Description	Item 22 Category	Item 22 Status	Item 22 Priority	Item 22 Risk	Item 22 Impact	Item 22 Action	Item 22 Date	Item 22 Status	Item 22 Priority	Item 22 Risk	Item 22 Impact	Item 22 Action	Item 22 Date	Item 22 Status
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Fig. 9 PFMEA obrazec, Tomos, 2004.

PFMEA is a methodical approach used for identifying risks on process changes. The Process FMEA initially identifies process functions, failure modes their effects on the process. If there are design inputs, or special characteristics, the effect on end user is also included. The severity ranking or danger of the effect is determined for each effect of failure. Then, causes and their mechanisms of the failure mode are identified. The assumption that the design is adequate keeps the focus on the process⁴.

A high probability of a cause drives actions to prevent or reduce the impact of the cause on the failure mode. The detection ranking determines the ability of specific tests to confirm the failure mode / causes are eliminated. The PFMEA also tracks improvements through Risk Priority Number (RPN) reductions. By comparing the before and after RPN, a history of improvement and risk mitigation can be chronicled.

Risk is the substitute for failure on new processes. It is a good practice to identify risks for each process step as early as possible. The main goal is to identify risk prior to tooling acquisition. Mitigation of the identified risk prior to first article or Production Part Approval Process (PPAP) will validate the expectation of superior process performance. Risks are identified on new technology and processes, which if left unattended, could result in failure.

4. Conclusions

People who work in organizations, in the private or public sector, must be aware of the quality policies and their own contribution to effectiveness, including better quality of implementation. The introduction of a quality management system is, of course, the strategic decision of each organization. In order to achieve high customer satisfaction, customer expectations must first be met even when they are not precisely defined, presumed or binding. The challenge is to recognize these requirements, as the expectations of customers change over time. Requirements are today becoming defined expectations. By this, in addition to clearly defined requirements and the application of standards, undefined and unspoken expectations are also referred to. This change of perspective is interpreted by successful organizations as a trend, a direction of development, and a larger focus on customers.

A few years before the new ISO 9001: 2015 standard was issued, our project team was already well aware of the fact that risk and uncertainty can only be the result of perceiving the opportunity. At that time, we managed to obtain the nomination for the manufacture of a complex BMW product because of our desire, ingenuity and knowledge that was then more competitive than that of the others. The product – the first prototype – made with different technologies of rapid prototyping was presented to a group of BMW auditors. The effort we had invested into creating the prototype and the successful completion of the assessment SPQM and PFMEA brought us BMW's assurance and official nomination for the serial production of the steel frames BMW F 800 S and BMW F 800 ST. The nomination for the manufacturing of this complex product still guarantees the company the serial production of complex steel components and welded components made from aluminium alloys not only for BMW but also for other well-known motorcycle manufacturers.

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INFLUENCE OF THE WORKING ENVIRONMENT ON SAFETY AND HEALTH PROTECTION AT WORK AND PERFORMANCE OF THE EMPLOYEES IN AN OFFICE SPACE

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Abstract: Currently, most employers ignore the fact that colors affect the behavior and thinking of employees in the work process. Workers are austere, colors, and they are places where employees only routinely perform tasks. In such an environment, employees can not feel good, do the best they can and work safely. It is important for employers to realize that by creating suitable working conditions they will help their employees to better manage their job tasks. Their performance will improve, they will work safely and significantly help in the development of society. The article deals with experiments that deal with the performance of test people who perform specific activities with different color backgrounds. This section evaluates the measured values and determines which colors affect the lowest performance, which colors are disturbing and cause many mistakes, human workplace problems, which can lead to arguments or even aggression. But also which colors can help achieve the highest efficiency that positively affect staff performance, support thinking and develop creativity, improve relationships and create a comfortable atmosphere.

Keywords: SAFETY, PERFORMANCE, INFLUENCE OF THE COLOURS, WORKPLACE

1. Introduction

Workplace injury and illness account for a substantial source of sickness and disability burden in working-age populations. (Lay, 2010). People spend a significant part of a day at the working place and for delivering the best possible performance it is necessary to feel nice, to be all right, not to be distracted, not to feel disturbed or negative. It is colours that have the essential influence on all of these factors. It matters in what kind of environment the employee Works (Gilks, 2010). Studies and different surveys and researches proved that not all colours are suitable for each kind of work. If the employees should perform their best, it is necessary to adjust their working environment, including choosing the most suitable colour combination. The article deals with an experiment which looks at performance of the tested people doing particular activities with an influence of different colour backgrounds. This part evaluates the measured values and defines which colours influence the lowest performance, which colours are disturbing and cause making a lot of mistakes, interpersonal problems at the working place, which can result in arguments or even aggression. But also, which colours can help reach the highest effectivity, which positively influence the performance of the employees, support thinking and develop creativity, improve the relationships and create a pleasant atmosphere.

2. Working environment

Working space and its surroundings influence potential or current employees. It influences the performance to a great degree, number of mistakes made, it reduces or minimalizes extreme workload, exhaustion, illnesses and work injuries. Design, structure, suitable ergonomic conditions, safety management and health protection system are listed among the most important factors that make the company development possible. Management trends highlight international standards, such as quality management system, safety and health protection or environment protection (Hrehová, 2011). Space, where machinery, devices, different tools, objects designed for performing the tasks of employees are placed, is called a work space. It can be a space where production or administrative activities are performed. Employees are integrated into a particular working environment on basis of their abilities and skills. It comprises of different factors of social, material and general conditions for work activities (Pikala, 1976). One of the key factors when choosing a job is the working environment. Its positive or negative factors influence the behaviour, mood but most of all, people's health and work. (Oravec, 2007). That is why it is extremely essential that the employers design and create a suitable atmosphere and space for work for all

subordinates in their company and also aim at suitable physical, organisational, hygienic, aesthetic, socio-psychological conditions and also safety and health protection conditions (Hrehová, 2011).

Working environment influences people by its factors:

- physical: microclimatic conditions, radiation, air temperature, relative humidity, ventilation, lighting, noise, vibration, colour design of the environment,
- chemical: cigarette smoke, formaldehyds, volatile substances, biocides and other gaseous matters,
- biological: insects, viruses, bacteria, fungi, biological allergens etc.
- socio-psychological: motivation to work, kind of work, way of work organisation, relationships at work, communication (Hrehová, 2011).

Eventhough people feel and evaluate well-being in a complex way, they use individual senses so specifically that we can distinguish different kinds of well-being:

- sound (acoustic) – set limits for noise expositions for particular activities are not exceeded,
- optical – includes the illumination of the surface, quality of illumination (blinding glare, stability, regularity), phototropic influences (encouragement or attenuation), artistic aesthetic feeling, especially that of colour design,
- thermal – influenced by heating and ventilation, air-conditioning and air humidity,
- clean air – elimination of intensive odours, smells, dust, pathogenic germs, cigarette smoke, sweat,
- psychological – dependant on factors: physical health, physical or intellectual performance and social relationships (Hrehová, 2011).

When choosing a colour, it is necessary to take into account especially sex and age of the workers, temperature of the environment, possibilities of lighting, whether it is artificial lighting or natural light, the size of working zones as well as the kind of work in question (Hrehová, 2011).

Meanings of choosing a colour:

Functional meaning – this means using colours for fast orientation of an employee in the working space and for reliable handling of the necessary operations. It also contributes to creation of working atmosphere needed for performing the work.

Safety meaning – in the area of safety and health protection it is applied in form of colour markings, where blue colour means an order, yellow signals warning, red represents prohibition or danger and green colour marks escape ways.

Aesthetic meaning – colour desing of the working space contributes to creating working comfort for the employees.

Economic meaning – productivity is increased and number of injuries decreased. Some surveys show performance increase of 25 %. Sometimes, even higher numbers are listed. The fact is, that this influence exists and demonstartes itself (Berry, 1998) .

3. Legal framework of the European Union related to factors at work

Given safety regulations, rules and principles must be followed during working activites, occupations or jobs. What results from the legal regulations is (see Table 1), that one of the basic obligations of the employers is to protect and maintain good health condition of their employees, make prevention measurements regularly, so that there are no accidents at work and health deterioration and job-related illnesses do not occur. All working individuals have a right to know all the risks which can endanger them during performing of their work and must attend the necessary trainings.

Table 1: Regal regulations of the EU related to factors at work

Directive EÚ
89/391/EHS
European framework directive about implementation of measurements to support the improvement of safety and health protection of the employees at work. The aim of the dierctive is to set an equal level of safety and health protection for all employees. It guarantees the minimal requirements for safety and health protection in the whole Europe (Council Directive, 89/391/EEC).
2003/10/ES
Directive about minimal health and safety requirements regarding the risks resulting from exposing employees to physical influences (noise). The aim is to decrease the risks resulting from exposition of employees to noise (Directive, 2003/10/EC).

4. Theory of colours

The word colour has many definitions. From the physical point of view, colour is a visible area of the electromagnetic radiation with wavelenghts of 380 – 730 nm, see picture no. 2. If a ray of particular wavelenght falls onto the eye, it causes a stimulus in it on basis of which a perception of colour is created in brain (Kvasňovský, 2010).

Cells in retina are receptors of light which change light signal into perception in neurons and are called rod cells and cone cells. Rod cells are responsible for perception of light and cone cells for distinguishing of colours (Woodson, 1992).

Blue, green and red are the primary, or basic colours. Some authors list yellow to the primary colours as well. If we mix two primary colours, we get a secondary colour. Tercial colour is created by mixing primary and secondary colours. It is suitable to combine all primary, secondary and tercial colours with neutral colours like white, black, grey and beige (www.suvke.sk).

Color scale divides colours to:

- warm colours, which are in the right half of the colour circle,
- cold colours, which are in the left half of the circle, (see Fig. 1).



Fig 1: Colour circle (www.suvke.sk)

Warm colours in the right half are suitable for smaller spaces, they will make them look bigger and give them more light. They create a pleasant and optimum atmosphere for higher work performance of the employees.

Cold colours in the left half of the circle are suitable for large areas which we do not need to make optically bigger. They support positive thinking and creativity of the employees. They will stimulate a sense of authority, seriousness, intelligence and development of the company, organisation or firm (www.suvke.sk).

Colour models

Colour model describes primary colours and schemes of mixing these colours to the final colour. Colour in the nature is a mixture of light of different wavelenghts and various colour models try to imitate the colour in the best possible way. We use models that are a suitable compromise between accuracy of the colour image and complexity of the particular model (Kvasňovský, 2010).

RGB colour model

It is a model in which each colour is created with a proportion of red (R), green (G) and blue (B) colour. These colours are primary for RGB model. Colours are mixed additively in this model. By adding a particular element a lighter colour is created. If all of them are added, white colour comes out. A combination of green and blue makes turquoise (cyan – C), red and blue make purple (magenta – M). And last but not least, if green and red are mixed yellow comes out (yellow – Y). This means that by combination of the basic colours of RGB additive mixing, basic colours for opposite subtractational mixing CMY are created, see Fig. 2. RGB model is used for televisions, monitors and screens. The screen of the televisions comprises of densely squashed red, green and blue points (www.suvke.sk).

Table 2: Colours

Red	Green	Blue
R	G	B

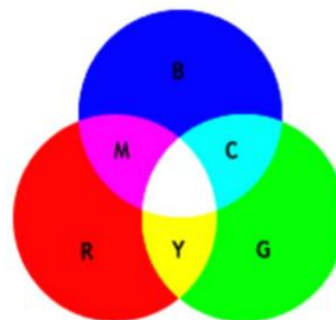


Fig 2: GB model (www.suvke.sk)

CMY/CMYK Colour model

With this colour model, each colour can be created by a proportion of turquoise (cyan – C), pink (magenta – M), yellow (yellow - Y). These colours are the basis for CMYK model. The colours come from reflected light and are mixed subtractively. By adding a particular element, we get a darker colour. If all are added, black comes out. This kind of mixing is used in painting. It is suitable to use this model for printing purposes but from practical reasons it is necessary to include black colour (black - K), that is CMYK (Kvasňovský, 2010).

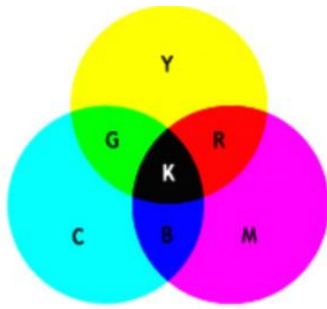


Fig 3: CMYK model (www.suvke.sk)

5. Material and methods

Many studies dealt and deal with a question of how colours affect the working environment.

A study of how a colour can have a positive effect on someone's psychic, which is not that known, is called "pink prison experiment" and is from the late seventies of the 20th century. According to the study, the prisoners in Seattle and Washington were placed in bright pink cells where they showed less aggressive behaviour and characteristics. This result was accepted and quickly spread to many prisons in the USA and Canada. But when the same experiment was repeated several years later by a researcher from Canadian university, it did not have the same result. The new conclusion was that the change of colour generates less aggressive effects (www.informedesing.org).

Nancy Kwallek, a researcher from Texas University tested the influence of colours on the productivity of employees. A chosen group of people was to solve a given task in three different rooms which were painted with different colours. The first room was painted white, second red and third was cyan. The tested employees were divided into two groups on basis of the results of the experiment. The first group comprised of so called high-screener, which means highly resistant employees and the second group comprised of so called low-screener, employees of low resistance. Colour did not have influence on the first group. The second group was significantly affected by colours. The first group, the high-screener, did not have any problem with dealing with the task in the red room. The second group was disturbed by the red colour. Both groups made the biggest number of errors in the white room. Best results were reached in the cyan room by both groups (www.informedesing.org).

The newest studies by Konica Minolta proved that blue colour can partially negatively influence the mood.

Table 3: Influence of colours research (Hrehová, 2011)

Colour	Positives	Negatives
Blue	Positive mood of the employees working in the blue environment was 72% lower to those of different colour.	Employees had a negative perception of their work and leisure time proportion (64%).
Yellow	85% of the interviewed listed that they feel more energy and can focus on work better. Psychological well-being of employees working in yellow environment was 72% higher.	No significantly negative effects of this colour were proved.
Red	Employees felt more motivated by their colleagues (58%), managers (43%) and feedback (30%). It is suitable for team work.	Some listed that they felt irritated in a red office.
Grey	It is an ideal choice for a administrative or office environment.	A majority of respondents (52%) had a lower performance. It is boring and inexpressive.
Black	Perception of motivation in a form of financial reward and professional growth was 40% higher.	It gives an impression of a meeting room and respondents felt strict and relentless.

6. Aims, construction and preparation of an experiment

The aim of the experiment is to find out how certain chosen colours affect the person's performance during their working activity.

A group of chosen individuals was asked to reach the highest possible score while playing an online game. Before starting the game, a respondent looks at a chosen colour for a period of 60 seconds. After this period is over, the game starts. During playing the game, the participant observes the chosen colour.

A group of 20 participants was chosen for the experiment. It is a group of homogenous age (20-25 year-olds). Each person was informed in detail about the course of the experiment.

The experiment took place in a room where all participants had equal conditions for making the experiment.

The temperature in the room was 22°C. They also had adequate lighting. Each participant was wearing a so called eliminator on their eyes, through which they could only see the monitor.

In the beginning of the article, the characteristics of particular colours are described. As red, green, blue, white, orange/yellow and black colour have significant characteristics, they are the subject of the experiment.

Schematic representation of the experiment

The picture (see Fig. 4) shows the preparation, implementation and evaluation of the experiment.

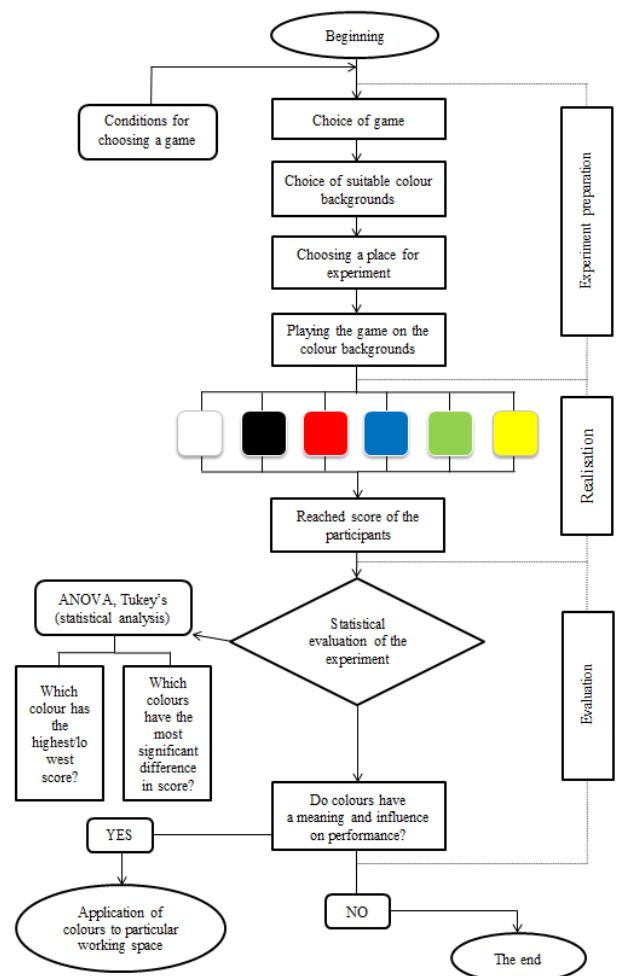


Fig 4: Schematic Picture of the experiment

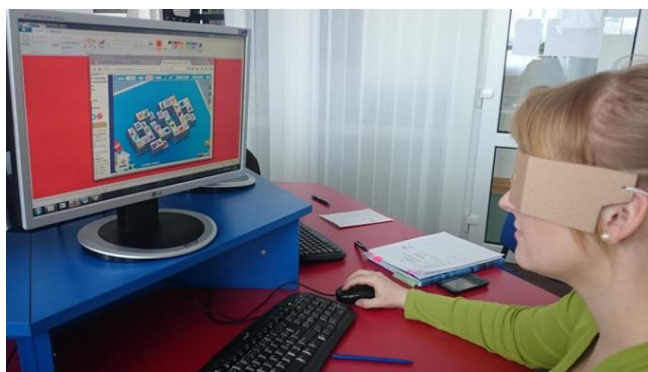


Fig 5: Red background

Reached score with particular colour backgrounds

In table 4, a reached score of twenty students is listed. They played the chosen game with a white, red, blue, green and yellow background.

Table 4: Reached score

	White	Black	Red	Blue	Green	Yellow
Student 1	5478	4698	5420	6544	8136	5661
Student 2	7742	6159	7218	7053	6494	7461
Student 3	4638	4197	4655	6281	6935	6523
Student 4	3490	5233	5786	6454	6935	6523
Student 5	3404	4616	5588	6245	6428	5624
Student 6	4661	4788	4472	5928	6294	6792
Student 7	4830	7646	7626	6878	7010	7491
Student 8	5014	5285	6537	5844	6603	7276
Student 9	4386	4880	6344	6829	6669	5935
Student 10	3792	4096	6274	6340	7823	6065
Student 11	4383	4753	5429	7262	4131	6894
Student 12	4180	4845	6882	4817	6391	7217
Student 13	7754	6920	6754	6876	7702	6868
Student 14	5622	6473	6595	5885	6083	6908
Student 15	5292	6692	5779	8455	7470	7553
Student 16	3686	5644	6190	6676	6039	6376
Student 17	5715	5375	5782	5428	6872	5356
Student 18	7777	5445	6213	8016	6990	6360
Student 19	4787	4657	4277	5623	6034	5992
Student 20	6758	5651	6601	7566	6228	7802

7. Analysis and experiment evaluation

Risks are omnipresent in most human activities. Risk analysis helps to establish the level of risk of a given situation, and to determine if the risk is acceptable, tolerable or unacceptable. (Tchiehe, 2017). After realisation of the experiment and collection of data and reached scores of the tested students, an evaluation follows. A right choice of suitable analysis is important for evaluating of the measured figures. It is also necessary to set hypothesis which will be tested by a suitable analysis. Statistical analysis will prove or deny whether there are differences in the reached score among the various colour backgrounds. If it is proved, then it will be necessary to find out which colours have the biggest difference. By proving the differences among the reached scores with individual colour backgrounds, we can assume that colours can influence performance of employees at work.

Method ANOVA was chosen for evaluation of the experiment. All statistical counting were realised in Excel 2007 - Microsoft Office.

We call method ANOVA an analysis of dispersion. It looks at relation between interval variable Y (reached score) and one or more nominal variables X, these are factors (individual colour backgrounds). (Knežo, 2011). It is necessary to find out whether the reached scores of tested persons (Y) is in relation to individual

colour backgrounds (X). The file is divided into groups according to individual factors and it is tested whether the measured differences in score among the colours are only a coincidence or whether they are also statistically relevant. If the average of the groups is significantly different, the factor is statistically significant. That means that the variable X (score) really depends on the factor (colour). If it is proved that average scores among individual colours are significantly different, it is necessary to find out between which colours are the differences the biggest. Post hoc analysis is used for it. There is a wide range of Post hoc tests but in this case, Tukey's test is suitable. The subject-matter of the test is comparison of all possible pairs of colours and substantial differences analysis (Markechová, 2011).

So that we can use the analysis of dispersion, we need to meet the following conditions:

- the measured file must come from normal division (Shapiro-Wilk's test of normality),
- the same measured file must meet the homogeneity of dispersion (Cochran's test)

Proving or denying of conditions needed for fulfilling analysis of dispersion

Shapiro-Wilk's test was used for proving the conditions of normality. For correct condition check, it is necessary to set suitable hypothesis H_0 and H_1 .

Hypothesis statement:

- H_0 : The measured scores of the tested participants come from normal division.
- H_1 : The measured scores of the tested participants do not come from normal division.

In tab. 5 to tab. 10 measured values are compared according to relevant test formula using Excel programme and table critical values at significance level of $\alpha = 0,01$ a $n=20$ (file extent, number of tested participants).

$$W \leq W_{\alpha}(n) \quad (1)$$

where:

W – counted value according to tested characteristics for counting normality

$W_{\alpha}(n)$ - table critical value for Shapiro-Wilk's test of normality

α - the level of significance

n - file extent

Table 5: Normality test for white colour

White background	Shapiro-Wilk's test		Hypothesis H_0 is not valid, if
	Measured value W according to formula (5)	Table critical value $W_{0,01}(20)$	$W \leq W_{0,01}(20)$ (the calculated value is smaller or the same as the table critical value)
	0,893	0,868	The equation not proved, H_0 denied, measured score values with white background come from normal division. Condition fulfilled.

Table 6: Normality test for black colour

Black background	Shapiro-Wilk's test		Hypothesis H_0 is not valid, if
	Measured value W according to formula (5)	Table critical value $W_{0,01}(20)$	$W \leq W_{0,01}(20)$ (the calculated value is smaller or the same as the table critical value)
	0,928	0,868	The equation not proved, H_0 denied, measured score values with black background come from normal division. Condition fulfilled.

Table 7: Normality test for red colour

Red background	Shapiro-Wilk's test		Hypothesis H_0 is not valid, if
	Measured value W according to formula (5)	Table critical value $W_{0,01} (20)$	$W \leq W_{0,01} (20)$ (the calculated value is smaller or the same as the table critical value)
	0,967	0,868	The equation not proved, H_0 denied, measured score values with red background come from normal division. Condition fulfilled.

Table 8: Normality test for blue colour

Blue background	Shapiro-Wilk's test		Hypothesis H_0 is not valid, if
	Measured value W according to formula (5)	Table critical value $W_{0,01} (20)$	$W \leq W_{0,01} (20)$ (the calculated value is smaller or the same as the table critical value)
	0,987	0,868	The equation not proved, H_0 denied, measured score values with blue background come from normal division. Condition fulfilled.

Table 9: Normality test for green colour

Green background	Shapiro-Wilk's test		Hypothesis H_0 is not valid, if
	Measured value W according to formula (5)	Table critical value $W_{0,01} (20)$	$W \leq W_{0,01} (20)$ (the calculated value is smaller or the same as the table critical value)
	0,902	0,868	The equation not proved, H_0 denied, measured score values with green background come from normal division. Condition fulfilled.

Table 10: Normality test for yellow colour

Yellow background	Shapiro-Wilk's test		Hypothesis H_0 is not valid, if
	Measured value W according to formula (5)	Table critical value $W_{0,01} (20)$	$W \leq W_{0,01} (20)$ (the calculated value is smaller or the same as the table critical value)
	0,952	0,868	The equation not proved, H_0 denied, measured score values with yellow background come from normal division. Condition fulfilled.

From table 5 – 10, it is clear that the first condition for all measured values of the colour backgrounds was fulfilled.

For proving the homogeneity condition, we used Cochran's test. For correct condition check, it is necessary to set suitable hypothesis H_0 and H_1 .

Hypothesis statement:

- H_0 : The measured scores of the tested participants fulfill the condition of homogeneity.
- H_1 : The measured scores of the tested participants do not fulfill the condition of homogeneity.

$$C \leq c_{\alpha}(k, n - 1) \quad (2)$$

where:

C - value measured according to tested characteristics for counting homogeneity

$c_{\alpha}(k, n-1)$ - table critical value for Cochran's test

α - the level of significance

n - file extent

Table 11: Homogeneity test

Cochran's test		Hypothesis H_0 is not valid, if
Measured value C according to formula (6)	Table critical value $C_{0,01} (6,19)$	$C \leq C_{0,01} (6,19)$ (the calculated value is the greater or the same as the table critical value)
0,33	0,36	The equation not proved, H_0 denied, readings scores in all color requested meets the requirements of homogeneity.

Table 11., proves that the second condition was fulfilled, too. That means it is possible to do analysis of dispersion ANOVA.

Use of ANOVA method

The aim of the method is to prove or deny whether individual colour backgrounds have an effect on the reached score of the tested participants.

Hypothesis statement:

- H_0 : Differences among measured scores among various colours are coincidental (colours do not have an influence on the score).
- H_1 : Differences among measured scores and various colours are statistically significant (colours do have an influence on the score).

$$F > F_{1-\alpha}(k-1, n-k) \quad (3)$$

where

F – measured value according to the tested characteristics

$F > F_{1-\alpha}(k-1, n-k)$ - table critical value for ANOVA

α - the level of significance

n - file extent

k - number of classes

Table 12: Analysis of colour influence

ANOVA		Hypothesis H_0 is not valid, if
Measured value F according to formula (7)	$F_{0,01} (5,14)$	$F \leq F_{0,99} (5,14)$ (the calculated value is the greater as the table critical value)
8,795	3,182	The equation not proved, H_0 denied, readings scores in colored backgrounds they are statistically significant, the colors affect the score obtained by the test subjects.

It is clear from Tab. 12, that statistical analysis proved influence of individual colour backgrounds, which were set during the realisation of the experiment, on the reached score of the students. It is necessary to find out where the difference in colour sticks out the most, that is compare all possible pairs of colours by using Post hoc analysis.

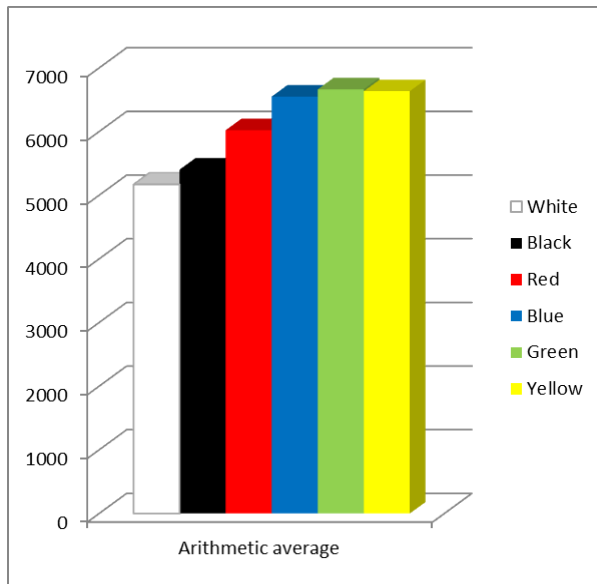


Fig. 6: Graphical Picture of average scores for individual colours

Arithmetic averages of reached scores for colour backgrounds are graphically pictured on Fig. 6. It is clear, that the highest average was reached by playing the game with a green background. It can be a result of the fact that human eye perceives this colour the most. Looking at green colour strengthens thinking which can have a very positive effect on increasing of the employees performance. Yellow colour came second. From theoretical knowledge it is known that it supports creativity, is a source of energy and has a significantly stimulating effect. Blue colour is third. It supports communicative skills and has a calming effect. Green, yellow and blue have the highest score according to the experiment. Based on reached score, red colour follows. In general, it decreases tiredness, increases energy levels, but is a colour with which we need to deal carefully. It can have a positive effect, but also negative or even aggressive one. The lowest score was reached with white and black background. Based on the measurements from the experiment and theoretical knowledge it is possible to propose colour plan for changing colours during the working hours, see chapter 6.3.

Use of Post hoc analysis

A suitable Post hoc analysis for evaluation of the experiment is Tukey's test, which will check the biggest differences in reached scores among the colour backgrounds.

Hypothesis statement:

- H_0 : There is no significant difference in score among individual colours (scores are equal).
- H_1 : There is a significant difference in score among individual colours (scores differ).

$$T > t_y(r, n - r) \quad (4)$$

where:

T – measured value according to tested characteristics

$t_y(r, n - r)$ – table critical value for Tukey's test of multiple comparison

r – number of classes

n – file extent

Post hoc analysis showed the most significant differences of the measured scores for individual colours, see Tab. 13.

The most significant differences in scores are between these pairs of colours:

- white and blue,
- white and yellow,
- white and green,
- black and blue,
- black and green,
- black and yellow.

Conclusion

In relation between colour, performance and safety at the working place, we can define colour as danger. That means its features can potentially cause undesired effect or event in case of wrong choice. Initiator of this event could be stress, tiredness, and unfavourable working conditions, especially insufficient lighting of the working place. If colour design of the working place is wrong and initiators are not avoided, an undesired event can occur. This could result in performance decline, health deterioration of the employee, injury or property damage.

The objective of the experiment is to show that colours have an ability to influence employees when performing their work.

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Table 13: Post hoc analysis check

Tukey's test				
Colour pair compared		Measured value T according to formula (8)	Table critical value $t_{0,99}(6,120-6)$	Hypothesis H_0 is not valid, if $T > t_y(6,120-6)$ Counted value is higher than table critical value
White	Black	1,074	4,87	Not valid, H_0 denied. There is not a significant difference in score between these colours.
White	Red	3,924	4,87	Not valid, H_0 denied. There is not a significant difference in score between these colours.
White	Blue	6,361	4,87	Valid, H_0 denied. There is a significant difference in score between these colours.
White	Yellow	6,493	4,87	Valid, H_0 denied. There is a significant difference in score between these colours.
White	Green	6,773	4,87	Valid, H_0 denied. There is a significant difference in score between these colours.
Black	Red	2,849	4,87	Not valid, H_0 denied. There is not a significant difference in score between these colours.
Black	Blue	5,286	4,87	Valid, H_0 denied. There is a significant difference in score between these colours.
Black	Green	5,698	4,87	Valid, H_0 denied. There is a significant difference in score between these colours.
Black	Yellow	5,419	4,87	Valid, H_0 denied. There is a significant difference in score between these colours.
Blue	Green	0,412	4,87	Not valid, H_0 denied. There is not a significant difference in score between these colours.
Blue	Yellow	0,132	4,87	Not valid, H_0 denied. There is not a significant difference in score between these colours.
Green	Yellow	0,280	4,87	Not valid, H_0 denied. There is not a significant difference in score between these colours.
Red	Blue	2,437	4,87	Not valid, H_0 denied. There is not a significant difference in score between these colours.
Red	Green	2,849	4,87	Not valid, H_0 denied. There is not a significant difference in score between these colours.
Red	Yellow	2,569	4,87	Not valid, H_0 denied. There is not a significant difference in score between these colours.

AN APPLICATION OF A NETWORK SCIENCE TOOL FOR EXAMINING AND ANALYSING THE STRUCTURE AND TOPOLOGICAL PROPERTIES OF PUBLIC-TRANSPORT NETWORKS: A CASE STUDY

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Abstract: More than one century network science (NS) has been extensively used in numerous studies of different research fields, including public transport (PT). This work presents an application of a NS tool enabling to explore complex public-transport networks (PTNs). This tool explores networks for small-world, scale-free and random network characteristics, in a case study to examine and analyze, by using NS concepts, two PT systems - Washington DC's Metro Network (WMN) and Oslo's Metro Network (OMN). The performed analyses focused on the structure and the topological properties of the examined networks. As the networks have longer average path lengths, compared with random networks, and because of not being clustered, these metro networks demonstrated they are not small-world networks. The analyses also show that in contrast to the OMN the WMN has certain characteristics associated with scale-free networks; that is, a small number of highly connected nodes (hubs) and node degree distribution that can be represented by a power-law function. Nevertheless, it still cannot be considered as a pure scale-free network because of its empirical distribution which is better approximated by an exponential rather than a power-law function. The metro WMN cannot be considered a random network because of having hubs. Thus, it is concluded that the examined WMN is an evolving complex network.

Keywords: NETWORK SCIENCE, PUBLIC-TRANSPORT NETWORK, NETWORK TOPOLOGICAL PROPERTIES, NETWORK ANALYSIS, NODE-DEGREE DISTRIBUTION, AVERAGE SHORTEST PATH LENGTH, NETWORK'S EFFICIENCY

1. Introduction

Network science [1] or the science of networks has revealed more opportunities for researchers and scientists who work in different research areas. One of the first attempts for application of network science as a tool is made by Euler [2] in the 18th century in resolving the well-known Koenigsberg seven bridges problem and De Solla Price [3] who pictured the network of scientific papers through linking each published paper to the papers that are directly associated with it. While network science is based on graph theory, it is also comprised of methods and approaches rooted in other research fields. Basically, network science is a result of the convergence of many fields, such as network analysis [4], social network analysis [5,6,7,8] as well as physical [9] and biological sciences [10]. Thus, by providing new tools, mechanisms, and improved methods, NS has enabled exploring, examining, analyzing, modelling and simulating the existing variety of complex networks through evaluating their characteristics and properties in different ways. Recent findings show that NS made it possible to understand complex networks' structure, topological properties and dynamics [11,12]. In this way, by revealing networks' strengths and weaknesses, and thereafter, establishing directions to improving networks' structure, NS has facilitated overcoming problems that have yet to be solved by applying existing methods. Theories related to NS and the findings of complex systems are a good foundation for practical studies of the structure of real-world networks (including PTNs) through an evaluation of topological properties such as average network clustering coefficient (appearing below only as clustering coefficient, CC), average network shortest path length (appearing below as an average path length APL), node degree distribution (NDD) and network efficiency (local and global) in different research fields, including public transport network design and operations [13,14].

2. Prerequisites and means for solving the problem

The limitations of the existing approaches and tools for analyzing real-life complex networks, such as PTNs, place a number of new challenges for researchers and scholars in terms of the data required, methods to be applied, and software to be used. Recently Dimitrov and Ceder [15] developed a method enabling to examine and analyse complex public-transport networks (PTNs) incorporating computer programming, large-scale network- and statistical data analysis techniques. The method was tested on a case study.

The objective of this study, which is practically oriented, was to examine and analyse the structure and topological properties of real-world public-transport networks on a case study by using an existing NS tool which uniquely combines computer programming techniques, implementation of known algorithms, network- and data analysis. A network-science perspective was applied, while seeking to reveal network strengths and weaknesses.

In order to achieve the objective, the following essential tasks have been completed:

- (i) Collecting, processing and analyzing data on a comparative basis of a case study;
- (ii) Examining the structure of the observed PTNs and evaluating their topological properties and characteristics by performing network- and statistical data analysis using the NS tool;
- (iii) Drawing reasonable conclusions and outlining the possibilities for a further research work for improving public-transport networks' operation.

A flow-chart of the tool applied for processing the general transit feed specification (GTFS) [16] data used, the calculations made, further data processing as well as all types of analyses performed, is shown in Fig. 1.

3. Solution of the examined problem

3.2. Data collection and data processing

The objects of examination in this case study were the subway (metro) networks in Washington DC (USA) and Oslo (Norway). The first of the observed public-transport metro networks in Washington DC, WMN, (Figures 2a and 2b) is composed of 91 metro stations serviced by six lines traveling between the terminal stations. The second of the observed metro networks in Oslo, OMN, also known as T-bane or Oslo Tunnelbane (Fig. 3) is composed of 101 metro stations serviced by five lines traveling between the terminal stations. It is interesting to mention that only 17 out of 101 of the stations in the Oslo's metro network are underground or indoors.

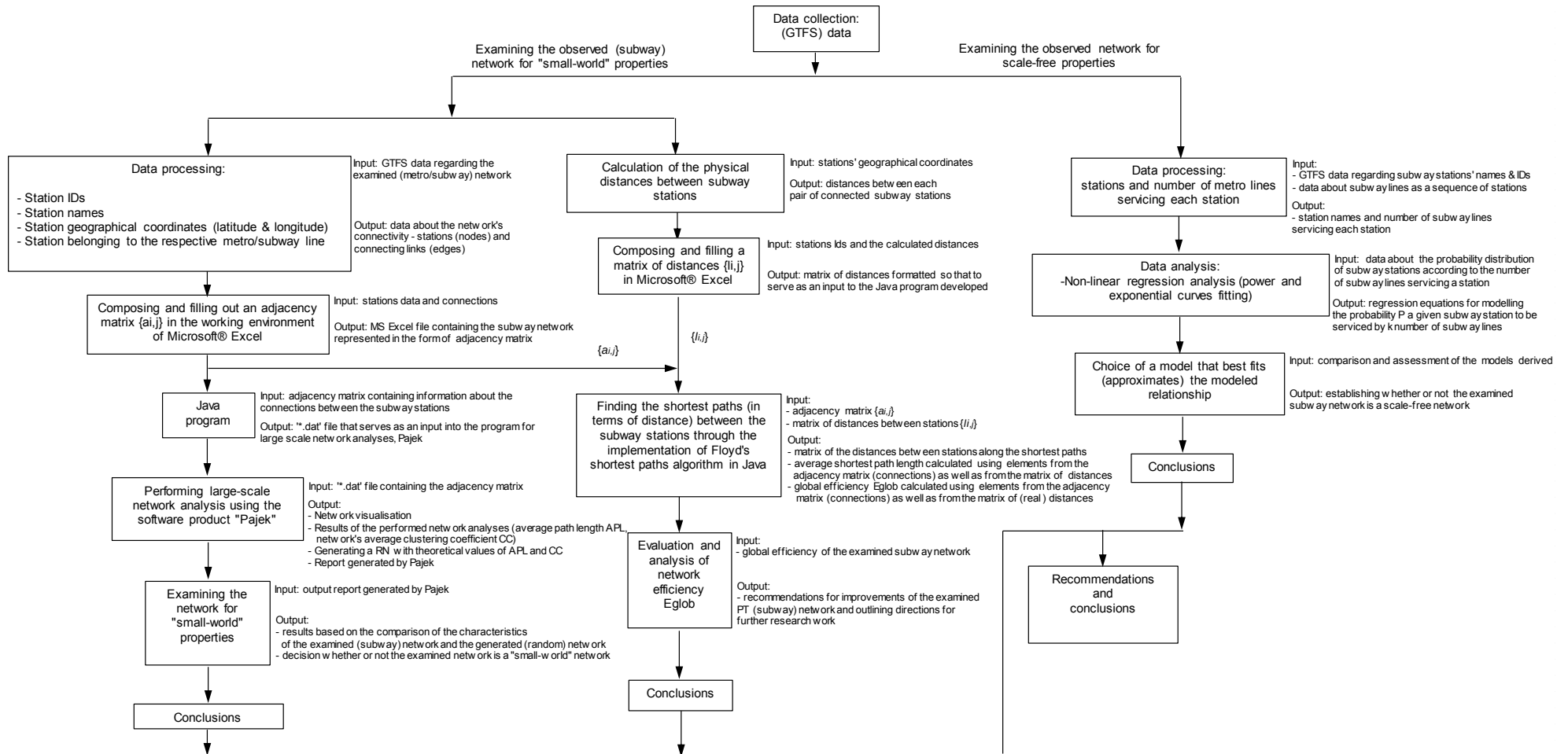


Fig. 1. Flowchart representing the sequence of steps outlining the logic of the proposed tool for examining and analysing PT (subway/metro) networks

3.3. Examining the subway network for small-world properties

Because of differences in data formats and descriptions used by the public transport operators within the GTFS feeds [17], in contrast to Dimitrov and Ceder (2016) who extracted and processed the required GTFS data by means of a Java program, in this work the data feeds in the form of text (*.txt) files. The GTFS data [18,19], provided by the Washington Metropolitan Area Transit Authority as well as by Ruter – the management company that plans, coordinates, orders and markets public transport in Oslo, was directly imported and further processed within the Microsoft Excel® working environment. As a result, useful information regarding the subway stations has been extracted, such as station names, codes (an identifying number), geographical coordinates (latitude and longitude) and the sequence of stations along each of the metro lines in the examined networks. Then, the data about the connections between each pair of stations have been further used to assign values in the Excel adjacency matrix $\{a_{i,j}\}$ showing the connectivity between each two nodes within the network, i.e., between each two subway stations. For example, if station i is directly connected by link (railway section) to station j , then the matrix element $a_{i,j} = 1$, otherwise $a_{i,j} = 0$. As a result, the subway network examined is represented as an undirected, unweighted graph within which each node represents a subway station (in this network the number of stations in both directions is the same and these stations are located opposite one another) and the edges (having length 1) represent the connection between two stations. The presence of a link between two stations means that there is at least one subway line servicing these stations.



Fig. 2a. Washington DC Metro system map, adapted from Washington Metropolitan Area Transit Authority [20]

3.3.1. Evaluation of the average network's shortest path length and the average network's clustering coefficient

The information extracted from GTFS files and saved in a MS Excel file is thereafter imported into a developed Java software program automating and accelerating the processing of the data. Within the Java program, the imported adjacency matrix data is then processed, transformed, and as a result exported and saved into a (*.dat) file that served as an input into the software program for large scale network analyses Pajek [23,7,8] which was used to visualize the network and perform further analyses. By using Pajek, topological properties of the examined network, such as average

path length (APL), clustering coefficient (CC) and average network's node degree (ANND), have been computed. Alternatively, apart from Pajek, the average shortest path length for undirected graphs was calculated within the developed Java software program by using the following formulae [24]:

$$(1) L = \frac{2}{N(N-1)} \cdot \sum_{i=1}^N \sum_{j=i+1}^N d_{i,j},$$

where:

L – APL;

N – number of nodes (stations) in the network;

$d_{i,j}$ – the shortest path (in terms of number of sections) between any two pairs of nodes i and j , and $d_{i,j} = d_{j,i}$.

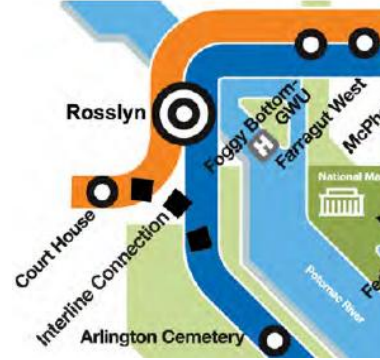


Fig. 2b. Washington DC Metro system map, Planned improvements, adapted from Momentum [21]



Fig. 3. Oslo Metro system map [22]

Formula (1) was incorporated within the Java program not only to calculate the average network shortest path length as a number of consecutive route sections, but also in kilometers by substituting in $d_{i,j}$ the distances between stations along the shortest paths computed through the Java implementation [25] of Floyd's shortest path algorithm [26]. To verify the output results of the software program developed, the value of the APL (in number of sections) calculated with the Java program was compared with the APL computed by using Pajek.

In order to discover whether the examined public-transport metro networks exhibit small-world characteristics, their properties, as shown in Table 1 and Table 2, have been compared to those of random Bernoulli/Poisson [8] networks that were generated with Pajek using the same number of nodes and average network node degree as an input, as did Watts and Strogatz [27].

Table 1. Washington DC's metro network compared with a random network generated using the software product Pajek

Public transport mode	Networks	Network properties				
		Nodes	Edges	ANND	CC	APL
Subway/ Metro	Examined subway/ metro network	91	93	2.044	0.0000	11.51
	Generated random (Bernoulli/Poisson) network		95	2.088	0.0156	5.06

Table 2. Oslo's metro network compared with a random network generated using the software product Pajek

Public transport mode	Networks	Network properties				
		Nodes	Edges	ANND	CC	APL
Subway/ Metro	Examined subway/ metro network	101	101	2.000	0.0000	14.68
	Generated random (Bernoulli/Poisson) network		105	2.079	0.0718	5.80

Based on the comparison made between the empirical (calculated) and the theoretical (generated) values of the topological properties, it can be concluded that examined metro networks (Washington DC's and Oslo's), characterized with average path lengths of 11.51 and 14.68 sections, respectively, which exceed more than twice the APL for the generated random networks, and both having clustering coefficient equal to 0, cannot be considered small-world networks. This is because the derived values differ from what is given as a definition for small world graphs [28]: "A small-world graph is a large- n , sparsely connected, decentralized graph ($n \gg k_{max} \gg 1$) that exhibits a characteristic path length close to that of an equivalent random graph ($L \approx L_{random}$), yet with a clustering coefficient much greater ($C \gg C_{random}$)."

3.3.2. Evaluation of network efficiency

In contrast to Watts and Strogatz [27], examining real life networks by using average path length (as a global property) and clustering coefficient (as a local property), Latora and Marchiori [29] introduced the concept of network efficiency – global and local – in their work, measuring the communication between the nodes within a network. In this way, they examined networks' local and global behavior with local efficiency E_{loc} and global efficiency E_{glob} instead of using CC and APL. In other words, E_{loc} and E_{glob} replace CC and APL. It is known [29] that small-world networks have both high E_{loc} and E_{glob} .

As the efficiency $\varepsilon_{i,j}$ between nodes i and j is inversely proportional to the shortest path $d_{i,j}$ between these two nodes [30]:

$$(2) \quad \varepsilon_{i,j} = \frac{1}{d_{i,j}},$$

the global efficiency E_{glob} was calculated via the following formulae implemented in the Java program developed:

$$(3) \quad E_{glob} = \frac{2}{N \cdot (N-1)} \cdot \sum_{i=1}^N \sum_{j=i+1}^N \varepsilon_{i,j} = \frac{2}{N \cdot (N-1)} \cdot \sum_{i=1}^N \sum_{j=i+1}^N \frac{1}{d_{i,j}},$$

where E_{glob} takes values within the range $0 \leq E_{glob} \leq 1$ [29], i.e., $E_{glob} \in [0; 1]$. Ideally, the global efficiency, considered [30] as the efficiency of the whole network, would have the value of $E_{glob} = 1$, which could be valid in complete graphs in which there is an edge between each pair of nodes connecting them.

The results showing that the global efficiencies for both the metro networks having values $E_{glob} = 0.14$ (Washington DC) and

$E_{glob} = 0.12$ (Oslo) means that these networks have only 14% and 12% of the efficiency of the ideal one ($E_{glob} = 1$), the latter having a direct line from each station to the others. The obtained low values are an indication of poor global efficiency of the networks, lacking direct connections between their stations. The low global efficiency values only show that possible network improvements could be achieved in network's topology (and not by the level of service it provides) through the construction of new links (sections), as long as it is proven that the cost incurred for this would be justified.

Since the network analyses, performed with the software program Pajek for the metro networks studied, established that they are not clustered at all ($CC = 0$), the alternative topological property of the clustering coefficient (which is the local network's efficiency E_{loc}) was not evaluated. Again, the value 0 of CC means that there are no metro stations within the networks having neighbouring stations connected to one another. Therefore, it can be concluded that the networks examined are not fault tolerant in the context that each disruption (disconnected stations) would significantly affect the transport service as there are no alternative connections between the stations. This leads to the conclusion that the higher the number of connections in the networks, the greater the fault tolerance of the networks. This can be achieved by increasing connectivity between stations in the network through constructing more sections linking important subway (transfer) stations – hubs.

The Washington Metropolitan Area Transit Authority's (WMATA) strategic plan [21] for 2013-2025 discusses constructing a rail track (section) that would serve as a connection between the Blue and Orange/Silver metro lines (see the Blue line's Arlington Cemetery station and the Silver/Orange Court House station as shown in Fig. 2b), as one of two potential alternatives. This would be a new edge within the existing subway network enabling passengers to make one seat (non-transfer) trips between Dulles Airport, Tysons Corner, Ballston, The Pentagon, National Airport, and the Alexandria metro stations, thus avoiding the need to travel through the core of the network. Both alternatives would result in an increase of train frequency with five more trains per hour, thus leading to an increase in the vehicle carrying capacity provided for up to 4000 passengers per direction per hour. People from WMATA expect the above measures to reduce the average passenger waiting time by an average of three minutes for around 16000 trips.

To explore how the above constructive changes planned for the subway network would affect the APL, CC, and the network's (global) efficiency, the newly created link was added as an edge into the adjacency matrix $\{a_{i,j}\}$, then the approach described in sections 3.3.1 and 3.3.2 was applied. As a result, the following values of the evaluated topological properties of the network examined were identified: APL = 11.32 sections in the proposed network as opposed to 11.51 for the existing network, and clustering coefficients, 0.0252 as opposed to 0, respectively. The network efficiency remains unchanged (0.14). Even after the expected changes, the network is still not a Small-world network (SWN) as it has a clustering coefficient ($CC_{ESP} = 0.0252$) commensurate to that of the Random network (RN) ($CC_{RN} = 0.0156$) and still quite long APL (11.32 sections) compared to that value for RN (5.06 sections). Thus, as expected, the structural change above (only one new link added) does not globally affect network connectivity. The positive effect on the network can be felt locally as the increased value of CC from 0 to 0.0252 means that the network would become more faults tolerant. This means that in an event of a breakdown (a disconnected link in the triangle Arlington Cemetery, Court House and Rosslyn), the network would still be functioning because of the presence of an alternative (a newly constructed) connection.

3.4. Examining the subway network for scale-free properties.

3.4.1. Data analysis

Based on the GTFS data processed regarding the metro stations and the metro lines in the two networks (see Figures 4 and 5) it turned out that the majority of the stations (76 stations) in the first (Washington DC's) network are serviced by only one metro line (48 stations) or two metro lines (28 stations). There are also 13 more stations serviced by three lines. On the other hand, there are only two stations serviced by four and five subway lines, respectively, that can be considered hubs. Thus, the network topology of the metro network examined resembles the topology of scale-free networks in which most of the nodes have a small number of links, with only a small number of nodes (called hubs) having multiple connections [31], which is in contrast with the second examined metro network in Oslo. Similar to the Washington's metro network, the majority of the stations in the Oslo's metro network (89 stations) are also serviced by one metro line (61 stations) or two lines (28 stations). However, Oslo's network does not have small number highly connected stations (hubs). Instead, it is characterized with 3 stations serviced by 3 lines, another 3 stations serviced by 4 lines, and 6 more stations serviced by 6 metro lines. For the sake of clarity, the 5th line of the Oslo's metro network (in green) can be considered as composed of two separated lines as it runs twice through nine stations and follows two separate routes. That is, when a vehicle runs in the direction from Vestli to Sognsvann (see Fig. 3), it can either pass through the station "Ullevål stadion" and continues to station Nydalen (the first route), or continues in the direction station Berg.

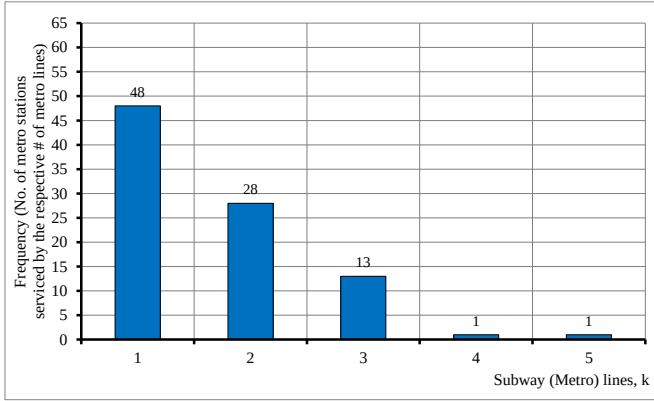


Fig. 4. Distribution of the Washington DC metro stations according to the number of lines k servicing a station

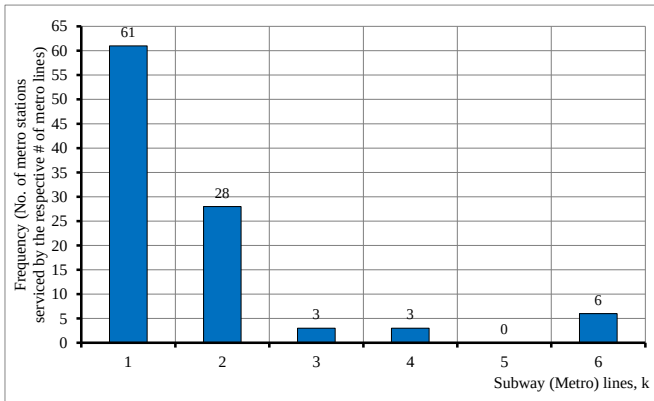


Fig. 5. Distribution of the Oslo's metro stations according to the number of lines k servicing a station

With the intention of confirming or falsifying the above supposition, in order to estimate the probability $P(k)$ with which a randomly selected station is being serviced by k lines, two types of functions – a power-law [32,33] and exponential – were approximated through performing a statistical data analysis [34] as shown in Table 3 (for Washington DC's network) and Table 4 (for Oslo's network) below. It is obvious (from Table 3) that the coefficient A in the power function has value which is close to 1, i.e.: $A = 0.948 \approx 1$. Therefore, it can be accepted that the formula $P(k) \sim k^{-B}$ satisfactorily represents the established statistical relationship between P (the dependent variable) and k (the

independent variable), i.e., $P(k) \sim k^{-2.61}$ in which the scaling factor B falls within the range $2 < B < 3$ [31]. Based on this result, it can be accepted that the network examined exhibits characteristics of scale-free networks. On the other hand, as shown in Table 3, the results of the least squares fitting procedure performed for the empirical values also revealed that the observed nonlinear relationship between P and k is better fitted by means of an exponential ($R^2 = 0.902$) rather than a power-law function ($R^2 = 0.813$). In contrast to the Washington DC's metro network the low R-square value ($R^2 = 0.69$) in Table 4 clearly shows for the Oslo's network that the probability $P(k)$ is not satisfactorily fitted by a power-law function $P(k) \sim k^{-B}$ describing scale-free networks, which means that this network does not exhibit the specific characteristics for scale-free networks. Therefore, it does not appear that the studied metro network of Oslo is a scale-free network.

Table 3. Derived regression equations with their estimated parameters, metro network Washington DC

PT network	Method	Function	Type	Parameter	Value	R-square
Subway lines	Least squares fitting	$P(k) = A \cdot k^{-B}$	Power	A	0.948	0.813
				B	2.610	
		$P(k) = A \cdot e^{-B \cdot k}$	Exponential	A	2.149	0.902
				B	1.100	

Table 4. Derived regression equations with their estimated parameters, metro network in Oslo

PT network	Method	Function	Type	Parameter	Value	R-square
Subway lines	Least squares fitting	$P(k) = A \cdot k^{-B}$	Power	A	0.505	0,69
				B	1.656	

Regardless of the fact that for the Washington DC's metro network examined the presence of a small number of highly connected nodes (considered hubs) was established, and that a power-law function satisfactorily describes the node degree distribution of that network, it still cannot be considered a purely scale-free network. The fact that the examined network is better described by an exponential rather than a power-law function supports this statement. As Barabási and Albert [35] wrote, "a common feature of the ER and WS models is that the probability of finding a highly connected vertex (that is, a large k) decreases exponentially with k ; thus, vertices with large connectivity are practically absent." Accordingly, "such networks are called the exponential networks" [36]. It is known [37] that in RNs, each node has approximately the same number of links, which means that the node degree k_i of each node i is close to the average network's node degree $\langle k \rangle$, i.e. $k_i = \langle k \rangle$. In the case study, the network was presented as of bus-station network which "retains the basic topological features of public transportation networks" [38]. In this network the average node degree having a value of 1.67 lines servicing each node is on the average 2.4 and 3.0 times less than the degree of the two highly connected nodes in the network (serviced by four and five subway lines, respectively). Therefore, due to the presence of hubs, the network also cannot be considered as an entirely random network. According to Albert and Barabási [39] who wrote that "if all processes shaping the topology of a certain network are properly incorporated, the resulting $P(k)$ often has a rather complex form, described by a combination of power laws and exponentials", it can be expected that the network examined should have a complex form, which shows that the PTN examined can be considered a complex network. The latter is not valid for the metro network in Oslo as the $P(k)$ is neither good fitted by an

exponential nor by a power-law function. In accordance with Albert and Barabási who wrote that the “evolving networks can develop both power-law and exponential degree distributions” [39] as the network examined can satisfactorily be described by a power-law as well as by exponential functions, it can be expected for it to be an evolving network.

4. Conclusion

The results of the examination of two real-life metro networks and the analyses performed as part of this case study, by using the proposed network science tool, have led to a few general conclusions that can be summarized as follows:

The network analysis performed in exploring the topological properties of the Washington DC's and the Oslo's metro networks showed that when represented in an L-space network topology [40], the networks examined do not exhibit small-world properties, and hence, they are not small-world networks.

The examination of the Washington DC's metro network and its analyses also showed that the network is neither a scale-free nor random network; this is based on the consideration of network's node degree distribution, the number of the metro lines servicing each station and representing the network as a bus station network. In contrast to the Oslo's metro network, the metro network in Washington appears to be a complex network.

The analysis considering the networks' global efficiency, performed by using network science concepts and findings, showed that both the metro networks examined appear not to be faults tolerant. In case of a railway section's breakdown, this would significantly affect the quality of the transport service provided, because of the lack of alternative connections linking the disconnected metro stations. These results illustrate connectivity weaknesses, thus indicating that there is a room for improving the connectivity between the stations within the networks.

This case study does not only examine real-world metro networks with their topological properties, but also performs network's reconstruction analysis for the Washington DC's network. That is, it considers a hypothetical construction of a section connecting two stations within the Washington DC's network to show that a new link would not sensibly improve the global network's efficiency; this is explicated by measuring the presence of direct connections between the metro stations of the network.

It turned out that both the metro networks examined have low valued global network's efficiencies. This global efficiency does not take into account the routes of the operational metro lines and the passenger trips. Thus, the above statement does not necessarily mean that these networks are inefficient in serving passengers and covering the existing PT demand.

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MODELLING AND SIMULATION OF HIGH-FREQUENCY AUTONOMOUS PUBLIC-TRANSPORT SERVICE

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Abstract: In this paper, a simulation model of the novel concept of autonomous vehicles is developed for public transport (PT) service. The model aims to serve PT planners as a tool enabling the simulation of a metro-like, high-frequency service with punctual autonomous vehicles running on exclusive lanes. The model was applied in a numerical example of a passenger bus, with different scenarios employed. The outcome of the simulation shows that characteristics of the modelled system are reproduced, with the following results: (i) high-frequency, metro-like PT service, with reduced passenger waiting time, (ii) reduced vehicle capacity with reduced average dwell time; (iii) the least number of unserved passengers, across all scenarios, and (iv) better utilisation of vehicle capacity (with fewer unserved passengers) achieved through a small decrease in vehicle frequency, which led to a negligible increase of the average passenger waiting times. In addition, the model allows us to examine the system's behaviour under uncertainty, considering passenger arrivals and vehicle headways as random input variables with predefined probability distributions. The proposed model enables modellers not only to evaluate a system's performance, but also to examine different working conditions and possible future scenarios.

Keywords: PUBLIC TRANSPORT, PUBLIC TRANSPORT LINE, SIMULATION SYSTEM, GPSS, MODEL, SCENARIO, VEHICLE CAPACITY, VEHICLE FREQUENCY, AVERAGE WAITING TIME

1. Introduction

One of the most significant factors influencing people's lives nowadays is time. When doing their daily activities, such as going to work, school, or shopping, people aim to save time, especially when travelling in private cars or on PT. Therefore, in order to make PT more competitive, public operators and authorities should fulfil transport demand [1,2,3] by providing passengers with adequate transport supply [4] and reliable and regular transport service. This can be done either by running large-capacity vehicles along a PT route or small-size vehicles with increased frequency (reduced headways), which reduces the uncertainty and waiting times, thus resulting in PT service with greater punctuality.

A small number of large-size vehicles running with lower frequency is less expensive for the carrier in terms of operating costs but leads to increased waiting times for passengers at PT stops (stations). On the other hand, more frequent public transport service decreases passenger waiting times at PT stations along a route, but requires more vehicles and drivers, thus leading to increased operating costs, including wages to drivers, as well as to increased vehicular traffic and CO₂ emissions.

In some towns around the world [5] PT is offered free to riders along some routes. Therefore, regardless of the kilometers travelled by the vehicles and without taking into account their operating cost and the cost of driver wages, the question that needs to be answered in this case would be: *Which PT control strategy would provide the adequate PT supply (with reduced waiting times at stops) to address the PT demand, by serving as many passengers as possible, regardless of the cost to the operator?* The main priority, therefore, is the level of service and reliability. One of the possible and modern ways to achieve this is to implement a PT service operating autonomous vehicles capable of providing riders with increased reliability and enough flexibility to accommodate the fluctuations of passenger demand along the different routes and throughout the different hours of the day.

1.1. Objective and tasks

The main objective of this study is to improve the reliability of PT service by reducing the average waiting time experienced by passengers. As part of the study, the following tasks were employed: (i) conduct a review of articles discussing simulation systems and tools that could be used to build a model for the problem examined; (ii) develop a simulation model enabling the modelling of passengers' transit process; (iii) apply the model calibrated on a numerical example using different simulation scenarios; (iv) analyse and discuss the simulation output results; and (v) draw reasonable conclusions and outline further research work.

1.2. Scope of work

The scope of work is to accurately model a single line of a PT service and precisely simulate the passengers' transit process. This was attained by examining a variety of simulation modelling systems, simulation programming languages, and simulation tools.

1.3. Significance of work

This work resulted in a flexible simulation model developed that uses the novel concept of autonomous vehicles. This concept was applied to the PT field through a numerical example of an autonomous-bus service. Through the application of the proposed simulation model, which utilises autonomous vehicles that run on isolated (exclusive) lanes, our paper answered the question "*Which operational strategy has the potential to improve the reliability of PT service?*" To do so, we performed simulations under different scenarios and examined the combined impact of parameters such as (i) rate of passenger arrivals at bus stops; (ii) vehicle headway (considered to be a deterministic or random variable); and (iii) vehicle capacity on a) the average waiting time (the most significant measure of transit service reliability) and b) the unserved demand (expressed in terms of the number of passengers who were not transported to their destination point by the end of the simulation). The achieved outcome of the presented example is metro-like, high-frequency (short headways), punctual autonomous buses running on isolated lanes (no intersections, no traffic lights, and no congestion) and arriving at bus stops on time.

2. Simulation Modelling Framework

2.1. Choice of a simulation tool

Of the rich variety of the existing simulation systems, programming languages, products, packages and tools reviewed in [6] and [7] – general-purpose and specialised – the modern and powerful system for discrete-event and continuous simulation GPSS (General Purpose Simulation System) "World" version for Windows (also known as GPSS W [8]) was chosen and used as a modelling tool to create a model of a PT line route. An alternative of the GPSS/H [9] version, GPSS W, falls into the group of simulation systems for modelling discrete systems. In GPSS the simulation model is built by means of consecutively linked (connected) standard blocks in a block diagram (flowchart) showing the logical structure of the modelled system. The dynamic components in the simulation model are represented by transactions. According to the algorithm's logic, these transactions flow in a sequence (sometimes simultaneously) from one block into another. Each block in the

model implements specific functionality such as generating passenger arrivals, simulating queues, servicing facilities (servers), processing times, etc. In addition to the existing functionality, GPSS allows a user, through the built-in programming language (PLUS – Programming Language Under Simulation), to create and execute his/her own (customised) procedures.

In addition to the above, it is worth mentioning that the GPSS World simulation system can be distinguished due to the following advantages:

- the student version of GPSS World is free to use;
- GPSS W has no high system requirements in terms of hardware. The installation file is small in size, which makes it easy and quick to install on the Windows operating system;
- the Graphical User Interface of GPSS is user-friendly;
- GPSS W is accompanied by two manuals, the Reference manual [10] and Tutorial manual [11], which provide readers with solid theoretical knowledge and contain plenty of practically-oriented sample simulation models, which accelerates the learning process and makes the work with the system more effective;
- GPSS W provides users with the possibility to write, save, and keep the program code in files that are easy to read with simple text editors, such as “Notepad”;
- the program code of the model compiles very quickly – it takes only a couple of seconds to compile and execute even complex simulation models;
- as already mentioned, GPSS W is equipped with a built-in programming language (PLUS) allowing users to use functions and probability distributions as well as enable them to create their own customised procedures, thus extending the capability of the systems and making the simulation model that is developed more powerful;
- GPSS W provides graphical tools and reports enabling users to represent the simulation output results and further analyse them;
- GPSS W also enables users to:
 - generate arbitrary sequence of random numbers by means of the built-in random-number generators;
 - perform repetitive realisations (implementations) with the model;
 - check (debug) the program source code for errors;
 - observe the flow of the dynamic components (transactions) from one block to another at run-time (during the simulation) in accordance with program’s logic as well as to perform stepwise simulation in a sequence of steps;
 - automatically build a journal (log file) showing the history of the events;
 - produce detailed reports containing the simulation output results including values of the system’s parameters evaluated during the simulation as well as descriptive statistics and representation of the simulation results in tables;
 - build histograms representing the probability distributions of the random variables modelled.

2.2. Simulation model description

The simulation model developed is composed of the following four segments:

- the “Declaration segment” is used to declare all the constants,

variables, saved (accumulated) values, functions, procedures, queuing systems’ servers capacities, matrices containing in-vehicle travel times, and number of passengers who board/alight buses going through each bus stop;

- the “Passenger arrivals” segment models passenger arrival at each bus stop. This is the segment that models and implements the main logic of the passenger transportation process.

Each of the bus stops along the route has been modelled from two different perspectives: that of passengers and that of vehicles:

- from the passengers’ point of view, the bus stops have been modelled with a queue characterised by an incoming flow of passengers whose inter-arrival times follow a specific probability distribution (Uniform, but Poisson arrivals can also be modelled), which remains unchanged during peak hour. The average time in the queue represents the average time a passenger spends waiting at the bus stop for a vehicle to arrive;
- from the point of view of the vehicles, since in theory more than one vehicle could arrive at the bus stop at a time, bus stops were modelled as multi-server devices capable of “accommodating” a predefined number of vehicles. Since vehicles are not “allowed” to stay outside the bus stop, the “bus bunching” phenomenon and waiting delays in waiting for other buses to leave the stop can be avoided;
- the “Simulation clock” segment controls the duration of the simulation and number of the realisations of the model;
- the “Procedures” segment is where two procedures are called during the simulation when a bus arrives at a bus stop with the purpose:
 - of checking for the maximum possible number of passengers (if there are any at all) who can board the bus depending on the vehicle’s capacity, thus making sure that the bus capacity is utilised as much as possible and ensure that the number of passengers who board the bus does not exceed the available vehicle’s capacity (depending on how many passengers are already on the bus);
 - of checking for the number of passengers getting off the bus at each bus stop, thus making sure that the number of passengers who get off the vehicle does not exceed the number of passengers in the vehicle.

Each vehicle that has a unique number has been modelled as a multi-server queuing system for which the server’s capacity represents the vehicle’s passenger capacity, and the servicing time is the in-vehicle travel time. The interesting factor is that in this case the server (i.e., the bus) is a dynamic element that travels through the route while servicing (transporting) the passengers.

An illustrative scheme of the system modelled is shown in Fig. 1 and a flowchart of the algorithm of the simulation model developed is shown in Fig. 2.

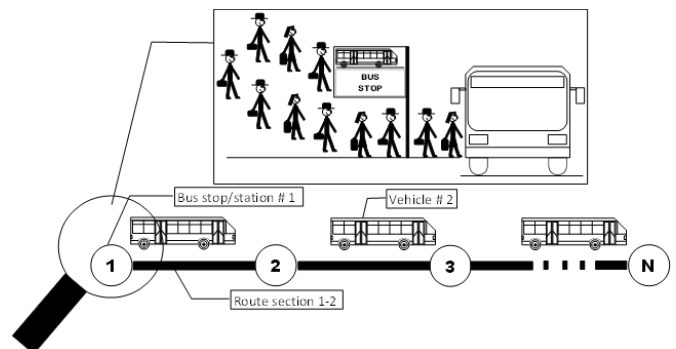


Fig. 1. Illustrative scheme of the simulation model

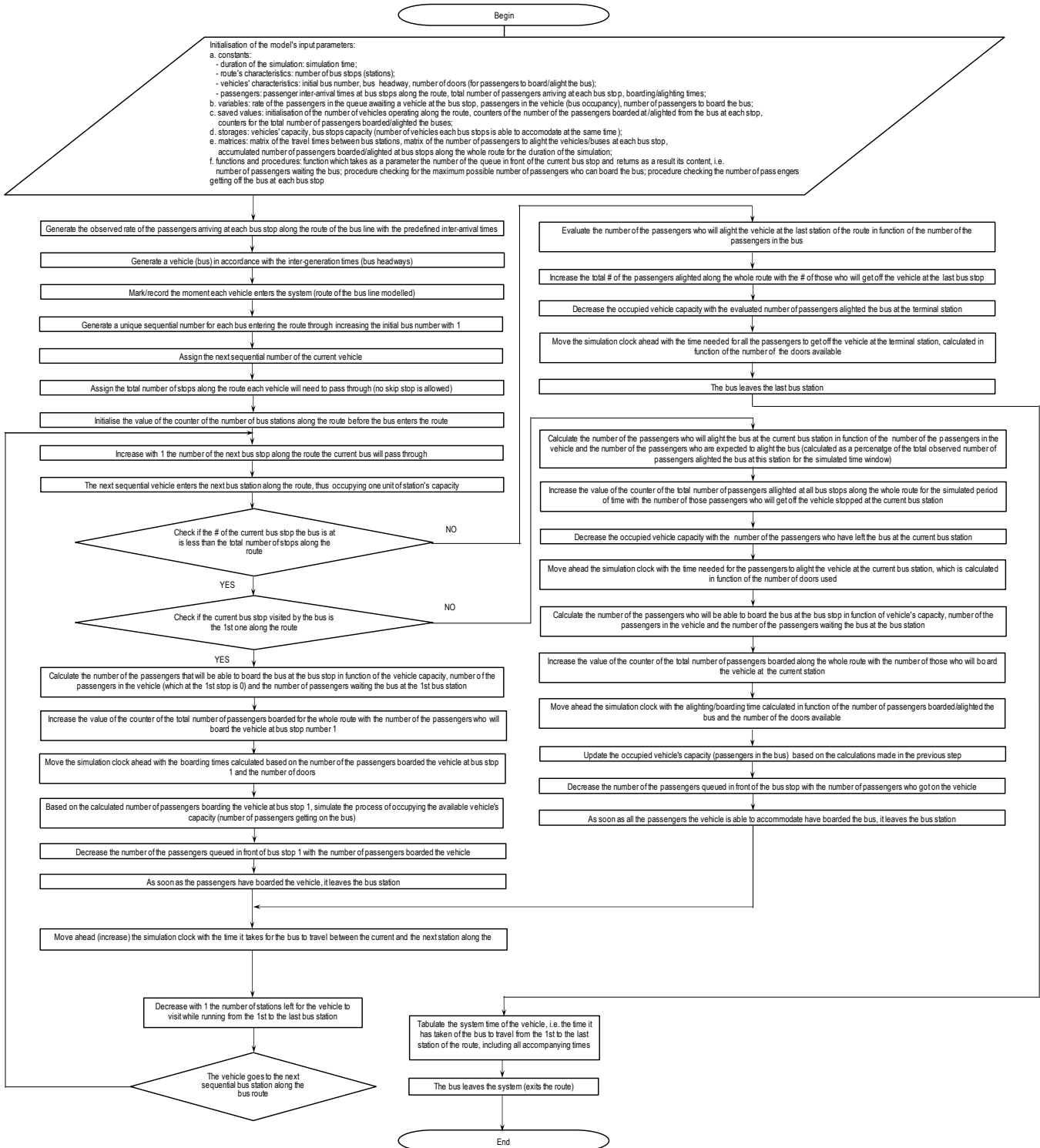


Fig. 2. Flowchart of the modelling algorithm of the simulation model

3. Numerical Example

The simulation model was applied on a numerical example considering a PT (bus) line passing through six bus stops in direction from bus stop 1 to stop 6. The input data used to feed the model was:

- duration of the simulation, seconds;
- number of bus stops;
- in-vehicle travel times between stops calculated for predefined distances (sections lengths) and average travel speed, km/h;
- number of passengers boarding/alighting the vehicle at each stop during the simulated period of time (peak-hour);
- boarding and alighting times per passenger, seconds;
- bus headway, seconds;
- bus capacity, passengers;
- bus stations capacity expressed with the number of buses each stop can accommodate.

The output data comprises:

Stops:

- maximum and average number of passengers who waited for a vehicle at each stop as well as the number of passengers at each bus stop at the end of the simulation;
- total number of passengers who arrived at each bus stop during the simulated window of time according to the demand;
- average passenger waiting time at each bus stop;
- average time spent boarding/alighting the vehicle at each stop along the route.

Vehicles:

- maximum and average number of passengers in each vehicle (vehicle's load) during the simulation as well as utilisation of vehicle capacity;
- rate of unused passenger capacity at the end of the simulation;
- vehicle capacity that is in use at the end of simulation;
- total number of passengers who boarded each vehicle during the simulation;
- total number of passengers who boarded all the vehicles during the simulation (which does not necessarily equal the total number of passengers who arrived at the bus stops);
- total number of passengers who alighted all the vehicles during the simulation;
- total number of passenger who have not been served (transported) by the end of the simulation;
- total in-vehicle travel time along the whole route from bus stop 1 to bus stop 6;
- total dwell time accumulated along the whole route.

3.1. Scenarios

Four main scenarios have been created and implemented with the model to simulate the headway-based PT service provided to passengers:

Scenario 1: This scenario considers the passengers' transportation process along the examined bus route serviced by six buses, each with a capacity of 200 passengers, running with a 10-minute headway (frequency: 6 vehicles per hour).

Scenario 2: This scenario considers the passengers' transportation process along the examined bus route serviced by ten buses, each with a capacity of 120 passengers, running with a 6-minute headway (frequency: 10 vehicles per hour).

Scenario 3: This scenario considers the passengers' transportation process along the examined bus route serviced by twenty buses, each with a capacity of 60 passengers, running with a 3-minute headway (frequency: 20 vehicles per hour).

Scenario 4: This scenario considers the passengers' transportation process along the examined bus route serviced by thirty buses, each with a capacity of 40 passengers, running with a 2-minute headway (frequency: 30 vehicles per hour), thus operating

in a metro-like way corresponding to the “think tram – drive bus” concept [12].

3.2. Input data and assumptions

3.2.1. Assumptions regarding passengers' demand

Passenger arrivals

Uniformly distributed passenger inter-arrivals times at bus stops were modelled. In order to introduce uncertainty, the model proposed allows simulating passenger arrivals according to a predefined probability distribution such as Poisson distribution [13].

Passenger demand

The number of passengers boarding/alighting at each bus stop along the bus line route over the simulated period of time is shown in Table 1.

Table 1. Passenger demand at bus stops (boarding/alighting passengers)

Bus stops	Passengers boarding	Passengers alighting	Sections, i-j	Distance, km	In-vehicle travel time, seconds
1	500	0	-	-	-
2	400	100	1-2	2.0	180
3	300	200	2-3	2.0	180
4	200	300	3-4	2.0	180
5	100	400	4-5	2.0	180
6	0	500	5-6	2.0	180
Total:	1500	1500		10.00	900

Boarding/alighting times

Adebisi in [14] found that although alighting takes less time than boarding, the difference between the two times is less than half a second per passenger.

Assuming that parameters such as travel time, passenger demand, number of transferring passengers, and dwell time are deterministic, in compliance with Dueker et al. [15], Ang and McIvor in [16] set default values for the passenger boarding and alighting times to be equal to 3.5 and 2.2 seconds, respectively.

According to Cats et al. [17] dwell time at the stops along with departure time at origin stations and travel time between stops is one of the sources of uncertainty in public transit operations.

Liu and Ceder in [18] and [19] accepted values of 4.0 seconds and 2.0 seconds, respectively, for the marginal dwell times per each boarding and alighting passenger.

Nesheli and Ceder [20,21] applied models to case studies in which they set values of 2.5 and 1.5 seconds for the boarding and alighting of each passenger.

Tang et al. in [22] set values for boarding and alighting times per passenger to 2 and 1 seconds, respectively.

Taking into account the finding of Adebisi [14] and that the vehicles used in the model proposed in this paper have no steps, values of 2.0 seconds and 1.5 seconds, respectively, were assigned for boarding and alighting the bus.

Dwell time

In some research works dwell time is considered deterministic [18] or fixed [14], while in others it is considered a dependent variable in function of the number of boarding passengers and alighting passengers during different times of the day and along different route types [15].

Dueker et al. in [15] examined and analysed the determinants of dwell time – passenger activity, lift operations as well as low-floor bus, time of day, and route type. In order to evaluate dwell times under different operating conditions Dueker et al. used a model that enabled modeling dwell time at different times of the day, different route types, and various number of passengers boarding and alighting a vehicle.

As Liu and Ceder [18] solved the timetable-planning problem rather than an operations-related one, they considered the dwell time as deterministic, and not time-varying within the planning period.

Liu et al. in [23] concluded that “bus dwell time contributes to travel time and headway variation”.

As defined in the Highway Capacity Manual cited by Dueker et al. in [15], dwell time is “the time in seconds that a transit vehicle is stopped for the purpose of serving passengers. It includes the total passenger service time plus the time needed to open and close doors”, and therefore it is not constant. It depends on the number of passengers boarding/alighting and the time it takes for each passenger to get on/off the vehicle. Therefore, in contrast to some models in which the dwell time is constant, in the model proposed in this paper it is in function of the number of passengers wanting to board/alight the vehicle, i.e., the larger the number of the passengers alighting/boarding the vehicle, the larger the dwell time, which sometimes forces vehicles to stay at the bus stops longer than in the models with a deterministic dwell time, thereby making the model more realistic.

3.2.2. Operational characteristics

PT line and route characteristics

The PT route servicing the modelled bus line has total length of 10 km. There are six stops in total along the route – two terminal stations and four intermediate bus stops. The route sections connecting the stops along the route are each 2 km long.

Vehicles

Depending on the scenarios played (Table 2), the values for the frequency of the vehicles [1,2] and bus headway varies from 6, 10, 20, and 30 vehicles (buses) going one after another with headways of 10, 6, 3, and 2 minutes, respectively. For the purposes of the simulation, buses with total capacity of 200, 120, 60, and 40 passengers (including seats and standing room) were considered for scenarios 1-4. The buses running along the route while servicing the bus line, depending on the vehicle’s capacity, are equipped with 4, 3, and 2 doors for scenarios 1, 2, and 3-4, respectively. The accepted discipline of servicing passengers is such that they can board the vehicle through all the doors available including the front, intermediate (if any), and rear doors.

Operating speed [3] and sections travel times

The in-vehicle travel times along the sections between the bus stops is calculated for a distance between the bus stops equal to 2.0 km and bus operating speed 40 km/h.

Based on the above, the main assumptions that have been made can be summarised as follows:

- vehicle headway is deterministic, i.e., it does not reflect any possible deviations due to traffic congestion (although the model enables modelling it as a random variable);
- passenger arrivals at bus stops are uniformly distributed throughout the modelled period of time;
- at bus stops passengers get on the first arriving vehicle. If the arriving vehicle is full, then passengers get on the next vehicle (which results in increased waiting time);
- a bus does not leave the bus station before all the passengers have boarded as long as the available vehicle capacity allows this to happen;
- since buses run along a lane considered isolated (separated) from the other vehicular traffic, there is no traffic congestion and traffic signals incurring delays;
- since buses go one after another according to the sequence by which they have entered the system (route), keeping a distance (one headway), one bus cannot bypass another.

A comparison of the observed (actual) and the simulated (reproduced) number of passengers who alighted the vehicles at each stop along the route of the examined bus line is shown in Fig. 3.

The simulated average waiting times were compared with those that were analytically calculated by the formula:

$$(1) \quad AWT = (AWT_{max} - AWT_{min})/2 = H/2, \text{ seconds,}$$

where:

H – vehicle (bus) headway, i.e., the time interval between two vehicles going along the route [1];

AWT_{min} – the minimum time (in seconds) passengers wait the vehicle at the bus stop, which is $AWT_{min} = 0$ seconds when a passenger comes at the time when bus arrives;

AWT_{max} – the maximum time (in seconds) passengers spend waiting when they arrive at the stop at the moment the bus departs the stop. In that case, passengers need to wait for the next bus, which arrives after time equal to H .

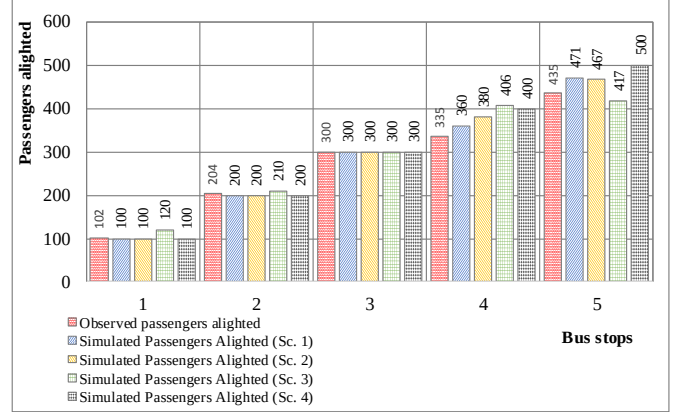


Fig. 3. Total observed vs. simulated number of passengers who alighted at each bus stop (in scenarios 1-4)

The simulated average waiting times at each bus stop, excluding stop 6, which is the last for the route, for each of the above four scenarios are shown in Fig. 4 below.

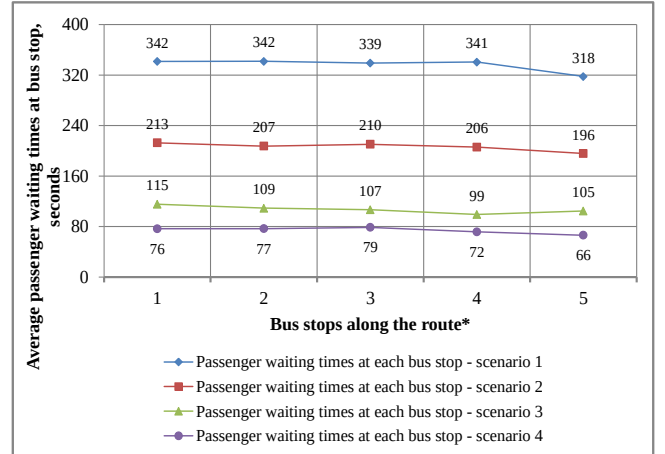


Fig. 4. Average passenger waiting times at the bus stops along the route *Bus stop number 6 is not displayed in the chart as it is the last stop for the route, and there are no passengers waiting there to board the vehicle.

Let us, for example, consider scenario 1 in which the bus headway is 600 seconds (10 minutes). Theoretically the minimum time each passenger will wait for a bus at the bus stop is $AWT_{min} = 0$ seconds and the maximum is $AWT_{max} = 600$ seconds; on average a passenger waits 300 seconds, i.e.:

$AWT = (600 - 0)/2 = 300$ seconds, which is almost equal to the average waiting time of 339 seconds evaluated as a result of the simulations performed as a weighted average of the passenger waiting times at the bus stops along the route. For scenarios 2-4, the analytical average waiting times have values:

$AWT = 180$ seconds for scenario 2, 90 seconds for scenario 3, and 60 seconds for scenario 4.

The above formula (1) does not take into account:

- any possible deviations due to bus delays or early arrivals;
- the time passengers spend due to a missed bus, i.e., if they have waited AWT_{max} for the bus, and after the bus has arrived if they did not board because the vehicle was full.

The average dwell time (ADT) shown in table 2 below accumulated along the whole route was calculated as a difference

between the average total travel time (ATTT) from the first to the last bus stop and the total in-vehicle travel time (TIVTT).

As can be seen in table 2, the comparison between the simulated weighted average waiting times and those times calculated via

formula (1) shows that the model satisfactorily reproduces the waiting times at all bus stops along the route.

Table 2. Scenarios played (Direction: From bus stop 1 to bus stop 6)

Scenario	Vehicle frequency, buses per hour	Bus headway, seconds	Vehicle capacity, number of passengers ¹	Number of doors	Average total travel time along the whole route (ATTT), seconds	Standard deviation of ATTT, seconds	Total In-vehicle travel time along the whole route (TIVTT), seconds	Estimated average dwell time (ADT) accumulated along the whole route, seconds	Simulated weighted average passengers waiting time at each bus stop ² , seconds	Analytically calculated average passengers waiting time at each bus stop, seconds	Number unserved passengers along the route ³
1	6	600	200	4	1070	5.9	900	170	339	300	112
2	10	360	120	3	1035	4.9	900	135	209	180	63
3	20	180	60	2	1001	3.7	900	101	109	90	51
4	30	120	40	2	968	3.8	900	68	76	60	46

¹ Includes the total passenger seats and the total number of standees

² Weighted average passenger waiting time calculated as a weighted sum of the simulated average waiting times at bus stops multiplied by the number of the passengers waiting these times

³ Number of unserved passengers calculated as a difference between the total simulated passengers who boarded and alighted the bus

Below are charts showing the relationship of the simulated average waiting time in function of vehicle frequency (Fig. 5) and the dwell time in function of bus capacity (Fig. 6) for scenarios 1-4.

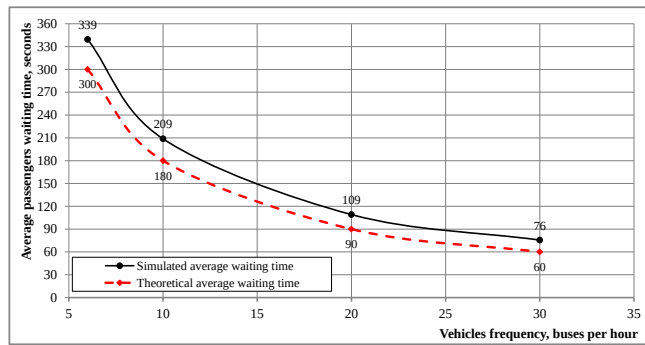


Fig. 5. Relationship between simulated average waiting time and vehicles' frequency

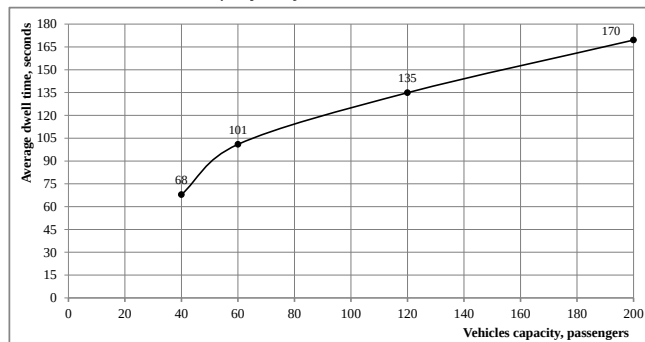


Fig. 6. Relationship between dwell time and vehicles' passenger capacity

Based on the results above, it can be concluded that variant 4 (with high-frequency, small-size vehicles) would not only provide PT users with decreased average waiting times due to the small bus headways, but also with reduced total travel times along the route due to the operation of small-capacity vehicles spending less dwell times at bus stops. Moreover, as can be seen in Fig. 7, in contrast to the three other scenarios, the highly frequent small-vehicle service (scenario 4) results in the lowest number of unserved passengers (those who have not alighted and are still traveling in the vehicles at the end of the simulation) (46 passengers), followed by scenario 3

with 51 passengers, and scenarios 2 and 1 with 63 and 112 passengers, respectively. In other words, compared to the scenario 1, in scenario 4 the number of the unserved passengers is more than 2 times less.

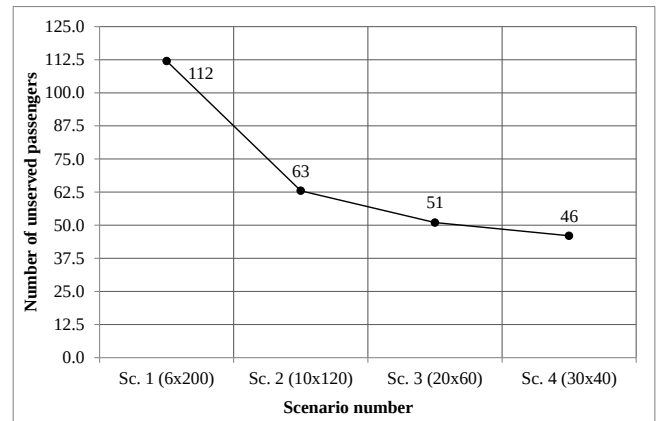


Fig. 7. Number of the passengers who have not been served by the end of the simulation

If we consider in detail the simulation output results for scenario 4, it can be seen in Fig. 8 that the PT operator satisfies PT demand entirely with a large number of small-size vehicles. The minimum and the maximum bus load along the sections are 24 and 36 passengers, which expressed as a percentage is 60% and 90% capacity utilisation, respectively. The average bus load is 29.3 passengers, which represents a capacity utilisation of 73.3%, indicating that around $\frac{3}{4}$ of the available passenger capacity is used. The model was used to evaluate and analyse the vehicles' capacity utilisation (Fig. 9) in a scenario with a reduced by 20% number of operating vehicles (from 30 to 24 buses) and reduced frequency in which the bus headway has been increased by 25% from 2 to 2.5 minutes. The purpose of this scenario was to answer the PT planners' question *What is the number of vehicles and the time interval between them that meet the existing PT demand, thus allowing PT planners to achieve improved bus utilisation and a small number of unserved passengers at the price of slightly increased average passenger waiting time?*

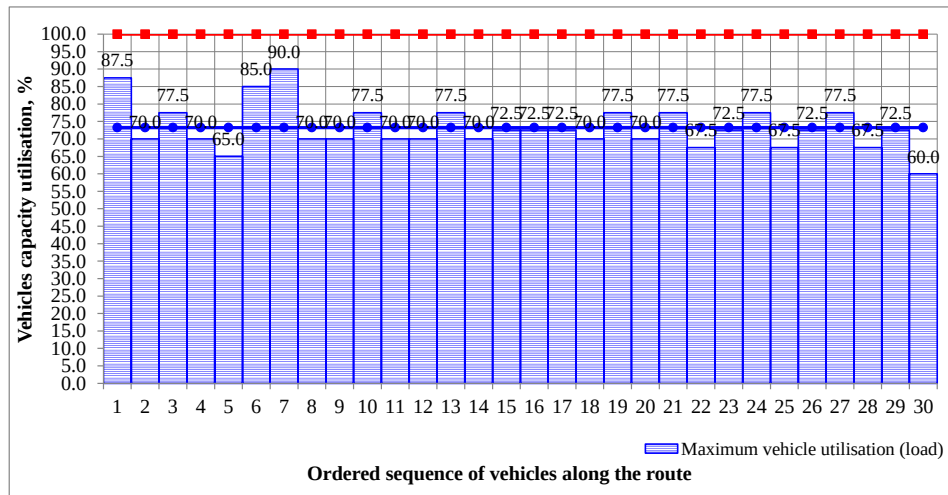


Fig. 8. Maximum vehicle capacity utilisation reached for the vehicles along the bus route (scenario 4: 30 vehicles with capacity of 40 passengers going along the route with a 2.0-minute headway)

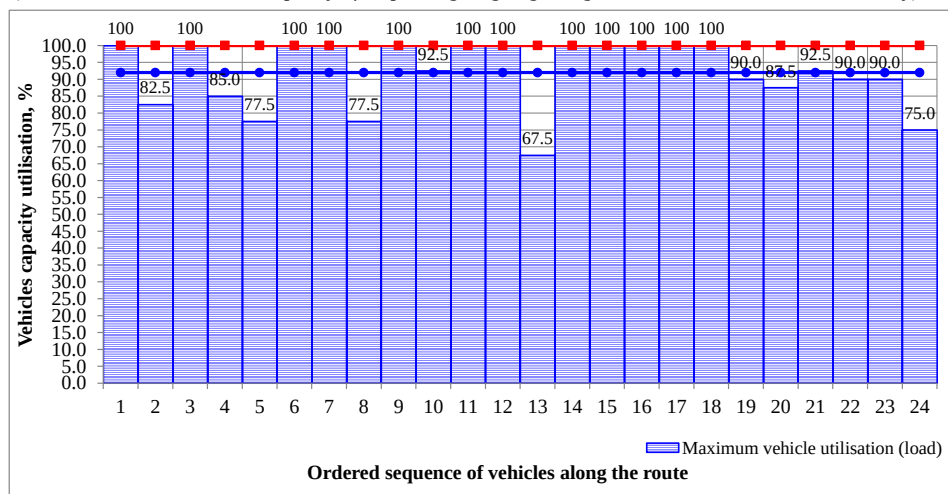


Fig. 9. Maximum vehicle capacity utilisation reached for the vehicles along the bus route (scenario 4.1: 24 vehicles with capacity of 40 passengers going along the route with a 2.5-minute headway)

The scenario with reduced number of vehicles (from 30 to 24, i.e., by 20%) and increased bus headway from 120 sec. to 150 sec. (25% increase) led to an increase in the average passenger capacity utilisation of the vehicles from 73.3% (29.3 passengers on average on the bus) to 92% (36.8 passengers on the bus), which is around a 20% increase at the cost of increased average passenger waiting time at the bus stops along the route from 65 sec. to 90 sec. (by 38.5%). The number of the unserved passengers has slightly decreased from 46 to 40 (13% decrease), which is insignificant and can be ignored. The average total travel time remains almost unchanged – it has been slightly increased from 968 to 985 seconds.

As can be seen in Fig. 10 and Fig. 11 representing the passenger load in vehicle # 7 (in scenario 4 with 30 buses running one after another with 2-minute headway) and vehicle # 3 (in scenario 4.1 with 24 buses running one after another with 2.5-minute headway) even for the most-loaded vehicle # 7 (Fig. 10) the maximum bus capacity utilisation has not been reached. The higher passenger load has been observed in 1 of the 5 route sections (# 3 between stops 3 and 4). In contrast, in the scenario with 6 fewer vehicles (24 rather than 30 buses) for vehicle 7, which is 1 out of 12 vehicles whose capacity has been reached (for half of the vehicles along the route, the maximum passenger capacity has been reached), is highly loaded in more than one section (section 3-4 between stations 3 and 4, followed by section 4-5 between bus stops 4 and 5). This shows how the proposed decreased number of buses running leads to better vehicle utilisation.

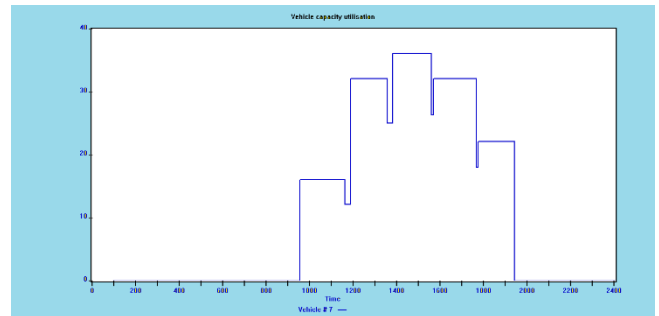


Fig. 10. Passenger load by sections along the route for bus # 7 (scenario 4)

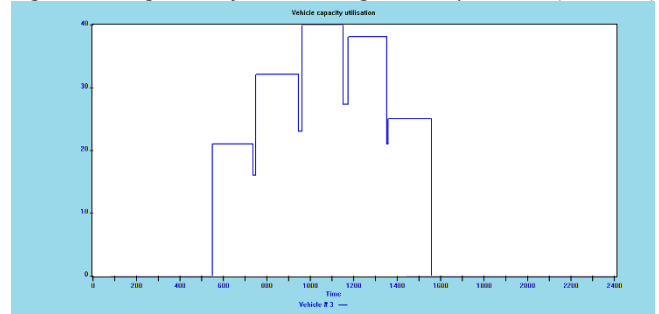


Fig. 11. Passenger load by sections along the route for bus # 3 (scenario 4.1)

The above example shows the power of the model that could be easily applied for planning the operations along a PT route. In the

example considered, the application of the model helped to better plan the PT service with reduced vehicle frequency, which resulted in better vehicle utilization and decreased number of the unserved passengers along the route.

4. Conclusion

Based on the analysis of the simulation output results, the following main conclusions can be drawn, and recommendations offered:

Although the choice of modelling framework depends on the purpose of the work, the characteristics of the system, and the existing constraints, models should:

- be easily implementable within at least some of the existing simulation systems, languages, and tools;
- be detailed enough to describe the system, reproduce the system's processes, and give accurate results;
- have a small number of input variables, which would make it possible to feed the model with data and directly apply it in practice;
- be easily maintainable, which would allow modellers to quickly adapt the model for different PT routes and transport conditions.

It turned out that among the large variety of existing simulation systems, programming languages, and tools, the GPSS World simulation system, used in this work, is a powerful tool enabling modellers to precisely design, easily build, and quickly implement a very flexible (in terms of the possibilities to be extended), and detailed enough model; after compiling for a couple of seconds, it provides modellers with output results and accumulated statistics in the form of generated reports that present the results in tables and graphs.

In light of the rich variety of simulation models and tools, this simulation model stands out because of:

- the small number of input variables, which makes the model's usage and subsequent application realistic;
- its flexibility, which enables, through minor modifications, relatively easily and quickly reworking the model and thus adapting it for modelling the passenger transportation process along a public-transport line characterised with specific parameters with regard to the route, the vehicles carrying passengers, and the variability of passenger demand;
- the ability of the model to enable evaluating the existing system's performance and efficiency along the route of a PT line under simulation, which would allow PT planners to effectively plan the PT service under different (existing and forecasted) conditions and scenarios.

The results from the simulation scenarios showed that the model satisfactorily reproduces the parameters of the system modelled, which allows us to summarise the simulation output results as follows:

- Among the scenarios, scenario 4 simulating a highly frequent, metro-like PT service, due to the small vehicle headways, provides passengers with a minimum average waiting time at bus stops;
- Due to the small capacity of the highly frequent vehicles used, which means less time for boarding/alighting (in contrast to the large-vehicle scenario), scenario 4 offers the lowest estimated average dwell time along the whole PT line;
- The highly frequent public-transit service provided in scenario 4 is the one that leaves the smallest number of unserved passengers along the route of the modelled PT line;

- A small decrease in the frequency of the vehicles (less operating vehicles) when a highly frequent, metro-like service is provided (scenario 4.1) leads to better utilisation of vehicle capacity (i.e. fewer unserved passengers) at the cost of an insignificant increase in the average passenger waiting time at bus stops.

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LOGISTICAL RISKS OF MARITIME TRANSPORT PROCESSES

ЛОГИСТИЧЕСКИЕ РИСКИ МОРСКИХ ТРАНСПОРТНЫХ ПРОЦЕССОВ

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Abstract: Risk exists objectively in any marine enterprise, since the human presence of a person on the sea is accompanied both by circumstances caused by the irresistible forces of nature and directly by activities in the sphere of trading navigation. Risk management in the logistics supply chain is a complex multidimensional problem addressed in the process of identifying and assessing the risks and taking measures of protection against them.

In logistics, risk refers to the likelihood of an insured event occurring, as well as the possible damage caused by this event. Risk and an insured event can be described by using methods of the reliability theory. In this case, reliability is the probability of operation of the logistics system with failure or with no failure.

In order to identify rational methods and techniques for insurance, it is advisable to construe the logistics system as the process of movement of material resources.

KEY WORDS: RISK MANAGEMENT; SOURCES OF RISK; LOGISTICS SYSTEM RELIABILITY.

1. Introduction

An increase in cargo-turnover has been recently observed in water transport, the functioning of which is influenced by numerous factors of the external and internal environment and involves risks that arise at different stages of the logistical transport process. Risk exists objectively in any marine enterprise, since the human presence of a person on the sea is accompanied both by circumstances caused by the irresistible forces of nature and directly by activities in the sphere of trading navigation. Negative events can occur when a ship is in the sea or in a port, but risks also exist at the decision-making stage on the choice of sea traffic, freight rates, etc. Reliability of the carriage and, consequently, risks, while adhering to the logistical principles "just in time", "in a cost-effective manner" and "necessary qualities and quantities" become problematic issues. Accordingly, if the activities of transport as an object of increased danger were not subjected to various negative impacts, including risks, the transport component in the price of the goods, taking into account logistical technologies, could be significantly reduced.

Risk management in the logistics supply chain is a complex multidimensional problem addressed in the process of identifying and assessing the risks and taking measures of protection against them. As a result of its solution, it is possible to balance potential losses and benefits, avoid costly mistakes and ensure the stable operation of the logistics chains involving maritime transport.

Transport and logistical risks in the field of the carriage of goods by sea represent a combination of conditions and factors posing a real and potential threat (challenge, risk) to the sea logistics cargo supply chain. Unfortunately, at present, practical activities on revealing, identifying and assessing risks are not been expanded as they should be. At the same time, risk management and their minimization can be ensured on the basis of the logistical approaches, which allow fore diminishing the danger of choosing poor decision at the time of its adoption, as well as for mitigating the possible negative consequences of making decisions at the stage of their implementation.

The so-called "logistical" specification is considered as an important indicator of transport and logistical risks, that is, their

belonging to the specific types of flows, by means of which the links are established and implemented in the system. Moreover, the main components of the marine logistics supply chains will be the channels of trade, supplies, logistics and their corresponding information, financial and cargo flows.

2. Preconditions and means for resolving the problem

Researchers make distinction between four main sources of risk in the supply chain involving maritime transport:

- Environment (natural, regional-geographical factors, as well as terrorism threats);
- Regulatory and political sphere;
- Networking environment – interaction of the organizations in the supply chain (relationships between suppliers and customers, the influence of their problems on the counterparties);
- Internal (organization) environment (inadequate preparation of a ship and cargo for the carriage, defects in a ship and equipment, labor troubles, curtailment or stoppage of production by the supplier).

The least manageable risk factors arise in the environment and in the regulatory and political sphere. Natural factors are often combined with regional-geographical factors or are conditioned by the latter. For example, because of insufficient depth, the Georgian Black Sea ports are unable to receive tankers with tonnage larger than 130-150 thousand tons, the similar restrictions exist in many European ports; also, on busy routes of the intercontinental seas, the use of large tankers is undesirable from the environmental standpoint, since the probability of accidents in such water areas is considerably higher than on ocean voyages. More commonly, such factors can be controlled out only by way of operational and strategic adjustments in the shipping business itself.

The dangerous natural risks (risks of the sea itself and other natural disasters) are generally insured, but this does not solve the problem for the logistics system, since insurance only compensates for

losses once the timeliness and the quality of supply have already been violated. Therefore, risk management in the context of logistics should be oriented towards comprehensive control and prevention.

Another external source of risk is represented by the regulatory and policy decisions taken unilaterally, and which are beneficial to companies in one country or region. So, in order to ensure its own environmental safety, Turkey has set limits on the passage of the ships across the Bosphorus; in particular, tankers over 200 m long or the with dangerous types of cargo are permitted to pass through the straits only in daytime.

Consequences of such restrictions for transportation of Caspian oil and oil products from Georgian ports through these straits are unfavorable, especially considering that the volume of Caspian oil is expected to grow [1].

Risks caused by regulatory and political factors are generally not insurable, and their management tools should be methodologies for analyzing and reviewing the decisions, changes in business processes and structural changes that are carried out with the most efficient use of the competencies, knowledge and ties that the company has.

The phenomenology of the third ("networking") source of risk in the supply chain has been studied the least to date, despite its critical nature in creating the risk situations. The main problem is the complexity of risk assessment, since risk factors are rooted in the complex organizational and business interrelationships. Until recently, the issues of risk assessment and control in transport systems were addressed mostly in the context of individual organizations, but not in a systemic, "networking" context. Attention to this context is strengthened due to the following circumstances [2].

The increasing complexity of infrastructure and processes in transport logistics systems inevitably leads to a weakening of attention to their quality and control. In the maritime transport systems, the consequence of this the increased number of catastrophes with large damages and strengthened factors threatening life and health of people at sea.

In logistics, risk refers to the likelihood of an insured event occurring, as well as the possible damage caused by this event. Risk and an insured event can be described by using methods of the reliability theory. In this case, reliability is the probability of operation of the logistics system with failure or with no failure.

In general, insurance constitutes a justified system of ensuring the interests of natural or legal persons with a particular risk.

In order to identify rational methods and techniques for insurance, it is advisable to construe the logistics system as the process of movement of material resources in the spheres of production and circulation. Considering this, a logistics system would consist of two subsystems. These are:

- 1) Commercial subsystem, that is, the movement of material and financial flows in the spheres of circulation.
- 2) Production subsystem, that is physical movement or change of material and supplies immediately before receiving finished products in the production, and all kinds of logistics equipment (vehicles, transshipment machinery, etc.).

The commercial subsystem comprises the following operations or elements: procurement, sale, transportation, storage, production and information services and so on.

The production subsystem comprises the basic and support technological operations of the creation and movement of finished products. Multiplicity of links of the logistics system is what

creates the possibilities of failures. In a broader sense, these cases are called risks.

Multiplicity of links is also associated with the infinity of the logistics system, which can be measured by initial entropy

$$H = -\sum(p_i \log p_i + q_i \log q_i),$$

where n – number of operations of the logistics system or chain;

p_i – probability of failure-free performance, or reliability of operations to be carried out;

q_i – probability of failure, or risk of operations to be carried out;

The formula $p + q = 1$ shows that the logistics system is characterized by a high level of potential risks, which is significantly decreasing, first of all due to the reasonable management of material flows, or in order to maintain the minimum level of entropy for the purpose of influencing adequately on the operation of the logistics system.

Computer-aided management by highly qualified personnel can increase reliability of the logistics system and bring it closer to 1. Sound management requires a lot of information, which complies with the following condition

$$1 = H_{pr} - H_{cir} \quad \text{when } H_{cir} \rightarrow 0,$$

where H_{pr} and H_{cir} – are initial and final entropies. This circumstance defines information as a risk to eliminate or minimize the risk.

For the participants of logistics process, particularly for the suppliers (sellers), consumers (buyers), consignors and consignees, wholesale intermedia, transporters, etc. First of all, there is need for information on the situation existing in the market and in its separate segments, where the given logistical process is implemented. In addition, there is also need for current and predictable information on the specific situation of material flow.

At present, the seaports represent a set of disparate business entities (in fact, competitors) that do not have organizational unity and body coordinating their joint activities. Their uncoordinated actions result in decreasing the port's capacity. In this regard, a new logistics mechanism is needed that allows for coordinating the interests of all participants in the transport process, as well as the body that brings together their efforts [3].

3. Conclusion

The ability to manage the risks, that is, to reduce, compensate and prevent losses, is determined after identifying the nature of the risk of obtaining its quantitative and qualitative estimates. When assessing the risks, there are used several basic approaches and numerous methods [5].

According to the theoretical approach, the risk is calculated as follows:

- based on the logical reasonings, empirically - by extrapolating the past situations, and predicting them for the future;
- based on statistics - by studying statistics on losses, with establishing the frequency of the occurrence of the certain loss levels;

- expertly - based on the assessments and information received from experts;
- calculative-analytically - by constructing the loss probability distribution curve.

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A PORT COMMUNITY SYSTEM OF GEORGIA AND ITS ROLE IN WORLD MARITIME TRANSPORT

СИСТЕМА ПОРТОВ ГРУЗИИ И ЕЕ РОЛЬ В МИРОВОМ МОРСКОМ СУДОХОДСТВЕ

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Abstract: Ports constitute one of the most important nodes of transport networks, and they represent the border control points and the freight handling points, the administrative service centers, place of the implementation of trade procedures, as well as the link connecting the land and maritime routes. The functioning of the international transport corridor depends to a large extent on the ports and maritime transport efficiency.

Despite significant investments, the operations of port and ships are mostly non-standard, which hinders the development of the maritime transport sector. However, infrastructure is not the major obstacle to maritime transport development. National regulatory policy should be revised in keeping with the growing popularity of the concept of economic globalization and supply network. It is necessary to reform the relevant roles of the private sector and the State, where the latter is represented by state-owned companies and state monopolies.

KEYWORDS: TRANSPORT EFFICIENCY; ECONOMIC GLOBALIZATION; TRANSPORT CORRIDOR.

1. Introduction

The paper provides an overview of a port system of Georgia and its development opportunities and options.

Ports constitute one of the most important nodes of transport networks, and they represent the border control points and the freight handling points, the administrative service centers, place of the implementation of trade procedures, as well as the link connecting the land and maritime routes. The functioning of the international transport corridor depends to a large extent on the ports and maritime transport efficiency.

Despite significant investments, the operations of port and ships are mostly non-standard, which hinders the development of the maritime transport sector. However, infrastructure is not the major obstacle to maritime transport development. National regulatory policy should be revised in keeping with the growing popularity of the concept of economic globalization and supply network. It is necessary to reform the relevant roles of the private sector and the State, where the latter is represented by state-owned companies and state monopolies [1].

2. Preconditions and means for resolving the problem

Georgia is an integral part of the Eurasian transport corridor. The location of Georgia creates unique opportunities for socio-

economic development: the seaside allows us for developing intensively sea transport, ports, the area of marine products – fishing, tourist and recreational infrastructure. Georgian ports terminal throughput is guaranteed by the current trade-economic and transport processes occurring across the enormous Eurasian land mass.

Georgia's port system comprises 2 ports of Poti and Batumi, as well as Supsa and Kulevi specialized oil terminals [2].

Poti and Batumi represent an intermodal gateway to the eastern coast of the Black Sea, from where the road goes west to the Black Sea, Turkey and Europe, and east to the Caucasus and Asia. Both ports serve regular ferry and container routes linked to other ports of the Black Sea and Mediterranean Sea.

Batumi port is a significant link in the Europe-Caucasus-Asia Transport Corridor, which originates in Europe and after crossing Bulgaria, Romania and Ukraine through the Black Sea, it ties the Caspian Sea region countries - Azerbaijan, Kazakhstan, Turkmenistan and so on.

The main competitors of Batumi port in the Black Sea region are: the ports of Odessa and Ilyichevsk in Ukraine, and Novorossiysk and Tuapse in Russia.

The advantage of Batumi port is that Ukraine's maritime territory freezes in the winter, and in the Russian ports, the strong winds are often blowing in the winter.

Batumi port has a container terminal and a harbor complex for servicing of ferries, as well as the dry cargo and passenger terminals. Figure 1 illustrates Batumi port scheme.

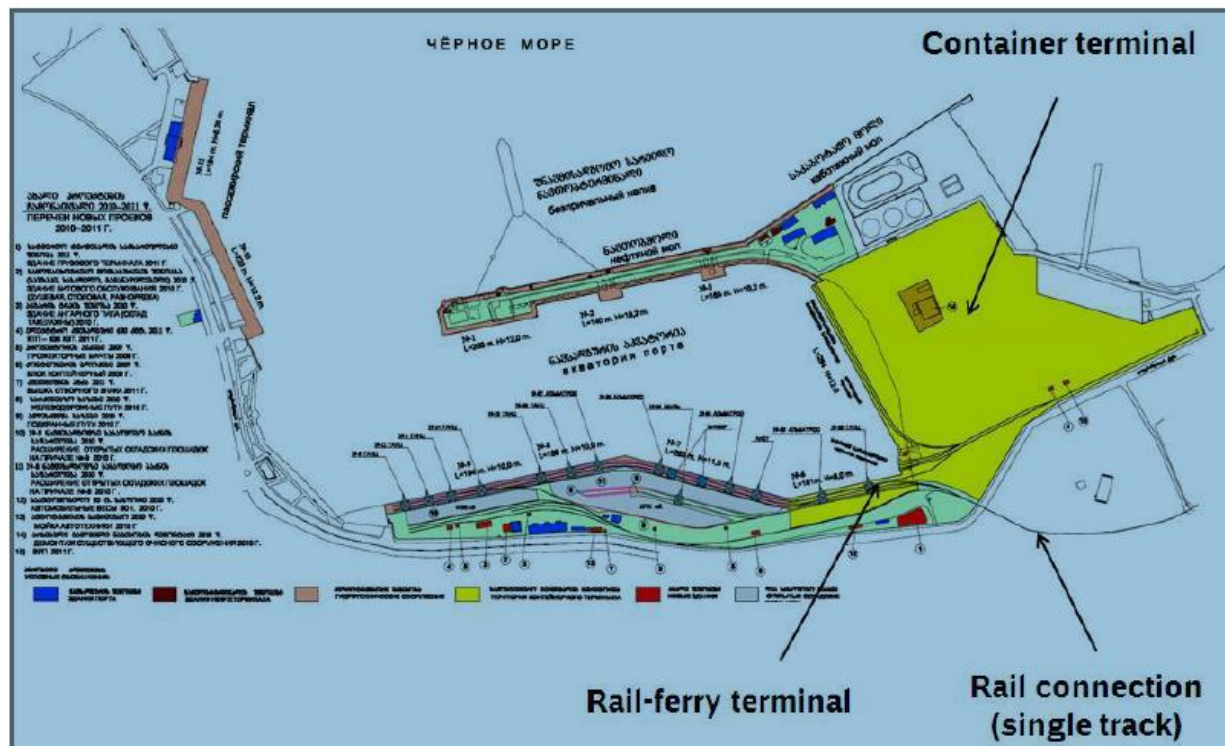


Fig. 1. Batumi port scheme

Container terminal throughput is 100,000 TEU per year. This terminal has the open storage spaces and load-carrying equipment, which are specialized in the handling of containers for the intended or storage purposes.

The ferry runs between Varna, Ilychevsky and Batumi harbors. The ferry system is completely automated. Nominal annual throughput of terminal is approximately 700,000 tons.

Dry cargo terminal provides servicing of large and small ships. It is specialized in handling of scrap metal (intended or storage purposes), bulk, liquid, general and breakbulk cargo. Dry cargo terminal's maximum throughput is 2,0 million tons per year.

The passenger terminal is located in the center of Batumi, along the coastal boulevard. The terminal's throughput is approximately 180 000 passengers per year. The passenger harbors provide servicing of passenger ships and the Ro-Ro type passenger-cargo ferries.

The main factor for the development of port was and remains the Caspian Sea oil. The Batumi Oil Terminal offers its customers the

services for transportation of oil and oil products from Kazakhstan, Azerbaijan, Turkmenistan, Georgia and other countries.

The total area of the terminal is about 90 hectares, where five tank parks and oil discharging complexes. The main advantage of the oil terminal is the convenience of storage and transportation of various types of oil and oil products. The terminal transport up to 22 types of oil and oil products. Oil is supplied to Batumi Oil Terminal via Georgian Railway, by railroad tank cars, unloading of which is carried out at the modern railway overpasses.

The oil terminal's throughput is up to 15 million tons per year. The terminal is specialized in handling of crude oil and practically all types of oil products - diesel fuel, petrol, heating oil, etc.

Poti Port is a connecting link for cargo transportation from Turkey, Middle East and Europe to Central Asia countries and Afghanistan. Figure 2 illustrates the cargo harbors of Poti port.

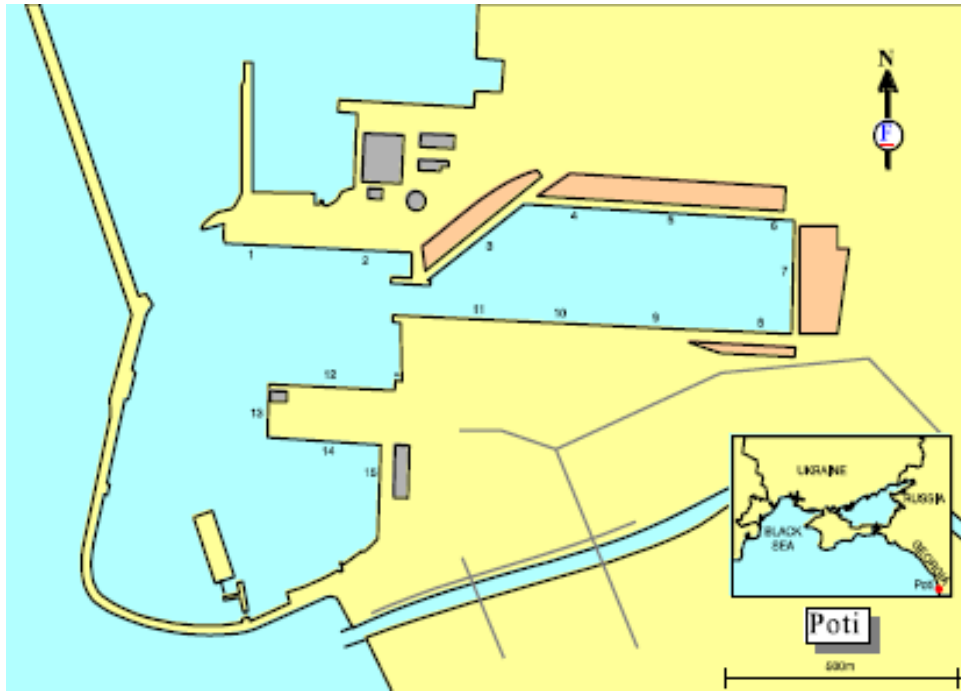


Fig. 2. Cargo harbors of Poti port

Poti Port carries out the carriage in three main directions:

- the carriage from the border strip adjacent to Azerbaijan and Russia – Samur-Yalama;
- the carriage to Turkmenistan, Afghanistan, Tajikistan and Uzbekistan by a ferry Baku-Turkmenbashi;
- the carriage to Kazakhstan, Uzbekistan and Kyrgyzstan by a ferry Baku-Aktau.

The continuous delays in the ferries Baku-Turkmenistan and Baku-Aktau, as well as in the border zones adjacent to Afghanistan (in the direction of Serhetabat-Turgundi and Galaba-Khairaton) significantly increases transit time from the port of Poti.

Kulevi Oil Terminal

The Kulevi LLC "Black Sea Terminal" construction began in 2000, and it was opened on May 16, 2008. The terminal's throughput is up to 10 million tonnes of oil products per year, including: 3 million tons of oil, 3 million tons of diesel and 4 million tons of heating oil. The overall storage capacity of the tank park is 320 thousand cubic meters, with the prospect of increase up to 380 thousand tons. There are two berths in the terminal for discharging oil products, which provide servicing of tankers with tonnage up to 100 thousand tons. Hourly loading performance is from 1000 to 8000 cubic meters per hour. The object has its own port-approach railway station, where 180 oil tank cars be placed simultaneously waiting for discharging. The railway overpasses allow for discharging 168 oil tank cars simultaneously.

Supsa Marine Terminal

The Supsa Marine Terminal, the last point of the Baku-Supsa pipeline, was opened on April 17, 1999, in a SupsaVillage The terminal has 4 tanks, with tonnage of 40000 tons each. The quantity of cargo handled in 2015 was 4,2 million tons. Annual throughput is 7 million tonnes.

.In the first seven months of 2017, Georgia's ports and the marine terminals handled 9.6 million tonnes of cargo, which was 3% less than in the previous year.

The absence of a deep-water port is considered to be one of the weaknesses of the transport corridor connecting Europe and Asia. Large ships cannot enter the ports of Poti and Batumi. Chartering of small-size ships costs almost the same amount as servicing of a much larger ship. This increases the cargo owner's costs of shipping, and consequently, this somewhat devalues the positive side of a physically shorter route.

As a result of the analysis, it has been established that the possibility of servicing of large ships in the case of the existence of a deep-water port will reduce shipping costs by about \$160 per container.

Realizing this need, on December 24, 2017, there was started the construction of the Anaklia's deep-water sea port, which is being implemented by the Anaklia Development Consortium [3]. The Consortium comprises the "TBC Holding" and the American Investment Holding "Conti International", which implements infrastructure and construction projects. The contractors of the Anaklia Development Consortium are also the well-known sea-port design company "Moffatt & Nichol" and Dutch consulting company "Maritime & Transport Business Solutions", which is specialized in the issues of port transactions. Figure 3 illustrates Anaklia port scheme.



Fig. 3. Anaklia port scheme

In the longer term, the port is expected to reach 100 million tons of throughput, but at the first stage it is planned to construct three phases are planned. The first 3 phases should be constructed within 12 years. For the first three years, the port's throughput will be 7 million tonnes, and by the 12th year, it will reach 40 million tons of cargo.

3. Conclusion

The construction of the new ports in Georgia, as well as the development and expansion of the existing ones will result in the necessity of a new resettlement policy, which involves the creation of the new port settlements, and in some cases, the creation of new city or cities, terminals and technical service zones. If we continue $\pi\pi\kappa$ $\sigma\pi\tau\epsilon\kappa\eta$ in this direction, Georgia's economy can be developed very quickly, moreover, in case of increasing cargo flows, we may need additional labor resources.

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APPLICATION OF RISK FACTORS EVALUATION METHOD FOR ASSESSMENT OF VOYAGE EFFICIENCY IN TRAMP SHIPPING

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Abstract: The present article outlines the risk factors affecting voyage efficiency in tramp shipping operations. The influence of factors of time and costs parameters is identified. The voyage revenue is formulated and studied according to variances of time and costs elements. For the evaluation of efficiency of voyage operations an approach based on value-at-risk method is proposed and voyage statistics in short sea shipping are studied. The results presented prove the applicability of the method for efficiency evaluation of tramp shipping operations and voyage planning.

Keywords: TRAMP SHIPPING, RISK FACTORS, VOYAGE EFFICIENCY, RISK ASSESSMENT

1. Introduction

Maritime transportation demand is derived demand as it depends mainly on the demand for certain commodities or products. Considering that the fee for transportation by sea is represented by freight rates (in general) same are affected both market factors (ration between supply and demand in the freight market) as well as the costs structure of transport activities. Tramp shipping is considered as highly risky business activity as freight rates and prices of bunker are characterized by volatility against the increasing costs for shipowners and maritime operators. The revenue and profit of shipowners and maritime operators are influenced by a number of factors that pertain to the external (market) parameters and internal (cost) parameters. The said uncertainty of tramp shipping operations can be attributed to the state of the freight markets, economic activity for a certain group of commodities, political events and economic cycle. The market risk for shipowners and operators is an object of analysis and measurement in view of its potential impact on revenues and profits. The purpose of the present article is to study in detail the main risk factors affecting voyage efficiency in tramp shipping. The income and costs structure of voyage implementation is presented along with details of each element thereof. Consequently, the risk factors for efficient voyage implementation are identified as cost and time parameters which value depends on the duration of the voyage and market prices of bunker fuel. The value-at-risk (VaR) approach is applied to evaluate the expected losses due to a prolonged voyage and/or increase of bunker prices. The results show that the proposed method serves as an applicable tool in controlling and evaluating the voyage efficiency in tramp shipping.

2. Voyage efficiency in tramp shipping and risk factors

Tramp shipping is generally characterized by volatile demand. Being an industry of high commercial risk, shipowners and maritime operators strive to apply new approached for evaluation of transportation efficiency. There are several studies for assessment of the market risks effect on voyage efficiency [4]. However, a few are focusing on voyage efficiency from an operational point of view. Policy implications for risk averse shipowners with a choice of employing ships between the spot and time charter markets, point to preferring the lower risk time charter market over the spot market in general [2].

The objective of this article is to develop a conceptual model for analyzing the effect of the market risks on the results of vessels' operations and to quantify the deviation of planned results versus actual results in voyage operations. As a first stage the most important market risks are identified and their impact on the voyage results. The system approach allows for structuring a conceptual model for evaluation of voyage efficiency under the effect of

market risks (Figure 1). The empirical analysis concerns the actual performance of voyages thus all the commercial factors are constants including freight rate, loading and discharging rates at ports, commissions and the cargo quantity margins. According to the established practice all elements of the voyage implementation are planned in advance via voyage estimating. Due to the latter we can assume with a high level of probability that the expected result will be close to the planned. The latter refers to the time and costs parameters as well. The time components (parameters) include: steaming time between ports (laden and ballast legs), port stay time (cargo handling operations and unplanned delays) as well as unplanned delays during the passages between ports.

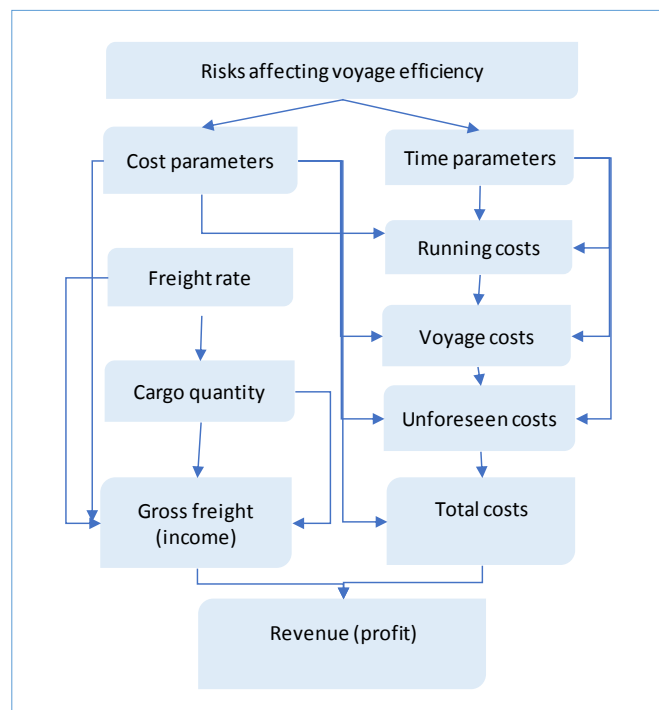


Figure 1. Conceptual model for evaluation of risk factor impact on voyage efficiency

The time components can be formalized as follows:

$$T_v = T_s + T_p + T_u \quad (1)$$

Where T_v represents the total voyage duration (number of days), T_s the steaming time both vessel being laden and in ballast, T_p represents the duration of time in port (number of days) and T_u is the duration of unforeseen delays (number of days).

The costs components (parameters) include the costs of disbursement accounts in ports, bunker costs, costs for passing canals as well as the running costs of the vessel. The costs for

bunkers, disbursements and costs related to cargo operations (in case same are for owners account) form the variable (voyage costs). The voyage implementation is also related to running costs, i.e. all costs that are incurred regardless of vessel's employment during the operational period. The level of voyage costs will depend mainly on the fuel prices, the current level of disbursement accounts in ports, etc. Running costs are also affected by the duration of all time components of the voyage as well as by the set budget of daily running costs. As voyage (variable) costs are mainly determined by time and costs parameters of the voyage depending on the bunker prices, disbursements and canal tolls. Thus we can assume that the most important parameters in evaluation of vessels' efficiency are the cost and time values given the agreed value of gross freight income. Therefore we can define the total costs of the voyage as follows:

$$T_v = VC + FC \quad (2)$$

The gross income basis the agreed freight is based on the total quantity loaded multiplied by the freight rate plus the due demurrage (if any).

$$R = Q \cdot f + dm \quad (3)$$

where R represents the gross voyage revenue, Q is the Bill of Lading weight of the cargo, f – freight rate and dm – the gross amount of demurrage due to the owners.

The net voyage revenue can be represented as follows

$$R_n = (Q \cdot f + dm) - \frac{(Q \cdot f + dm) \cdot K}{100} - ds \quad (4)$$

where R_n is the net voyage revenue, K – total amount of commissions agreed and ds – the amount of dispatch (if any). Commissions are due on gross freight, deadfreight and demurrage.

As an efficiency indicator the voyage revenue is used that can be presented as the difference between the net voyage revenue and total voyage (variable costs):

$$R_v = \left[(Q \cdot f + dm) - \frac{(Q \cdot f + dm) \cdot K}{100} - ds \right] - VC_v \quad (5)$$

where R_v is the voyage gross profit and VC_v are the variable (voyage costs) of the voyage.

On the basis of the net result of the voyage the daily financial results can be derived as follows:

$$TCE = \frac{\left[\left[(Q \cdot f + dm) - \frac{(Q \cdot f + dm) \cdot K}{100} - ds \right] - VC_v \right]}{T_v} \quad (6)$$

where TCE is the timecharter equivalent for the voyage.

The timecharter equivalent characterizes the profitability per day for a specific voyage and a specific ship. This indicator allows to perform comparison between different options of voyage employment of ships. As a rule, the planned timecharter equivalent should be higher than the rate of the daily running costs thus ensuring for a certain percentage of profit taking into account the pertaining risks during the voyage implementation.

The actual circumstance for implementation of the voyage as well as the risk factors may lead to the change of the time and cost parameters and thus to a change of the planned profit level. In practice, the planned result differs from actual result in a negative interrelationship, i.e. voyage revenue is lower than planned. Tramp shipping operations are affected by a number of external factors and risks [4]:

- change of bunker prices

Bunker prices are closely related to the state of the freight market. In the case of high market conditions the freight rates increase more slowly than the bunker prices. Conversely, the freight rates decrease sharply following the decrease of bunker prices

which shows a lower state of the freight market. Figure 2 presents the dynamics of bunker prices (IFO 380 cst) at Bosphorus for the period November, 2017 to April, 2018. As evident, the bunker prices can vary by more than 25% within a month only;

- delays in ports of loading and discharging

These refer to issues of discrepancies regarding cargo delivery in port, lack of cargo documents preventing customs clearance, etc. The latter can directly affect the port stay time and thus the overall duration of the voyage. Also these factors include the delays due to servicing of the ships in ports (activities of ship agents, pilots, tug companies, port authorities, etc.);

- change of port disbursements

These refer to the local price policy of port tariffs, most valid for larger ships performing longer voyages due to the longer time span between sailing from load port until arrival at discharge port. This factor affects the cost parameter in terms of voyage costs;

- weather conditions during the voyage

These factors refer to the weather conditions during sailing time and during port stay time. These may affect the safety condition of the ship and thus incur additional costs and time loss for unplanned repairs and/or supplies;

- human error

These refer to omissions of the crew that can affect negatively the operation of the ship and lead to loss of time due to incidents and delays. On the part of shore personal, with reference to the ship management activities, human errors can be related to improper and untimely decisions to/not to supply the ship or to decisions leading to loss of time due to unavailability of cargo, cargo documents, delayed formalities at ports, etc.

Factors described above can affect the time parameters of the voyage in terms of increase of steaming and port stay time.

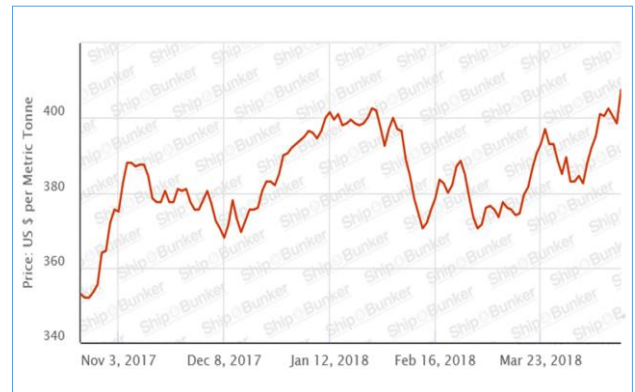


Figure 2. IFO 380 cst prices for bunker supplied at Istanbul [6]

As a result of the costs change (increase of bunker prices and/or port disbursements) and time parameters (increase of steaming time and port stay time) the voyage costs increase. It should be noted, however, that apart from the bunker prices and port disbursements, the weather delays are considered extreme external factors that are not liable to initial evaluation. The increase of voyage duration leads to increase of the running costs. The increase of running costs is often related to crew errors, ship management errors and delays of ships in ports. Therefore, when a voyage is planned, the entire system of affecting factors must be taken into account in order to evaluate correctly the expected voyage efficiency. Moreover, the decrease of daily revenue is due not only to the cost increase but also to the decrease of daily income.

Bunker consumption is planned in advance according to empirical evidence from ship's operation and to the technical specification of ship's engine. They are set separately for the sailing

period and for the port stay. It should be noted that the relationship between speed and bunker consumption is not linear therefore careful considerations should be made for the trade-off between time saved and bunker costs saved as concerns speed management.

Bunker costs will increase due to the increase of sailing time or time in port as well as due to the increase of bunker prices. As concerns disbursement accounts some of their elements are dependent on the duration of port stay – for example berth dues, anchorage dues, agency fee, etc.

3. Evaluation of risk factors impact on voyage efficiency

For the purposes of risk factor evaluation, we assume the commercial elements of the voyage, i.e. the charter party terms, are constant. The latter refers to the cargo quantity, freight rate and agreed brokerage. The margin of voyage elements values has been ascertained via statistical study of voyage implementation of a 5300 mts DWAT general cargo vessel performing contract voyages between Constanta and Ravenna for the period April, 2017 to April, 2018 (Table 1).

Table 1. Characteristics of 5000 mts DWAT general cargo vessel

Vessel type	general cargo
DWCC (bulk grain cargo)	5000 mt
Freight rate [7]	36 \$ per mt (net)
Service speed (average)	10 knots
Voyage rotation	Constanta – Ravenna
Distance (nm)	1312 nm
Total sailing time (incl. ballast)	10,93 days
Total time in port	5 days
Bosporus passage (one way)	1 day
Total voyage duration	16,93 days
Price of IFO 380 cst [6]	430 \$/mt
Price of MGO [6]	670 \$/mt
Total D/As and canal fees	26000\$
Daily running costs	3500\$/day

Models for estimation of market risks are of the purpose to predict potential losses as an outcome of external factors changes. One of the best-known and most widely used of risk measurement tools is value at risk (VaR) [5]. The findings of the present study can be applied in vessel's operations for short sea shipping in the Black Sea and the Mediterranean region particularly for the financial risk management in shipping.

A main concern for the market risk manager is the choice of the most appropriate market risk measurement method amongst a number of alternative models developed in the literature [3]. Value-at-risk method (VaR) is the maximum amount of loss that can be sustained with a given probability over a certain period of days. It is typically calculated within a 95% or 99% confidence interval. VaR is defined as the dollar (or percentage) loss to be exceeded with a certain probability (known as confidence level) over a given time horizon [1]. For the purposes of this study we strive to understand the overall risk factors structure for tramp shipping. The values of VaR measures are calculated for above mentioned period. The realized α -level VaR measures are computed as the $1-\alpha$ quantiles of the past n observations of X_t , as in the following equation [5]:

$$\text{VaR}(\alpha) = \text{Quantile}^{1-\alpha}(\{X_t\}_{t=1}^n) \quad (7)$$

VaR method is based on the determining of certain deviations (losses) at given probability. In order that the application of this method is correct it is necessary that the studies values of the cost and time parameters are random values with normal distribution. For the purposes of the latter we have conducted statistical study of the bunker prices and duration of port stay for a sequence of voyages performed by a general cargo vessel as described in Section 2 of the present article. Figure 3 presents the hypothesis test of the random value distribution type as concerns port stay in ports – as evident it is subject to normal distribution. The Pearson's test confirmed the on-contradiction to the initially adopted hypothesis of normal distribution with χ^2 with value 4,0655 and p with value 0,0678 which is acceptable for such analysis.

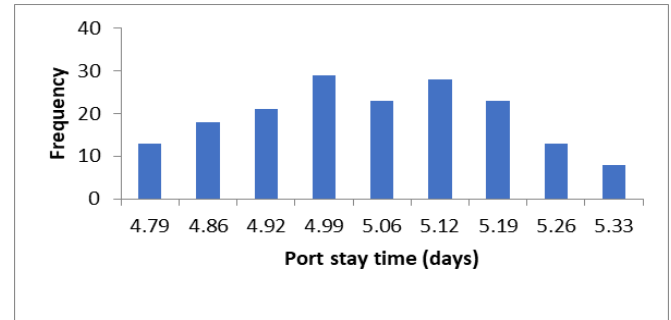


Figure 3. Statistical analysis of port stay time (number of days)

As a result it has been ascertained that the mean value of port stay time is $T_p = 5.06$ days that can be assumed as planned value. In accordance with (7) we have calculated with 99% and 95% probability the potential losses on case of deviation of the port stay time from the mean value. The results are presented in Table 2.

Table 2. Voyage VaR for a 5300 DWAT general cargo vessel (Constanta-Ravenna) for increase of port stay time

Increase of days in port	99% VaR	95% VaR	Total costs per voyage (USD)	Profit/Loss per voyage (USD)
4%	0.196	0.112	\$ 174,084	\$ 5,916
8%	0.201	0.115	\$ 178,557	\$ 1,443
12%	0.206	0.118	\$ 183,059	\$ - 3,059
16%	0.211	0.121	\$ 187,589	\$ - 7,589
20%	0.216	0.123	\$ 192,146	\$ - 12,146
24%	0.222	0.126	\$ 196,732	\$ - 16,732
28%	0.227	0.129	\$ 201,346	\$ - 21,346
32%	0.232	0.132	\$ 205,987	\$ - 25,987
36%	0.237	0.135	\$ 210,657	\$ - 30,657
40%	0.243	0.138	\$ 215,355	\$ - 35,355

It should be noted that the assumed losses in terms of increase total costs of the voyage will lead to incurring of loss for the implementation of the voyage. The latter is a direct result of the increased port stay time. Vessel operators are able to evaluate efficiently the direct impact of delays of port stay and plan in advance.

The evaluation of VaR in case of changes of MGO bunker prices for the presented voyage rotation are presented in Table 3. As in this case MGO consumption is limited only to port stay time the sensitivity of this factor is low as compared to the time parameter of prolonged port stay time. Planning of bunker supply is also considered as important element of vessel operations and therefore should be planned well in advance taking into account both the price of bunker, additional costs for bunkering and time loss thereof. It should be also noted that bunker prices can be extremely volatile within a short period of time and there is a large variance of

prices between different ports/regions, even for the same standard type of bunker fuels.

Table 3. Voyage VaR for a 5300 DWAT general cargo vessel (Contanta-Ravenna) for increase of MGO price

Increase of MGO price	99% VaR	95% VaR	Total costs per voyage (USD)	Profit/Loss per voyage (USD)
3%	0.195	0.111	\$ 172,900.67	\$ 7,099.33
6%	0.198	0.113	\$ 176,163.33	\$ 3,836.67
9%	0.202	0.115	\$ 179,426.00	\$ 574.00
12%	0.206	0.117	\$ 182,688.67	\$ - 2,688.67
15%	0.209	0.119	\$ 185,951.33	\$ - 5,951.33
18%	0.213	0.122	\$ 189,214.00	\$ - 9,214.00
21%	0.217	0.124	\$ 192,476.67	\$ - 12,476.67
24%	0.221	0.126	\$ 195,739.33	\$ - 15,739.33
27%	0.224	0.128	\$ 199,002.00	\$ - 19,002.00
30%	0.228	0.130	\$ 202,264.67	\$ - 22,264.67

The proposed VaR method allows for realistic conclusions about the expected deviations of the cost and time parameters for certain voyages implementation given the expected variations in MGO prices and port stay time duration. It should be noted that this method, although being straightforward, has certain drawbacks as larger losses (beyond the ones computed) are being ignored. Nevertheless, the application of the VaR method in voyage planning and operations, especially for shorter sailing distances, is a valuable tool for assessment of voyage efficiency.

4. Conclusion

Tramp shipping market, being highly volatile, required metrification of risk and evaluation of vessel operation methods. The present paper has analyzed the applicability of the VaR method for evaluation of voyage efficiency in tramp shipping. The findings have proved that time and cost parameters of the planned voyage and their variations can lead to significant loss in voyage revenue and profit. We have ascertained the system of risk factors that affect the voyage results such as prolonged port stay time, changes in bunker prices, human errors in ship management, weather conditions, omissions in vessel's servicing in ports, delays of cargo delivery in ports, etc. It has been proved that the abovementioned factors can affect directly the cost and time parameters of the voyage. The deviations of the latter lead directly to deviations between planned and actual result of the voyage. The analysis has been conducted on the basis of empirical study of data for actual voyages on the Black Sea and the Mediterranean region for a short sea shipping transportation. The total costs of the voyage and the profit/loss have been calculated. For the purposes of evaluation of the probable deviations of the port stay time and MGO process we have applied the VaR method in order to determine the maximum level of deviation of port stay time and MGO process at a given probability. For the purposes of the correctness of the study statistical analysis has been carried and its results proved the applicability of the VaR method for the evaluation of voyage efficiency. The results can be further used for evaluation of vessel operation activities based on the probabilistic nature of the cost and time parameters as part of the vessel's voyage on the basis of the proposed method for evaluation of vessel's voyage efficiency.

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RO-RO SHIPPING NETWORKS IN THE BLACK SEA REGION AND PORTS CONNECTIVITY: COMPARATIVE ASSESSMENT

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Abstract: The present article presents in detail the concept of ports connectivity of the ro-ro shipping networks in the Black Sea region. The existing ro-ro services in the region are studied in terms of transportation availability, frequency and capacity. A set of port connectivity indices is applied for measuring the interconnections between the ports in the region via ro-ro services. The results demonstrate that the ro-ro shipping network in the region has a potential for development and despite the low cargo volumes, low level of capacity utilization and lack of efficient hinterland connections of ports.

Keywords: RO-RO SHIPPING, PORTS CONNECTIVITY, SHORT SEA SHIPPING, MARITIME PORTS

1. Introduction

Short sea shipping in the European Union has been a focus of extensive studies during the last three decades. The quality of European shipping network is being measured by specific indicators. There are several main measures describing transportation networks, mainly its connectivity and network's port accessibility. It is assumed that networks connectivity shows whether all nodes are reachable from a certain port. The connectivity studies of ro-ro shipping in Europe has not drawn much attention. Connectivity of ports in ro-ro shipping networks is highly relevant as a lot of ports set forth objectives for expansion against the underdeveloped road infrastructure in the hinterland. Due to this reason, Black Sea ports operators strive to increase the volumes of ro-ro shipments as a tool for expanding their market coverage. In order to achieve a larger market share of ro-ro shipments more efficient connectivity between ports is needed. The latter is feasible in case the connections with the hinterland are developed. In view of the latter, the development and application of port connectivity indicators within the European ro-ro shipping network allows for evaluation of the ro-ro network quality.

The present study presents in detail the concept of ports connectivity in ro-ro shipping networks. The applied indicators measure the port performance and the links between the ports in the region. The ports connectivity indicators within the ro-ro shipping network is evaluated and presented on a comparative basis for each country in the region. The results show that the application of such measurement tools help to outline the strengths and weaknesses of the ro-ro shipping networks within the region.

2. Ro-ro shipping in the Black Sea region – issues and challenges

Being part of the European short sea shipping network, ro-ro transportation has attracted considerable attention for the last several decades. The network design is affected by the port operators' strategies, demand for ro-ro transportation and availability of ro-ro vessels. Due to this each port location is determined by the intensity of cargo flows between the ports in the region. The structure of the ro-ro shipping network, the number of service providers and the service frequency are dependent on the status of ports' development and respective cargo volumes. These factors will affect the carrying capacity of the ships employed, number of ports in the service and the schedule. On the other hand, restructuring of ports to specialize in ro-ro shipments will depend on the hinterland access to/from the ports, available port superstructure and infrastructure and the geographical position of the port. Policy issues concern mainly the issues related to cabotage transportation in the form of restrictions (for example, cabotage transportation can be carried out by vessel flying the national flag only), customs formalities for exports and imports of cargo, policies

for development of European transport corridors and the existing form of cooperation between the ports. Last but not least, hinterland connections also matter as these ensure for sustainable and reliable hinterland transport. Higher density of ro-ro shipping networks ensures for minimum transshipments and higher capacity utilization. The service quality is backed up by increased number of sailings, higher turnaround time at ports and higher reliability of services.

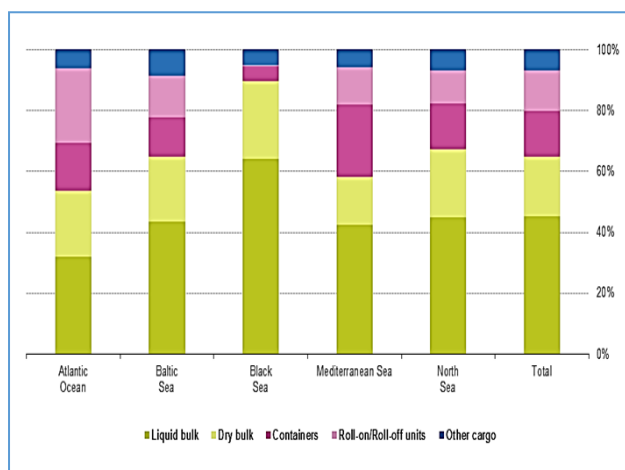


Figure 1. Short Sea Shipping in EU in 2016 [11]

Figure 1 present the volumes of different types of cargoes carried during 2016 via short sea shipping in the EU. Short sea shipping of liquid bulk cargoes prevailed for all the regions during the period - over 64 % of total short sea shipping of goods in the Black Sea [11]. Containerized cargoes accounted for only 5 % of the short sea shipping in the Black Sea, likewise cargoes transported in ro-ro shipments accounted for less than 2% in the Black Sea region.

Unlike the generally adopted perception, short sea shipping has certain disadvantages as compared with road transportation. It is necessary that the efficiency and service quality of short sea shipping is improved as well as the port infrastructure. The latter objectives should include: integration into multimodal transport chains or networks, stimulation of new maritime transport technologies, removal of administrative barriers, creation of reliable market data on existing land transportation that could be used for decision making, integration of border crossing systems, automation of customs and immigration security systems [8]. The advantages of short sea shipping as compared with land transport are:

- higher energy efficiency and environmental performance;
- favorable geographical location of the ports in the region;

- enhanced regional development for some of the countries;
- benefits for the ports development and expansion;
- carrying capacity increase for vessels flying the national flag (cabotage shipping).

As concerns ro-ro transportation in the region there several fallbacks. The frequency and scheduling of services depends mainly on the available for transportation cargo volumes and thus there are imbalances between front hauls and back hauls within the network. There is also the problem with inefficient integration with other modes of transport mainly due to the underdeveloped road structure. The latter impedes the integration of ro-ro shipping into the intermodal supply chains. It should also be noted that ro-ro vessels employed in the region are not of high service speed that leads to longer voyage duration and schedule irregularities. As concerns the marketing of this type of shipments, it should be noted that it is difficult to compete with containerized cargoes freight levels. Figure 2 presents the presently available ro-ro lines in the region, serviced by several operators.

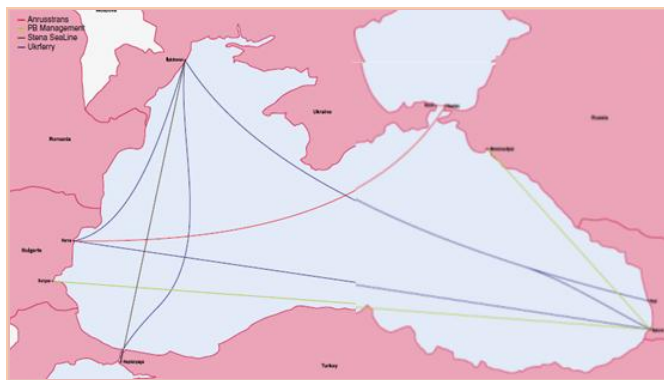


Figure 2. Ro-ro shipping network in the Black Sea region in 2016 [6]

As explained above there are frequency imbalances and variability of market shares among the main ro-ro operators and routes. In addition, shipping companies are faced with the issue of capacity underutilization and therefore general approaches are to be applied for each route/destination. Higher frequency can increase the income and decrease the unit costs by allocating fixed costs to a greater number of departures [7]. Most of the ro-ro operators maintain weekly departures from starting port and only a few maintain departures twice of thrice weekly. One of the methods to increase frequency of service is to include more vessel but the latter would involve considerable investments in assets which could not be paid-off given the low cargo volumes. Presently for all routes low frequency and low extent of capacity utilization are present. We should also consider the seasonal fluctuations in demand whereas cargo volumes will be imbalanced during winter and late autumn periods also due to unfavorable weather conditions. The optimal level of capacity utilization is directly related with the price levels whereas the pressure to reduce the prices for transportation would potentially increase the capacity utilization. Given the high level of competition between ro-ro companies, it is highly unrealistic that potential clients will be able to differentiate between companies on the basis of price other than the routes directions. Another issue is the routes' diversification which is unattainable for most of the companies due to lack of sufficient cargo volumes and lower frequencies of service. There is also the problem of insufficient statistics to evaluate both the market shares and levels of capacity utilization of the ro-ro operators in the region. Table 1 presents the currently operating ro-ro companies in the Black sea region providing regular ro-ro services for trucks, rail wagons and passengers.

Another issue is related with the national jurisdictions as the companies are based in countries with different national legislation.

Table 1. Ro-ro operators in the Black Sea region in 2016 [6]

Ro-ro operator	Routes	Type of service
Akdeniz Ro-Ro (Turkey)	Eregli-Chernomorsk Samsun - Novorossiysk Samsun - Gelnzhik Samsun-Tuapse	ro-ro
Anrusstrans (Russia)	Kavkaz - Krym Kavkaz-Varna	ro-pax
PB Management (Bulgaria)	Bourgas - Batumi - Novorossiysk	ro-pax
Stena SeaLines (Turkey)	Chernomorsk - Haydarpasa	ro-pax
Ukrferry (Ukraine)	Chernomorsk - Varna Chernomorsk - Poti Chernomorsk - Batumi Varna - Batumi Chernomorsk - Haydarpasa	ro-pax

Other parameters are to be taken into consideration as well. These include the integration of ro-ro shipping into the existing intermodal chains (for example transport corridors IV and VII of the EU network), selection of optimal routes, the time needed for the trucks and rail wagons to reach the ports or the final destination from the port. As for the ports in the area there are certain problems that are to be overcome: inefficient port infrastructure; lack of efficient connections with the hinterland and the potential delays in ports due to that; considerable differences in port charges that result in different disbursement accounts for the ships, etc. Therefore, ro-ro operators must focus on the following strategic objectives – increase frequency and reliability of services, enhance service quality and achieve cost efficiency via increase of capacity utilization.

3. Measuring ports connectivity of ro-ro shipping networks in the Black Sea region

Ro-ro connectivity measures the extent of the ports in the network being connected to each other [2]. The data used for this study have been collected from the companies' websites as concerns routes, vessels and schedules and refer to year 2018 [9,10, 12,13,14]. It is assumed that the websites of the ro-ro operators present accurate data as concerns timetables, vessels' types and capacity and routes (Table 1). The study uses the following data, providing the variables needed: travel time, frequency of service, level of interconnectivity and the number of service operators. As concerns frequency of service this represents the number of sailings from the first port every week (officially published timetable of departures and arrival from/at each port).

In this part of the study we apply a method to measure the ports connectivity of the ports within the ro-ro shipping network. It is important, therefore, to establish the components of the connectivity indicators and how the indicator is calculated [4].

Unlike the feeder networks of containerized cargoes there is almost no transshipments in ro-ro shipping which is due to the shorter distances and the direct interrelation between transportation prices (freight) and time. Therefore, all connections between the ports in the ro-ro network are direct and are taken into account for the evaluation of the ro-ro network connectivity and calculation of connectivity indices.

For the evaluation of the connectivity of the ro-ro network in the Black Sea region we apply the beta index and gamma index measures developed by [1, 4, 5]. The first index evaluates the number of connections for each port being a quotient (Formula 1):

$$\beta = L / n \quad (1)$$

where

L = number of links for each port;

n = number of ports in the country, servicing ro-ro shipments.

Gamma index is an aggregate value showing the level of connectivity of the network being the ratio between the number of actual links and the maximum number of potential links [5]. Gamma index is expressed by Formula 2:

$$\gamma = L / [n*(n-1)] \quad (2)$$

In addition, on the basis of the data available, for each ro-ro operator in the region we have collected the following data presented in Table 2. The number of links presented for each country are based on one-way directions only.

Table 2. Number of nodes and links of the Black Sea region ro-ro shipping network [company web sites]

Country	Number of nodes per country (n)	Number of links (L)
Georgia	2	5
Bulgaria	2	5
Turkey	4	6
Ukraine	1	5
Russia	4	7

The applied indices can be used for measuring the connectivity of various types of transportation networks. For the calculation of the indices the following limitations have been applied [3]:

- ro-ro service is considered as regular transportation linking a certain set of ports in the region;
- ro-ro services considered have a minimum of weekly departure from the first port in the service;
- several of the ro-ro operators are servicing same ports and nevertheless these are considered as separate ro-ro services;
- intra-national services are considered only in cases where same is part of an international (regional) ro-ro service.

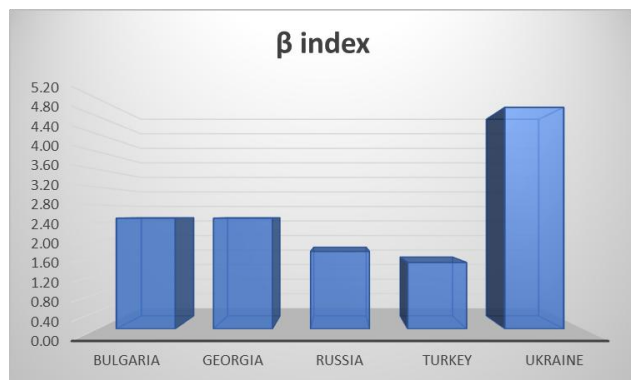


Figure 3. Beta index for each country in the region [own calculation]

As shown in Figure 3, Bulgaria and Georgia have an equal beta index at 2.5 having two ports each and 5 links respectively. As for Turkey, the beta index is at value 1.5 having four ports and six links within the network. Ukraine is present with only one port in the network (Chernomorsk) and five links thus having beta index equal to 5. Russia is relatively well presented with four ports and seven links leading to beta index of 1.75.

As explained above, gamma index represents the ratio between the number of actual links and the maximum number of potential links [5]. Figure 4 presents the gamma index for the ro-ro network in the Black Sea region evaluated on the basis of available data.

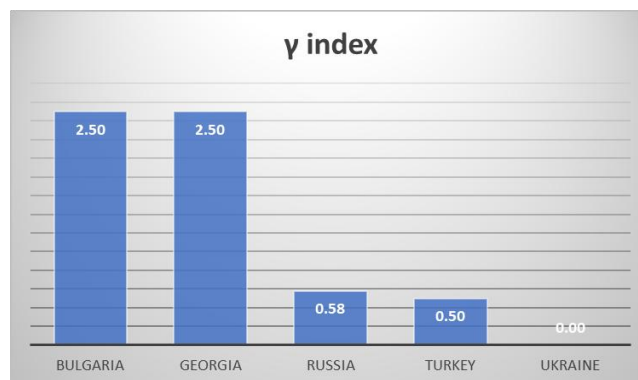


Figure 4. Gamma index for each country in the region [own calculation]

Gamma indices for Bulgaria and Georgia are at the same level for the described network, while for Russia and Turkey it is about five times lower mainly due to bigger number of ports and links. An interesting observation is the gamma index for Ukraine, presented in this network by only one port but with five links, which clearly denotes that there is a need for inclusion of other nodes in the network to improve the country's ro-ro connectivity.

Ports connectivity in the region can contribute to the increase of cargo flows and ports throughput. On the other hand, it is proved that higher connectivity leads to decreased costs of trade flows between the region and other regions in Asia and Europe. The higher the number of ro-ro connections, the higher the share of short sea transportation in intermodal chain. It should be also noted that the hinterland connections are a vital element of the network in terms of increasing the quality of port services.

Ports connectivity in the modern ro-ro network in the Black Sea region is also related to the overall performance of the regional ports. It promotes intermodal connectivity of the port being considered as a key element of supply chains. Ro-ro transport and increased ports connectivity should promote quality customs formalities to ensure for faster turnover of goods and transfers from and to the ports. On the other hand, higher levels of port connectivity will decrease road congestions due to modal shift to ro-ro shipments.

Ports connectivity of the ro-ro shipping network can be analyzed also on a comparative basis with adjacent regions (for example the EU Mediterranean region) or with a group of ports. As leading indicators, the average values of the indices should be taken into account to achieve realistic comparison of the ro-ro connectivity of several regions.

4. Conclusion

The present paper has presented a study on the applicability of port connectivity indices to Black Sea ro-ro shipping network. Port connectivity is a valuable tool for policy makers and ro-ro operators as it provides guidelines for the development of this network feature.

The applied indices are similar to the already developed by UNCTAD liner shipping connectivity index (LSCI) related to liner shipping (containerized cargoes). However, unlike container liner shipping, ro-ro shipping does not involve transshipments and ro-ro services are direct services [4]. The main reason behind this type of transportation via short sea routes is the carriage of goods that are of high value and are time-sensitive. Over 50% of the ro-ro operators in the Black Sea region offer service both for freight (trucks and rail wagons) and for passengers. The application of the beta and gamma indices to measure the port connectivity of the ro-ro transportation in the Black Sea region show that the port of Batumi, Georgia is the port with most connections in the region. The latter is due to its connections with ports in Bulgaria, Russia and Ukraine. We proved that the port of Chernomorsk has the highest link quality which is

due to the high frequency of ro-ro services. The potential topics for further research should include: adding additional variables for development of more complicated indicators to measure ro-ro connectivity of ports based on frequencies and number of service providers, expanding the application of port connectivity indices to include the available links with dry ports in the hinterland and analysis on the issue whether ro-ro connectivity indices influence the trade volumes and trade flows.

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СИСТЕМАТА ВОДАЧ- АВТОМОБИЛ –СРЕДА И УЧАСТИЕТО НА ПЕШЕХОДЦИТЕ В НЕЯ

THE DRIVER-AUTOMOBILE SYSTEM -THE ENVIRONMENT AND THE PARTICIPATION OF THE PEDESTRIANS IN IT

ВОДИТЕЛЪ-АВТОДОРОЖНАЯ СИСТЕМА И УЧАСТИЕ ПЕШЕХОДОВ В НЕЙ

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Abstract: The most vulnerable part of the external environment in the driver-car-environment system is pedestrians. Unpredictable behavior, the large age range, coupled with inadequate transport culture, place these road users at risk of accidents. With the increase in road traffic, the problems with the protection of life and pedestrian health require thorough analysis and adequate solutions.

Keywords: PEDESTRIANS, TRAFFIC SAFETY

1. Увод

Системата водач-автомобил-среда е съвкупност от целенасочено взаимодействащи елементи, които са свързани организационно. Понятието среда включва в себе си: път, природни и климатични условия, микроклимат в автомобила, условия на движение т.е други участници в движението-превозни средства и пешеходци, правила за движение и други нормативни документи.

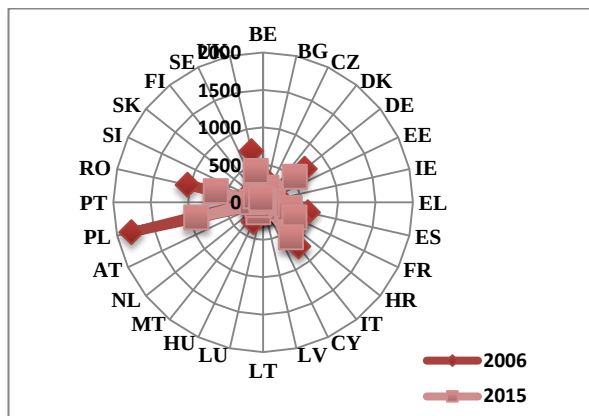
Националната стратегия за подобряване безопасността на движението по пътищата на Република България за периода 2011-2020г. е политически рамков документ, задаващ насоките за изпълнение на политиката за подобряване условията за движение по пътищата и намаляване на жертвите при пътнотранспортни инциденти. Стратегическият документ е израз на политическата ангажираност на правителството на европейското развитие на България и е в съответствие с неговата програма 2009-2013 г. и Стратегията за национална сигурност на Република България 2011-2020г. Стратегията се вписва в контекста на развитието на европейските политики в областта на безопасността на движението и обявено от ООН „Десетилетие за активни действия за безопасност на движението по пътищата 2011-2020г [1].

В европейски план усилията се концентрират във въвеждане на стандарти за автомобилен дизайн по отношение на качеството на пасивната безопасност и в изграждане на подходяща инфраструктура за намаляване на честотата и тежестта на ПТП с участието на пешеходци. Годишните данни за смъртните случаи при пешеходците в държавите-членки на ЕС, Исландия, Норвегия и Швейцария от 2006 до 2015 г. са представени в табл.1. Латвия, Ирландия, Словения и Дания имат най-значително намаление на смъртните случаи при пешеходците между 2006 и 2015 г.(над 55%). В Гърция, Хърватия, Унгария и Полша смъртните случаи за пешеходците намаляват почти наполовина, докато в Швеция, Португалия и Холандия намаляването на смъртните случаи при пешеходци е по-ниско от 10% [2].

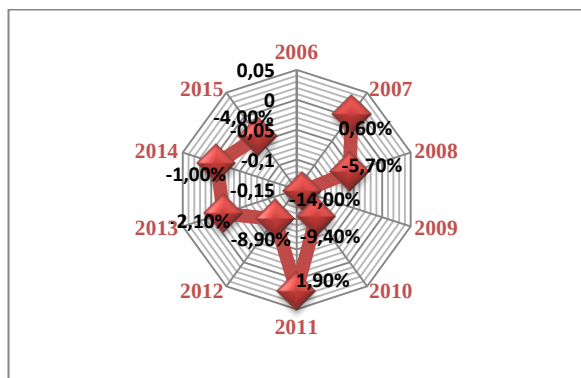
От данните в табл.1 и фиг.1÷3 се вижда ясно динамиката и положителните тенденции за намаляване на жертвите-пешеходци в страните от ЕС.

Табл.1 Данни за смъртните случаи на пешеходци в страните от ЕС

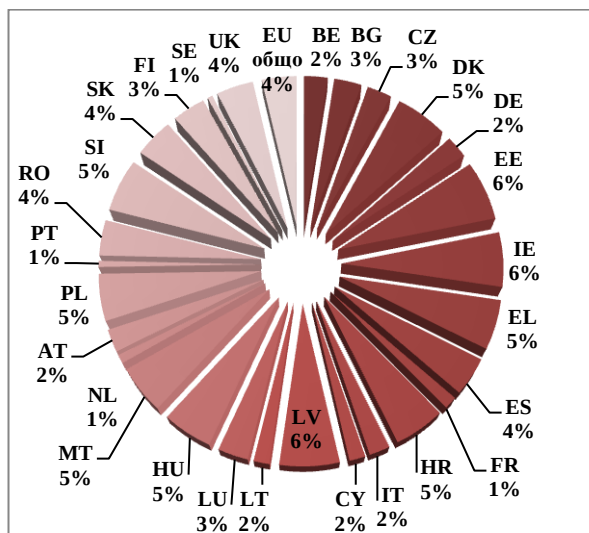
Държава	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	средно за страната	процентно намаление спрямо 2006г.
BE	122	104	99	101	106	113	104	99	106	92	104,60	24,59%
BG	278	278	278	198	198	198	198	198	198	198	222,00	20,78%
CZ	202	232	238	176	168	176	163	162	130	150	179,70	25,74%
DK	60	68	58	52	44	33	31	33	22	27	42,80	55,00%
DE	711	695	653	591	476	614	527	561	527	545	590,00	23,35%
EE	64	38	41	23	14	26	29	23	26	24	30,80	62,50%
IE	72	81	49	40	44	47	29	31	31	31	45,50	56,94%
EL	267	255	248	202	179	223	170	151	125	128	194,80	52,06%
ES	614	591	502	470	471	380	370	371	336	367	447,20	40,23%
FR	535	561	548	496	485	519	489	465	499	466	506,30	12,90%
HR	124	124	136	103	105	71	72	69	73	61	93,80	50,81%
IT	758	627	646	667	621	589	576	551	578	602	621,50	20,50%
CY	19	17	16	9	13	13	10	8	10	16	13,10	15,79%
LV	153	158	105	82	79	60	62	70	71	63	90,30	58,82%
LT	0	-	-	-	-	-	-	96	109	81	71,50	15,63%
LU	10	7	6	12	1	6	6	5	3	7	6,30	30,00%
HU	296	288	251	186	192	124	156	147	152	149	194,10	49,66%
MT	4	3	1	4	2	2	2	2	2	2	2,40	50,00%
NL	66	86	56	63	62	65	64	51	50	60	62,30	9,09%
AT	110	108	102	101	98	87	81	82	71	84	92,40	23,64%
PL	1802	1951	1882	1467	1236	1408	1157	1140	1116	915	1407,40	49,22%
PT	156	156	155	148	195	199	159	144	145	146	180,30	6,41%
RO	1034	1113	1067	1015	868	747	728	726	697	649	864,40	37,23%
SI	36	32	39	24	26	21	19	20	14	16	24,70	55,56%
SK	214	217	204	113	126	126	126	126	126	126	150,40	41,12%
FI	49	48	53	30	35	41	29	34	36	32	38,70	34,69%
SE	55	58	45	44	31	53	50	42	52	52	48,20	5,45%
UK	697	663	591	524	415	466	429	405	464	427	508,10	38,74%
EU общо	8508	8559	8069	6841	6290	6407	5836	5716	5660	5425	6742,10	36,12%
Година промяна		0,60%	-5,70%	-14,00%	-9,40%	1,90%	-8,90%	-2,10%	-1,00%	-4,00%		
IS	4	1	0	2	2	4	2	1	0	1	1,70	75,00%
NO	36	23	31	26	24	16	22	18	18	12	22,60	66,67%
CH	76	79	59	60	75	69	75	69	43	58	66,30	23,68%



Фиг.1 Брой на жертвите пешеходци за страните от Европа



Фиг.2 Годишна промяна в % за периода 2006÷2015 г.



Фиг.3 Намаление в проценти за 2015г. в страните в Европа спрямо 2006

Относителният дял на загиналите пешеходци при ПТП в нашата страна е един от най-високите спрямо страните от Европейския съюз и е обусловен преди всичко от високата конфликтност на пътната инфраструктура в населените места, слабото разделение на транспортните от пешеходните потоци, ниската транспортна култура и дисциплина на пешеходците, неадекватната скорост на движение и др.

2. Предпоставки и начини за разрешаване на проблема

Човешкият фактор в системата от една страна водач, а от друга пешеходец, трябва да възприема голямо количество информация за характера и режима на движението на другите участници в движението, пътя и околната среда. Този процес

изисква определено време, а ситуацията се променя много бързо и може да се вземе грешно решение или неправилно действие поради следните обективни причини:

- недостатъчно време за процеса „възприемане – действие“;
- възприетата информация не отговаря на действителността;
- информацията е оценена и се обработва неправилно;
- изпълнено е неправилно действие.

Съществуват и обективни причини които стимулират допускането на грешки като: бърза промяна на характеристиките на движението и пътната ситуация, състояние на пътя, внезапен отказ на автомобила.

Рискът за пешеходеца да бъде убит при произшествие на един пропътуван километър е 9 пъти по-висок, отколкото за пътника в моторно превозно средство. Пешеходците и велосипедистите са най-уязвимата група участници в движението.

Най-застрашени да бъдат блъснати от автомобил през есенно-зимния период са възрастните пешеходци. В основната рискова група попадат главно мъжете на възраст над 50 години, носещите тъмни връхни дрехи, имащите опасния навик да пресичат пътното платно където и да било, без да изчакват преминаването на приближаващите автомобили.

Фактът, че са регистрирани случаи на загинали пешеходци, на очертани или не с пътна маркировка пешеходни пътеки, води до заключението, че нивото на пътна култура на водачите, тяхната теоретична и практическа подготовка, както и психологическата им зрялост следва да се оценят като ниски по отношение задължението и отговорността на водачите да пазят живота и здравето на уязвимите участници в движението каквито са пешеходците.

Безопасността на децата-участници в пътното движение е един от най-сложните проблеми на обществото. Той е особено актуален, тъй като е пряко свързан с опазване на живота и здравето на децата днес от една страна, и с подготвянето на знаещи, културни и дисциплинирани участници в движението утре.

Четири са основните моменти от всекидневието на децата, когато е застрашена тяхната безопасност на пътя: в играта на улицата, на път до училище и обратно, при каране на велосипед, кьнки, скейтборд и др. и при използване на МПС за обществен превоз.

Децата като участници в движението влизат в различни роли: на пешеходци, водачи и пътници в превозни средства. Всяка една от тях крие специфични опасности за здравето и живота им, когато са на пътя.

Всеки ден повече от три деца стават жертва на ПТП по пътищата в нашата страна. От тях 43.2% като пешеходци, 39,4% като пътници и 17,4% като водачи на велосипеди, мотопеди, мотоциклети, каруци и др. Най-голяма е смъртността при децата пътници. Пътнотранспортните произшествия са третата по ред причина за смъртността на децата от 1 до 14 годишна възраст.

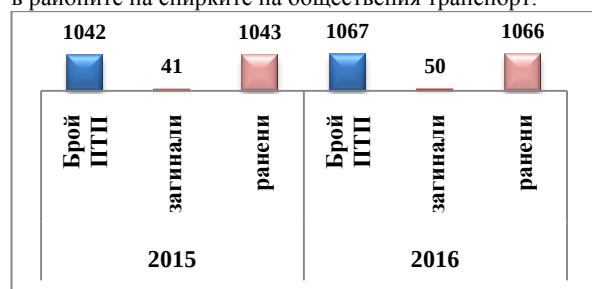
3. Резултати и дискусия

През 2010 г. по пътищата на страната при ПТП са загинали 174 и тежко ранени 2030 пешеходци.

От загиналите през 2015 г. 708 участници в движението 48,87% са водачи, 27,82% са пътници и 23,16% са пешеходци [3]. Основният брой тежки произшествия са регистрирани в големите населени места. Повече от 50% от жертвите на ПТП са хора на възраст над 65 години. Голяма част от ПТП с пешеходци настъпват в тъмната част от денонощието. Висока е пешеходната аварийност в зоните на пешеходните пътеки и спирките за МПС за обществен превоз на пътници.

Пешеходците са най-застрашени в периода от настъпването на сумрака и през цялото времетраене на вечерта. Най-много злополуки с тях стават между 17.00 и 20.30ч. Причините най-често са съчетание на несъобразена скорост на водачите при движение на фарове и неправилно движение и присъствие на пешеходците на платното в същия момент.

По причина отнемане на предимство фиг.4 на пешеходец настъпилите ПТП най-често възникват в населени места, в зони между кръстовищата, на пешеходни пътеки, вследствие неправилно движение на пешеходците по платното или неправилно и внезапна навлизане в зоните на кръстовище, в районите на спирките на обществения транспорт.



Фиг.4 Отнемане на предимство при пешеходци

Друга основна причина за настъпване на ПТП е поради нарушения на правилата за движение на пешеходци. През 2015г. по тази причина са настъпили 114 ПТП с 14 загинали и 101 ранени. От данните за нарушения извършени от пешеходци се налага изводът, че преобладаващият брой ПТП при този вид нарушения е при съвина на водачите и пешеходците – неправилно движение на пешеходците и несъобразена или превишена скорост на водача в населено място.

Следва да се има предвид обаче, че този вид пътни инциденти се касае за сериозни травми, причинени от неравностоен и несравним по сила удар между участниците в сблъсък, което определя тежестта на вида ПТП “блъсване на пешеходец”, като изключително висока.

В рамките на "транспортния модул" на ЕС претърпелите наранявания при ПТП се записват като процент на жертвите в болница, средната продължителност на престой, характер и вид на увредената част от тялото и потенциално и дългосрочни последици от нараняванията.

Настъпилите ПТП (фиг. 4 и фиг.5) в повечето случаи са от преждевременно действие, което се отчита много по-често при пешеходците, отколкото при водачите и се описва като критично събитие с действие, започнало твърде рано, преди подаването на сигнал или установени условия. Този контраст между групите участници показва сценарии, при които един пешеходец започва действие твърде рано без право на път, а водачите реагират твърде късно, или не предприемат възможни действия.



Фиг.5 Брой настъпили ПТП със загинали и ранени на характерни места в населени места

4. Заключение

Основните пречки пред пешеходното движение са лошите тротоари, ниската безопасност, конфликтът между пешеходци и автомобили, препятствия в инфраструктурата. Велосипедното придвижване /което е една 1,8% от видовете транспорт/страда от лоша инфраструктура, липса на безопасност, липса на свързаност и мръсен въздух.

Тези препоръки са извлечени от анализа на най-характерните пътно-транспортни произшествия, настъпващи през есенно-зимния период, и биха спомогнали за изграждане на защитно поведение на участниците в пътното движение, което би предотвратило злополуки със самите тях и другите на пътя.

Броят на инцидентите с участието на пешеходци може да бъде намален чрез:

- ограничения на скоростта в определени зони;
 - непрекъснати тротоари;
 - подходящо улично осветление;
 - носене на светлоотразително облекло;
 - подходящо проектирана предна част на автомобилите (за намаляване на травмите).
- Финансирани от ЕС проекти за предпазване на пешеходците са: Системата „Watch-over“, състояща се от сензори с малък обхват, сигнализира при опасност от сблъсък на автомобила с пешеходец, позволявайки на водача да завие или да спре. Проекти като „APROSYS“ изследват как промени във формата на предната част на превозно средство могат да намалят риска от наранявания за пешеходците.

5. Референции:

- НС за подобряване безопасността на движението по пътищата на Република България за периода 2011-2020г
- <https://ec.europa.eu>
- Бюлетин Автоматизирана информационна система „Отчет и анализ на ПТП“

INFORMATION SUPPORT FOR DECISION-MAKING WHILE FORECASTING AVIATION PERSONNEL'S PROFESSIONAL DEVELOPMENT LEVEL

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Abstract: The paper relates to the field of research of "human factor" in civil aviation. It concerns the influence of human factor on the procedures aimed at aviation security provision in airports. The work continues a series of the author's articles on the problem of "human factor" in Russian civil aviation. In this paper, special attention is devoted to the information support for decision-making while forecasting professional development level of aviation personnel who is involved into aviation security provision in airports.

Keywords: aviation security, human factor, aviation personnel's professional development level, forecasting, information support for decision-making.

ВВЕДЕНИЕ

Представленные ранее работы автора [1,2] в области прогнозирования уровня профессиональной подготовки авиационного персонала требуют логического завершения, в качестве которого автор предлагает материал, связанный с вопросами информационной поддержки принятия решений при прогнозировании. Основной вопрос, решаемый в рамках системы принятия решений, состоит в определении метода прогнозирования, статистического или квалиметрического, что определяется конкретной ситуацией в аэропорту, точнее наличием идентифицируемых параметров прогноза. Метод экспресс-прогнозирования включает такой анализ и дает возможность принять ту, или иную альтернативу.

ПОСТАНОВКА ЗАДАЧИ И МЕТОДЫ РЕШЕНИЯ

Решение сформулированной задачи квалиметрического прогнозирования уровня мобилизационной готовности персонала САБ с использованием кусочно – линейной аппроксимации может быть получено в рамках алгоритма, представленного на рисунке 1. Некоторые этапы алгоритма требуют комментария.

На этапах 1-3 решается задача выбора метода прогнозирования. На этапах 1-2 идентифицируется объект прогнозирования с точки зрения его формального представления и исследуются исходные данные, т.е. на данном этапе должны быть получены ответы на следующие вопросы:

- возможно ли описание исследуемого процесса с помощью временных рядов,
- достаточно ли статистических данных для определения характера огибающей временного ряда,
- возможно ли формирование экзаменационной и обучающей выборок,
- возможно ли формирование и использование критериев оценки качества прогноза,
- возможно ли формирование совокупности альтернативных прогнозов,
- какой уровень точности прогнозирования является необходимым и достаточным с учетом некоторой неопределенности при формировании исходных данных, зависящей от экспертного характера оценочных процедур,
- имеет ли авиапредприятие достаточное количество ресурсов для решения задачи прогнозирования статистическими методами,
- каков порядок совокупности объектов, подлежащих прогнозированию,

- удовлетворяет ли авиапредприятие соотношению «цена – качество» для рассматриваемого процесса прогнозирования.

При получении всех положительных ответов задача решается статистическими методами с использованием соответствующего алгоритма.

При получении хотя бы одного отрицательного ответа лицо, принимающее решения (ЛПР), имеет две альтернативы:

1. Провести дополнительные исследования, эксперименты и мероприятия, в результате выполнения которых ответы на все, приведенные выше, вопросы становятся положительными.
2. Отказаться от использования методов статистического прогнозирования.

Переход ко второй альтернативе означает выбор для решения исходной задачи квалиметрического прогнозирования.

Этапы 4-5 включают процедуры измерения уровня мобилизационной готовности как минимум в двух точках, проведение линейной аппроксимации по этим точкам и анализ прогнозного значения временной точки, в которой уровень $R_{\text{мг}}$ опасно приближается к критическому значению.

На этапах 6-7 формируется следующий участок кусочно-линейной аппроксимации. Если на этом участке не сохраняется монотонно-убывающий характер изменения аппроксимируемой кривой $R_{\text{мг}}$, процедура приобретает

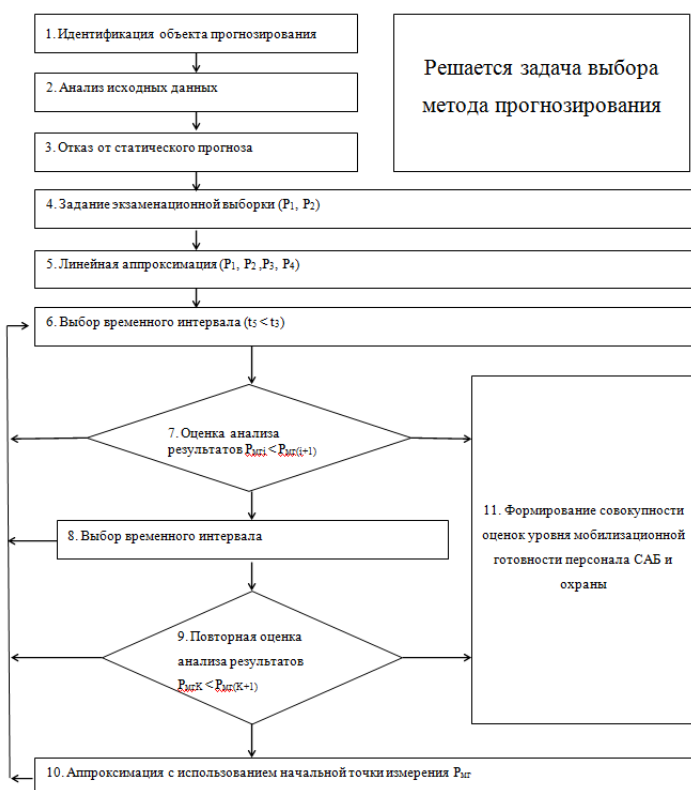


Рисунок 1. Алгоритм квалиметрического экспресс-прогнозирования уровня УМГ.

циклический вид и идет последовательное формирование отрезков аппроксимации.

В противном случае – переход к этапам 8-9 для реализации процедуры выбора нового временного интервала измерения $P_{мг}$. При неудовлетворительном результате возможен переход к начальной точке аппроксимации (этап 10). На всех этапах анализа (7,9) происходит формирование совокупности статистических оценок $P_{мг}$ (этап 11), которые накапливаются с целью дальнейшего использования, в том числе и для статистического прогнозирования.

Ниже представлен алгоритм реализации метода квалиметрического прогнозирования (Рисунок 2).

Введем некоторые обозначения.

t_x – момент времени в который выполняется условие: $P_{мг} - P_{мгн} = 0$. Т. е. это момент пересечения прямой прогноза с нормальным уровнем мобилизационной готовности $P_{мгн}$;

t_y – момент времени последней рассматриваемой точки;

t_y' – момент времени предпоследней рассматриваемой точки. t_y и t_y' вводятся для того, чтобы заиклнить данный алгоритм, так как возможны несколько способов прогнозирования в зависимости от ситуации;

t_z – момент времени находящийся за 1/5 от временного отрезка $[t_y; t_x]$ до наступления t_x , но не позднее чем через 6 месяцев от момента t_y . В этот момент сотрудник должен будет пройти следующее тестирование.

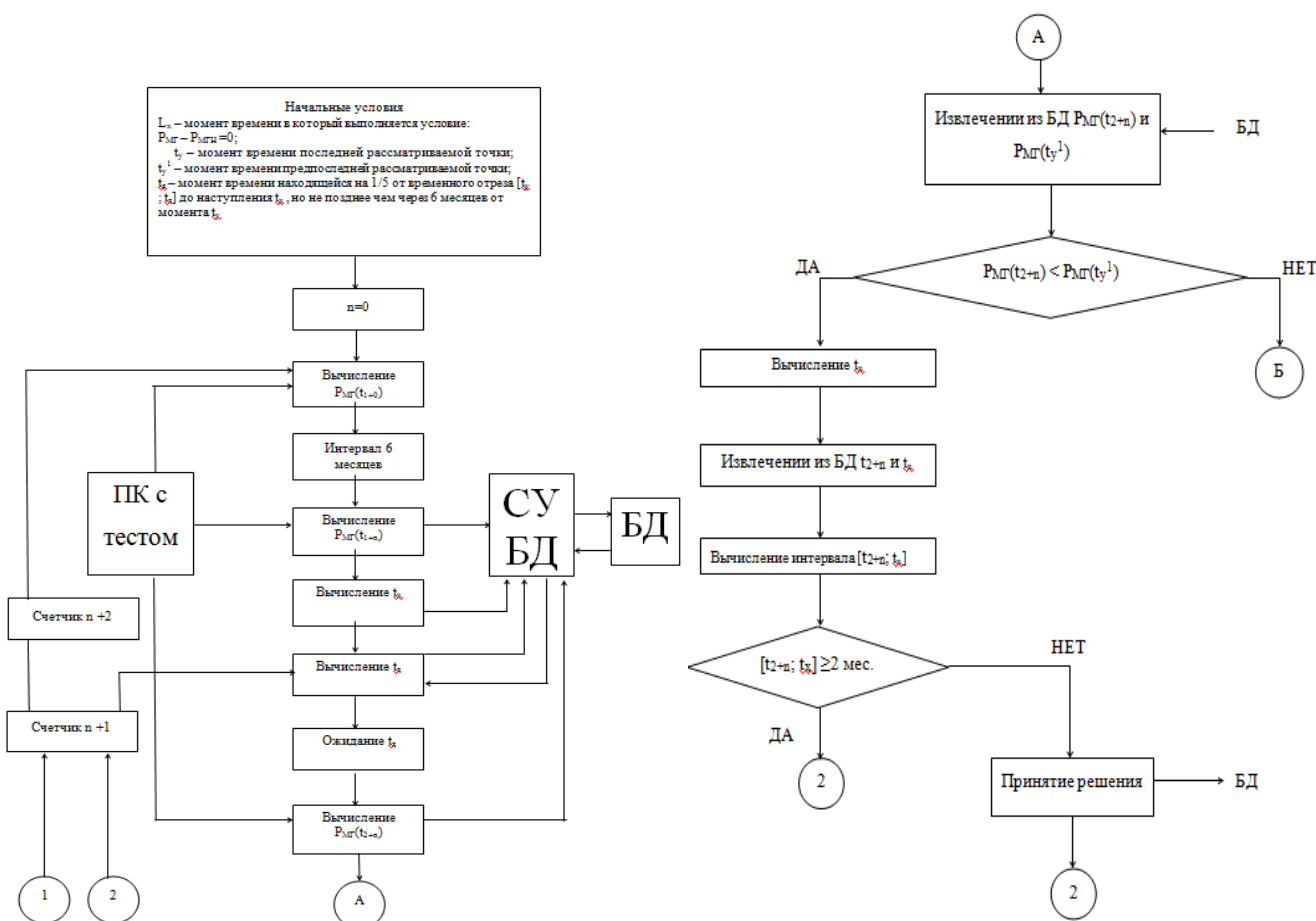
Подчеркнем, что все цифровые данные основаны на опыте реальной производственной деятельности и соответствуют нормативным документам по авиационной безопасности.

Здесь еще раз необходимо отметить, что точность квалиметрического прогнозирования определяется выбором временных интервалов и точек, в которых происходит измерение (оценка) $P_{мг}$, и, при удачном решении этой задачи, является вполне удовлетворительной. Существенное сокращение количества точек измерения $P_{мг}$ по сравнению с равномерным подходом позволяет говорить также об экономической эффективности метода.

На рисунке 3 представлена укрупненная структурная схема подсистемы информационной поддержки ЛПР в процессе статистического прогнозирования. Схема отражает только основные концептуальные решения по созданию системы [2,4].

Блок тестирования представляет тематический вопросник, который формирует квалиметрические оценки в зависимости от характера ответов и выставляет соответствующую оценку в баллах. Совокупность этих оценок служит для прогнозирования уровня $P_{мг}$.

Рисунок 2. Алгоритм реализации метода квалиметрического прогнозирования.



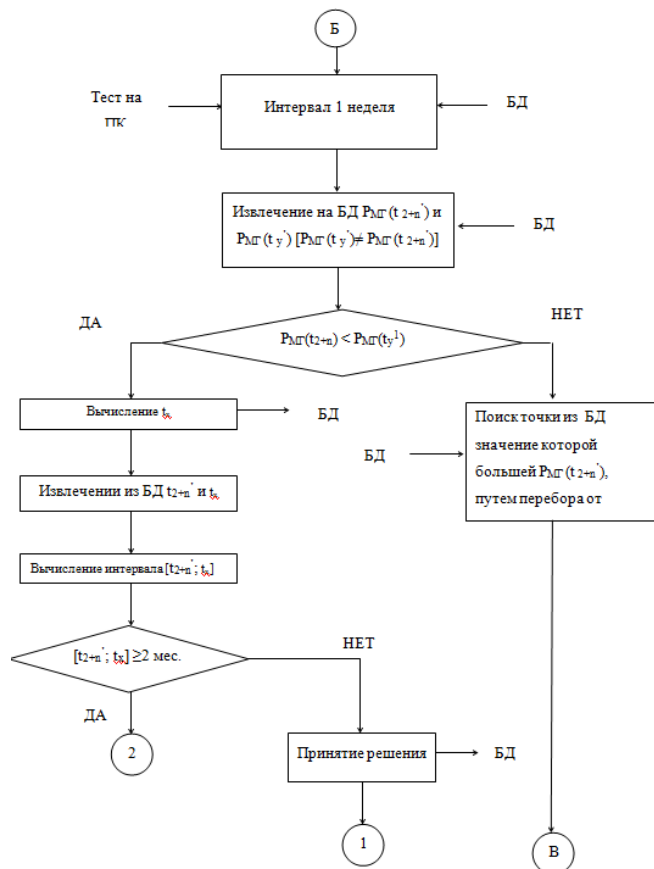


Рисунок 2-3

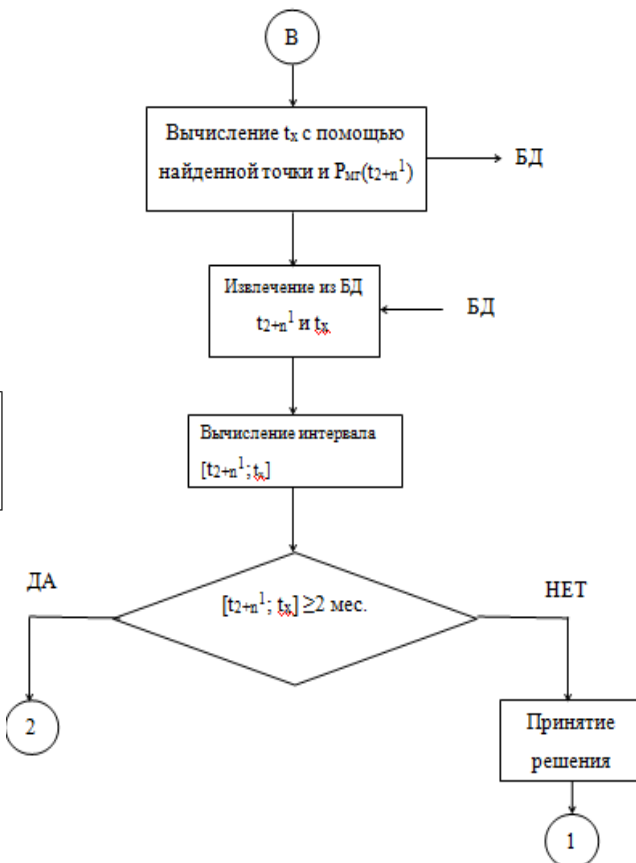
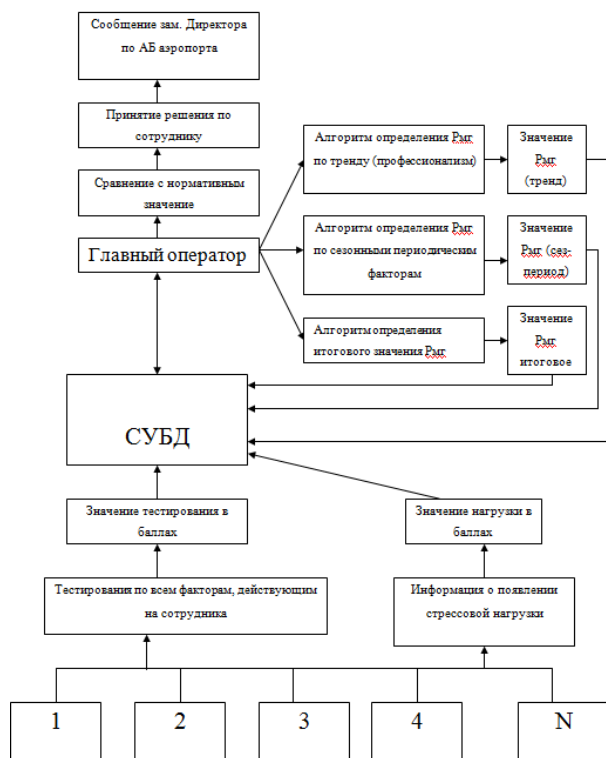


Рисунок 2-4



1, 2, 3, 4...N - сотрудники

Рисунок 3. Структурная схема подсистемы информационной поддержки ЛПР в процессе статистического прогнозирования

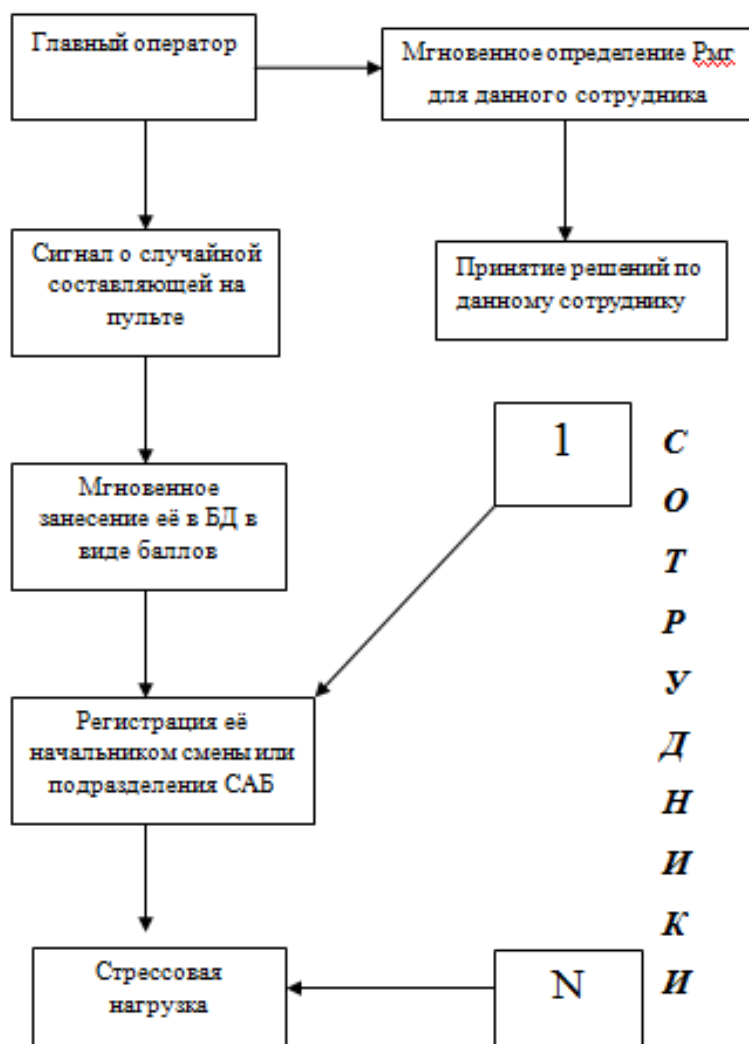
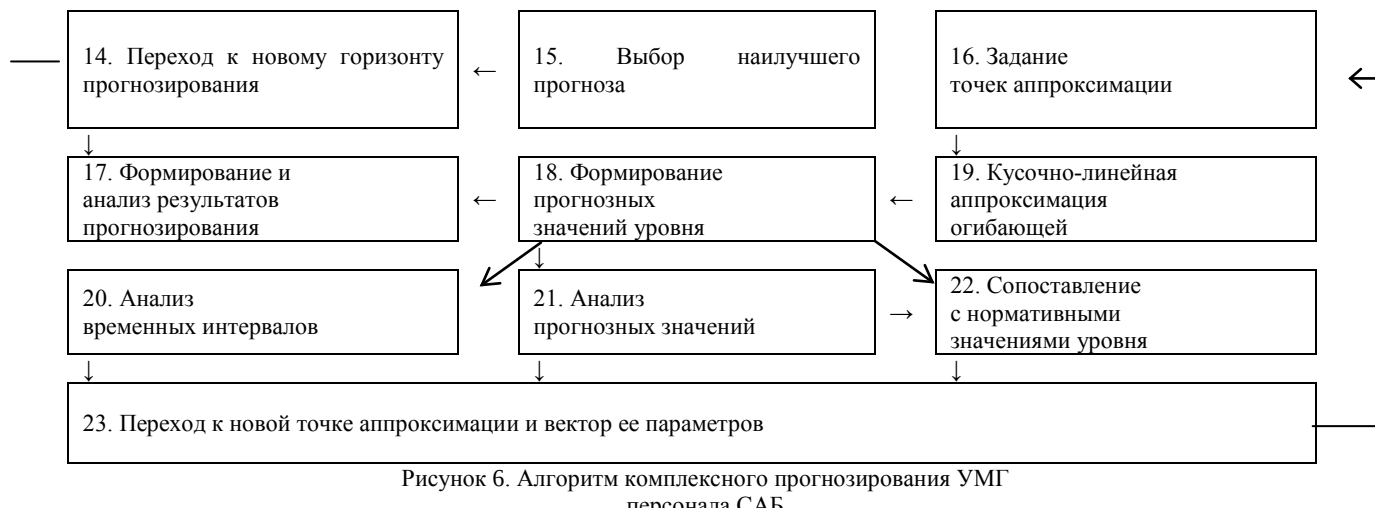


Рисунок 4. Системный элемент, реализующий функции системы при появлении случайной составляющей

С целью обеспечения оптимальных путей внедрения в производственную деятельность авиапредприятий предложенных подходов и методов ниже представлен алгоритм комплексного прогнозирования уровня мобилизационной готовности персонала САБ (Рис. 6).





Некоторые этапы алгоритма нуждаются в комментариях.

Этап 1 заключается в осмысливании результатов исследования факторов, влияющих на уровень мобилизационной готовности персонала САБ и охраны, в результате чего решается вопрос о формировании тренда и других составляющих временного ряда в его аддитивном разложении.

На этапах 2, 3, 4 формируются статистические оценки уровня мобилизационной готовности и решается вопрос о выборе методики прогнозирования: статистической (7) или квалиметрической (13).

Этапы 5, 6, 8, 9, 10 относятся к статистическому прогнозированию. Выбор наилучшего прогноза (этап 15) осуществляется квалиметрическими методами на основе оценки качества прогноза (этап 12) с помощью соответствующих критериев (этап 11). Прогнозные значения на определенный период времени фиксируются (этап 17), анализируются и по результатам анализа принимается решение об адекватности уровня мобилизационной готовности требованиям, формируется и реализуется план соответствующих мероприятий, после чего осуществляется переход к новому горизонту прогнозирования (этап 14).

Этапы 16, 19, 20, 21, 22, 23 реализуют методику квалиметрического прогнозирования. При этом полученные результаты (прогнозные значения) объединяются с результатами статистического прогнозирования (этап 17) и исследуются по той же схеме.

Следует заметить, что здесь основные решения принимаются компетентным специалистом или соответствующим управленческим органом. Комплексный алгоритм применим как для решения достаточно сложных задач в условиях избытка статистических данных, так и для решения простых задач экспресс - прогнозирования при отсутствии таковых [5,6].

ЗАКЛЮЧЕНИЕ

Предложенные решения образуют единую, с точки зрения программного контента, информационную систему. Это важно, поскольку вопросы, связанные с проблемами «человеческого фактора», тем более с проблемами управления уровнем профессиональной подготовки авиационного персонала, решающего задачи обеспечения авиационной безопасности аэропортов, могут быть реализованы только в условиях автоматизированного управления, где информационная поддержка процедур прогнозирования представляет локальную функцию в совокупности множества функций, определяющих целевой функционал всей автоматизированной системы управления службой авиационной безопасности.

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DEVELOPMENT OF THE MARKET OF AVIATION TRANSPORTATION IN UKRAINE: PROBLEMS AND PROSPECTS

Развитие рынка авиационных перевозок в Украине: проблемы и перспективы

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Abstract: It is determined that civil aviation in Ukraine has a number of problems that are the result of a chronic crisis in the deep fields of the industry. It is revealed that the "open sky" policy acts as an incentive to increase competition. The analysis of dynamics of the air transportation market of Ukraine is carried out. The decline in demand for air transportation in Ukraine is considered as a continuation of the negative trends in the national economy. The analysis of the Ukrainian airlines market has showed that the share of 4 leading airlines in the total volume of passenger traffic was almost 93 %. Regular flights between Ukraine and rest of the world were carried out by 9 domestic airlines (to 39 countries of the world) and 35 foreign airlines from 29 countries of the world. The ratio between international and domestic transportations of Ukrainian carriers during the year amounted to 85 % and 15 % in favor of international ones. It was found out that leading aviation carriers do not meet the modern requirements of the world aviation community. The study of the air transportation market in relation to specialization by types of business has revealed that nine major types of air carriers were formed. Functioning of Low Cost business model on the market provides a significant change in the structure of aviation. The main specific features of the stages of development of Low Cost business-model airlines are determined. The analysis of the situation on the air transport market was conducted on the basis of PEST-analysis. Measures that make it possible to intensify the process of development of the market of aviation transportations are listed: renewal of the airport infrastructure; establishment of high technical standards for airplanes and air services; security enhancement; modernization of air traffic control procedures; updating sectoral legislation. The prospects for the development of the air transport market of Ukraine are the creation of new organizational forms that fully meet the requirements of the market. Consolidation can occur in several areas: the formation of a national carrier-flagship, merger with foreign companies or consolidation with domestic players in the market.

KEYWORDS: AVIATION, AIR TRANSPORTATION MARKET, BUSINESS-MODEL, AIRPORT INFRASTRUCTURE, PEST-ANALYSIS

1. Introduction

A number of problems, that Ukrainian civil aviation now faces, are, in fact, a consequence of the chronic crisis in the underlying areas of the industry. Organizational crisis is a condition in which forms of organization of market entities do not allow them to function effectively in conditions where the external environment is positively adjusted to these entities.

The "open sky" policy, to which Ukraine aspires, acts as an incentive for competition and, accordingly, an increase in the number of operators (mostly European ones). It will lower the fares and increase the quality of service. However, Ukrainian carriers may lose their positions. In response to increased competition, it is necessary to increase capacity and improve the efficiency of airlines. It is possible to reach this goal in various ways, in particular through consolidation with other participants in the aviation transport market [1].

The study of problems and organizational and economic changes in air transport should begin with the diagnosis of a market situation, because this factor is the most important in eliminating the problems that exist in Ukrainian airlines.

2. Analysis of dynamics of the air transport market in Ukraine

In Ukraine, 78 aviation organizations engaged in transportation or aeronautical chemical works were registered in January 2017. Almost a third of carriers specialize exclusively in passenger transportation. According to experts, more than 85% of passenger traffic is carried out on regular flights and only 15% – on charter flights, with the freight traffic the opposite is the case – almost 90% is on charter flights.

There were 33 domestic airlines operated on the passenger and freight market in 2016. According to the statistics, during the year, 66,300 commercial flights were performed (by 2015 – 74.8 thousand). The number of passengers carried decreased by 2.7 percent compared to the previous year and amounted to 6302.7 thousand people (Table 1). The volume of cargo and mail was 69.1 thousand tons (in 2015 - 78.7 thousand tons).

Table 1. Volumes of transportations by air transport of Ukraine [2]

Indicators	Units	Total			including international ones		
		2015	2016	% 16/15	2015	2016	% 16/15
Passengers transported	thousand people	6475,2	6302,7	97,3	5828,6	5678,0	97,4
including on regular lines	–	4553,9	4629,8	101,7	3924,7	4018,3	102,4
Passengers-kilometers completed	billion. pas. km	11,6	11,4	98,3	11,3	11,1	98,2
including on regular lines	–	7,6	8,1	106,6	7,3	7,8	106,6
Cargo and mail transported	thousand tons	78,7	69,1	87,8	78,2	68,8	88,0
including on regular lines	–	10,9	13,8	126,6	10,6	13,5	127,4
Freight-kilometers completed (cargo and mail)	million tkm	239,3	211,0	88,2	238,9	210,8	88,2
including on regular lines	–	30,4	39,6	130,3	30,2	39,5	130,8
Committed flights	thousand	74,8	66,3	88,6	61,3	56,0	91,4
including on regular lines	–	50,3	45,8	91,1	39,6	37,1	93,7

The decline in demand for air transportation is a continuation of the negative trends of 2015, which arose because of an unstable military-political and economic situation in the country and stoppage of air services between Ukraine and the Russian Federation from October 25, 2015.

A general overview of air transportation by Ukrainian companies is important for analyzing the airline's operating environment (Figure 1).

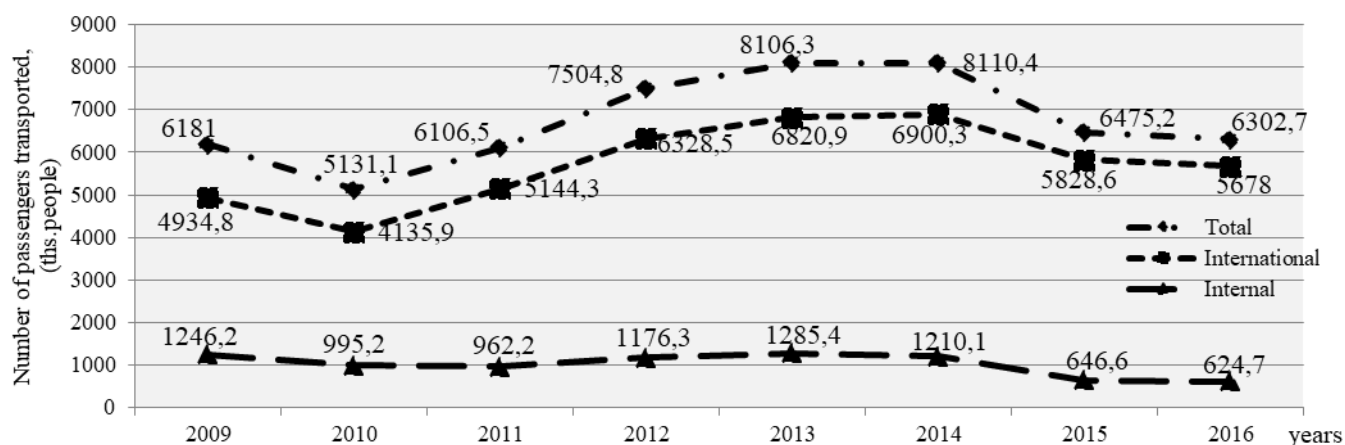


Figure 1. Volumes of passenger transportation by air transport of Ukraine (2009-2016), thousand people [2]

Commercial flights of domestic and foreign airlines were served by 20 Ukrainian airports in 2015. According to statistics, the number of the aircrafts sent and arrived during the year was 120.7 thousand (versus 142,400 in the previous year). Passenger traffic through Ukraine's airports decreased by 1.8% and amounted to 10695.2 thousand people, mail traffic – by 9.5% and totaled 34.4 thousand tons. At the same time, 68 percent of all serviced passengers and almost 88 percent of cargo flows fell on the Boryspil airport. According to the results of 2016, passenger traffic through the main airport of country, Boryspil increased by 5.6% compared to 2015. There was also growth in passenger traffic at airports in Odessa (at 9.8%), Zaporizhzhya (at 69.9%), and Kherson (by 7.8 times). Passenger traffic through Dnipropetrovsk airport decreased by 22.5%, Kharkiv - by 14.6%, Kyiv (Zhulyany) - by 13.6%, Lviv - by 2.5%. According to the results of 2016, passenger traffic through the Boryspil airport increased by 5.6% compared to 2015.

3. Analysis of the market by types of air carriers

Passenger traffic was performed by 21 Ukrainian airlines in 2016. The share of 4 leading airlines (Ukraine International Airlines, Azure Air Ukraine (Utelier Ukraine), Rose of Winds and Dniproavia) in total passenger transportation accounted for almost 93 percent (Figure 2). At the same time, the growth of volumes of transportation took place only in the airline "International Airlines of Ukraine" (by 28.2%). Passenger transportation of the Azure Air Ukraine (UTair Ukraine) decreased by 12.2% compared to 2015, Dniproavia - by 13.5%, Wind Rose - by 54.9%.

Regular flights between Ukraine and other countries were carried out by 9 domestic airlines to 39 countries of the world and 35 foreign airlines from 29 countries of the world. Ukrainian Airlines transported 4,018.3 thousand people (growth - by 2.4%), and foreign airlines – 3769.3 thousand people (reduction - by 1.1%) (Figure 3). During 2016, five new international airlines were launched on a regular basis: Dniproavia airline from Dnipropetrovsk to Bourgas and from Odessa to Batumi, Ukraine International Airlines from Odessa to Vilnius and from Lviv to Bologna, Atlantic airline Ukraine from Zaporozhye to Istanbul. Passenger transportation between nine Ukrainian cities was carried out by 5 Ukrainian airlines on domestic regular lines, and 611.5 thousand people were transported (versus 629.2 thousand people in 2015).

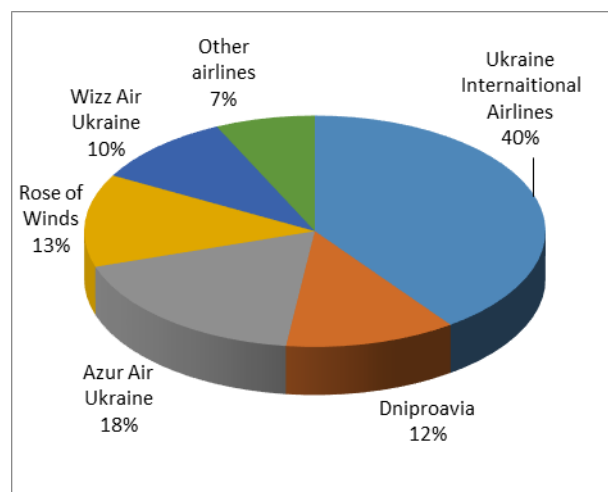
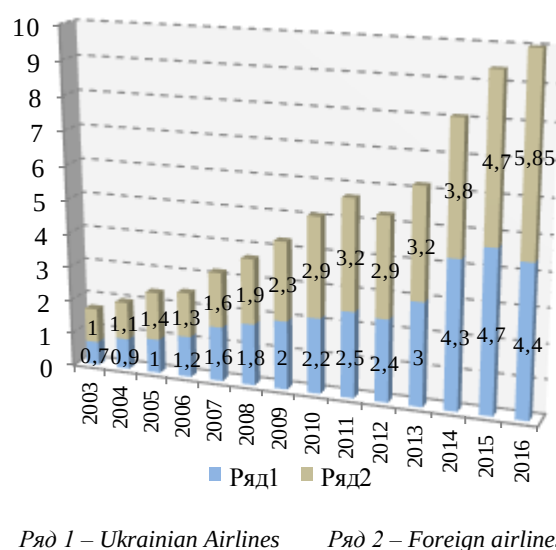


Figure 2. The share of airline companies in the total volume of passenger transportation by air, (%) [3]



Ряд 1 – Ukrainian Airlines Ряд 2 – Foreign airlines

Figure 3. Volumes of passenger air transportation on regular lines between Ukraine and other countries of the world, million people [4]

The average percentage of passenger load on international regular flights of Ukrainian airlines in the reporting period increased compared with the previous year by 6.4 percentage points and reached 79.4%, and on domestic regular flights – by 6.1 percentage points and was 71%.

Transportation of goods and mail in the reporting period was carried out by 19 domestic airlines, 76% of the total volume of traffic was performed by ANTK “Antonov”, “Ukrainian International Airlines”, “Maximus Airlines”, “Zeta Avia” and “Urga”. Most of the transportation was carried out by charter flights in other states within the framework of the UN humanitarian and peacekeeping programs, as well as contracts and agreements with other customers.

The correlation between international and domestic transportations of Ukrainian airlines was 85% to 15% in favor of international ones in 2016.

Unlike international regular flights of Ukrainian airlines, which have not fully recovered compared to the indicator of the previous 2016, a significant increase in traffic volumes was observed in the segment of international charter flights (Figure 4). According to statistics, in 2015 domestic airlines carried out 26.1 thousand commercial charter flights against 23.2 thousand flights in previous year, the number of passengers transported increased by 18.1% and amounted to 2.5 million passengers. Significant volumes of chartered transportation were carried out by the following airlines: “Roze of Winds”, “Ukrainian International Airlines”, “Utelier-Ukraine”, “Aviatrans K” and “Kharkiv Airlines”.

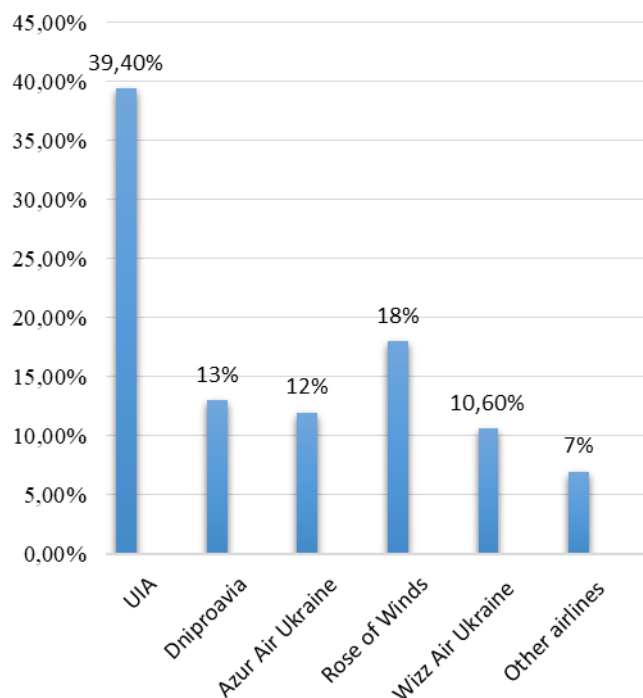


Fig. 4 Ukrainian charter flights market in 2016 (%) [5]

4. Business models in the air transportation market

In the air transportation market, there is a certain specialization in the types of business, resulting in the formation of nine major varieties of air carriers: network airlines; regular international carriers and regional carriers; charter transportation airlines; combined express carriers; cargo operators; mixed airlines; isolated airlines; low cost airlines.

The operation of the relatively new Low Cost business-model in the market makes significant changes to the structure of air transportation, since it is aimed at minimizing costs by refusing additional service. The arrival of low-budget airlines in the market forces national carriers to lower their tariffs, as well as to implement

customer loyalty programs. All this affects the general level of competition of Ukrainian carriers.

The Table 2 demonstrates the main features of development stages of Low Cost airlines.

Table 2. Characteristics of development stages of Low Cost airlines [6]

Stage	The name of the business-model at the development stage	Characteristics
1	Classical Low Cost (70s, 20th century)	Oriented on max minimizing costs and lack of free service. Flights are carried out to secondary airports at an awkward time, passengers carry luggage independently, the distance between the seats is reduced, and money is not returned to passengers in case of cancellation of the flight.
2	Low Cost with additional services (80s, 20th century)	Flights are carried out from major airports, soft drinks and light snacks are distributed during the flight, transit flights through hub airports are offered. Example: American "Frontier", British "EasyJet", German "Air Berlin".
3	Low Cost with a full set of services (90s, 20th century)	Airlines use exclusively new aircrafts, the distance between the seats in the cabin is increased, television and the Internet are on board. Example: American "JetBlue", Canadian "WestJet".
4	Low Cost with Business Class (2000s, XXI Century)	Airlines offered business class travel at prices 30-50% lower than traditional airlines; flights were carried out long distances (Europe-Asia, Asia-USA, Europe-USA). They did not survive the competitive struggle with traditional companies and left the market.
5	Long Range Low Cost (2010s, XXI Century)	Reduced costs are due to the same type of aircraft, reduced costs for ticket sales, low tariffs for intercontinental airlines, minimum free service. Example: Asian "Air Asia X", Australian "Jetstar".

It should be noted that the competitive pressure on the Ukrainian airlines by foreigners causes certain concerns not only to weak regional companies, but also to leaders. Unlike foreign competitors, regional airlines, as a rule, do not occupy significant positions in the international market and attract for flights to the cities of Ukraine for some reason far from being the best aircrafts and commercial potential. First-class foreign airlines ("British Airways", "Lufthansa"), as well as airlines of the CIS countries, offering world-class services with almost dumped prices ("Transaero", "Estonian Airlines", etc.) are competitors of Kyiv-based airline leaders. Therefore, the confrontation with this pressure requires the mobilization of all resources of airlines and their maximum concentration in this direction. The principle of moving away from internal competition in favor of concentrating maximum efforts on the external one gets even more urgent.

5. PEST - Analysis of Airlines of Ukraine

Dynamic development of the air transportation market of Ukraine takes place, despite certain problems related to the economic situation in the country. To investigate the situation in the air transportation market, PEST-analysis was conducted, which made it possible to analyze the conditions of companies in the domestic aviation market and external factors that affect the conduct of business at an adequate level. PEST analysis is designed to identify political factors (P - political), economic impact (E - economic), social tendencies (S - social) and technological innovations (T - technologies). The work was carried out in two stages: at the first stage, the degree of influence of factors on the activity of airlines in the form of relative normalized weighted coefficients was determined, and at the second stage - the

probability of their influence on the five-point evaluation system, with 5 - the greatest impact, and 1 - the smallest (Table 3).

Table 3. The degree of probability of the influence of factors on the activities of airlines

Factors	Weight Coef- ficient	Direction of influ- ence	Experts (degree of influence)				Ave-rage rating	Ave-rage weigh- ted
			E1	E2	E3	E4		
1. Political								
Lack of basic state policy for Ukrainian airlines	0,07	+	3	5	2	4	3,5	0,25
Incompatibility of Ukrainian legislation in the field of air transportation to international requirements	0,01	+	1	2	1	3	1,75	0,02
Weak state regulation of competition in the aviation market	0,08	+	5	5	4	3	4,25	0,34
Lack of means to combat "oligarchization" in the aviation industry	0,04	+	1	2	3	4	2,5	0,10
2. Economic								
The unstable economic situation in the country	0,04	-	3	2	4	5	3,5	0,14
Weak investment climate	0,05	+	4	2	3	3	3	0,15
High customs duties and tariffs	0,06	-	3	3	2	5	3,25	0,20
Low income level of population	0,08	+	5	4	5	2	4	0,32
3. Technological								
An outdated fleet of rolling stock	0,08	-	5	5	4	4	4,5	0,36
Inappropriate level of technology in the organization of the transportation process	0,07	-	2	4	5	5	4	0,28
Insufficient level of infrastructure development of regional and international airports of Ukraine	0,08	-	5	4	5	3	4,25	0,34
Insufficient level of the system of transport-logistic complexes	0,05	+	1	3	4	3	2,75	0,14
4. Social								
Age structure of the population	0,07	+	2	4	5	4	3,75	0,26
Training level	0,06	-	4	3	4	2	3,25	0,20
Educational level	0,08	+	4	3	5	5	4,25	0,34
Cultural level	0,06	+	3	2	4	2	2,75	0,17

The following specialists were selected as experts: personnel policy specialists, marketers of the public relations department, economists of the economic and analytical department, legal advisers, leading aviation specialists and employees of the Ministry of Infrastructure of Ukraine.

Insufficient state support is a major factor among the political factors. There is no basic state policy for Ukrainian airlines in a difficult competitive environment. The weak point is also a discrepancy legislation of Ukraine in the field of air transport to international and European standards, including the International Civil Aviation Organization (ICAO), the European Union, the European Civil Aviation Conference (ECAC), and the European Organization for the Safety of Air Navigation (EUROCONTROL). Gradual displacement of a domestic air carrier to foreigners is due to weak state regulation of competition in the aviation market.

Regarding "oligarchization", there are no effective market means to combat this negative phenomenon today. Real methods of counteracting excessive monopolization and seizing control over the market by one entity are only direct administrative power and prohibitive actions, very unpopular and counteracting normal market laws. Therefore, it is necessary to take measures to prevent the situation with the prerequisites for the oligarchic seizure of the market to eliminate this problem.

For Ukraine, "open skies" means the intensification of the process of the air transportation market development due to: update of airport infrastructure; establishment of high technical standards for airplanes and air services; security enhancement; modernization of air traffic control procedures; updating sectoral legislation, etc. In order to solve these problems, it is necessary to implement the provisions of the Concept for the development of the aviation complex and the development of programs for the period up to 2020 and to ensure the safety of flights by improving the mechanisms of supervision and control of transport activities.

Economic factors include: weak investment climate in the domestic aviation industry; high customs duties and tariffs during the flight; an increase in the inflation rate that affects the rise in fuel prices; the growth of fares for flights. The price policy of flights is controlled and regulated not by the government, but by airlines, which leads to fluctuations in prices for services of various airlines. The growth of the rates of conclusion of various types of agreements with other airline companies for the sale of commercial rights (interlays, block-space agreements, marketing agreements, code-ranging agreements, agreements on joint operation of airlines),

as well as the creation of aviation alliances take place. In accordance with social factors, here it is possible to note the regulation of relations in the field of training; taking into account the age structure of the population, the level of education and culture.

Among the technological factors, insufficient level of the system of transport-logistic complexes, insufficient level of regional and international airports infrastructure development in Ukraine can be distinguished. It is necessary for the government of the country to adopt uniform concepts for the development of airports, which will allow passengers to travel more quickly and with greater comfort. There is reluctance to use domestic airplanes for air transportation. There is an inappropriate level of technology in the organization of the transportation process, insufficient information provision.

This issue can be addressed through the introduction of CNS / ATM global satellite systems for air traffic services, automation and computerization of airlines at international level; the creation of a system of transport and logistics complexes (to shorten shipping time, reduce transportation costs and optimize tariffs) and further development of information and logistics technologies [7].

The result of PEST analysis is the selection of key environmental factors that will create the ability and smooth out the threats to companies in the projected period. Analysis of Table 3 allows us to conclude that: the absence of basic public policy for Ukrainian airlines does not allow opportunities to expand business; the lack of compliance of Ukrainian legislation in the field of air transportation with international requirements has little impact; weak state regulation of competition in the aviation market is a major threat to companies, as well as the economy as a whole; economic instability in the country is a threat to the company.

6. Prospects for the development of the air transportation market in Ukraine

Regarding the structure of the aviation market of Ukraine, it should be noted that it is quite clearly divided functionally (airlines, airports, service and provision of structures, aircraft factories, etc.) and technologically (airlines for general transportation and special purpose). However, the global trend of civil aviation development shows that every year in the world aviation practice a large consolidation and integration of market actors is carried out both on a functional and a technological basis – powerful consortia and

alliances of air carriers and structures providing them are created. Alliance forms of interaction have become a necessary condition of existence on the market under current conditions of the economy.

There are three stages of creating alliances:

I. The first stage focused mainly on the production of additional revenue by attracting more passengers by expanding route network and joint marketing.

II. The second stage focuses on cost savings, as well as the continuation and strengthening of cooperation in the first stage, and involves separate agreements in one or more specific areas where joint activities can reduce costs. The implementation of the first two stages does not necessarily combine a long-term alliance. Its disintegration or exit from it are possible; although the longer the alliance exists, the more it is close, especially if cooperation is mainly carried out in the area of cost reduction.

III. The third stage is to unite the alliance, when partners start mixing their assets together and using them jointly, including joint product development and joint ventures to regulate various aspects of their activities. The final stage is the full merger of alliance member companies.

In order to overcome the organizational crisis, it is necessary to create new organizational forms that fully meet the requirements of the market, while the principle of integration and consolidation should become the general line. In the direction of consolidation, the result should be the unification of air companies under the joint coordination and supply – the creation of "alliances" or "consolidated air carriers" (at the state level – a national carrier, at the regional level – regional carrier, at the enterprise level – a specialized group, for example, a consortium of airlines). Consolidation will allow us to solve a number of issues at once, such as the distribution of a competitive market, optimal use of unused capacities, etc.

In the direction of integration, the results should be the merger of air companies with structures whose activities, directly or indirectly, are aimed at ensuring the process of aviation commercial operations. Integration will provide a positive solution to marketing and competition issues, issues of reducing the cost of airline and tariff policy, the problems of efficient supply, the issue of ensuring the inflow of financial resources on favorable terms. Economic mechanisms for solving this are the principles of acquiring (selling) shares, entering (accepting) into an authorized fund, lease relations, long-term preferential investment, establishment of subsidiaries, privatization.

Consequently, consolidation can take place in several areas: the formation of a national carrier-flagman, merger with foreign companies or consolidation with domestic actors in the market. Any reaction to factors of influence will lead to organizational and economic changes in the airlines themselves.

7. Conclusions

Investigation of the factors of influence becomes important in the analysis of the airline's activity. To determine the future behavior of the organization, its management needs to know as the internal and the external environment, its potential and trends, and its place among other organizations. The impact of both external and internal factors on the enterprise is diverse. An analysis of the environment gives the company the ability to minimize the dangers and negative effects that it encounters during its operation. Analysis of the internal environment allows company to identify the strengths and weaknesses of the enterprise and outline the prospects for its development. The following specialists were selected as experts: personnel policy specialists, marketers of the public relations department, economists of the economic and analytical department, legal advisers, leading aviation specialists and employees of the Ministry of Infrastructure of Ukraine.

Insufficient state support is a major factor among the political factors. There is no basic state policy for Ukrainian airlines in a difficult competitive environment. The weak point is also a discrepancy legislation of Ukraine in the field of air transport to international and European standards, including the International

Civil Aviation Organization (ICAO), the European Union, the European Civil Aviation Conference (ECAC), and the European Organization for the Safety of Air Navigation (EUROCONTROL). Gradual displacement of a domestic air carrier to foreigners is due to weak state regulation of competition in the aviation market.

In sum, it can be argued that the "open sky" policy, increased competition and ownership change have the most significant effect on organizational and economic changes.

Expansion of the presence of foreign airlines in the market significantly affects the competitive situation. The union of Ukrainian airlines is one of the options for strengthening the position of Ukrainian civil aviation, another option may be an alliance with major foreign airlines.

It should be noted that the leading domestic air carriers do not meet the modern requirements of the world aviation community, which results in the low competitiveness of our airlines in the air transportation market in Ukraine and in the world. However, the achievement of high requirements is possible only with the gradual harmonization of Ukrainian legislation with the international, implementation and application of international aviation standards in Ukraine.

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FRESHWATER SUPPLY FOR SHIPS DESALINATED BY METHOD OF ELECTRODIALYSIS

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Abstract: For the purpose of freshwater supply for ships, we have explored the desalination process of sea water by electrodialysis. From the analysis of the obtained results, the desalination process of the Black Sea water by electrodialysis has been explored. The average salt content of the Black Sea water is 15-16 g/l, and the global ocean water - 35 g/l, while the salt content in water from the Baltic Sea is 5.77 g/l. The Black Sea water was diluted with fresh water up to a concentration of 5.77 g/l.

Electrodialysis is the most effective method for desalination of natural waters with low salinity. So, we have taken water equivalent to salt water content of the Baltic Sea water. Desalination of this water is effective and requires little energy. To reduce salt content of sea water, the separation was carried out on reverse osmosis membranes with a selectivity of 70%, and then the penetrant was separated by electrodialysis. Every 5 minutes, the solution loses 55.8% of salt. During the treatment (45 min), water is desalinated up to a concentration of 51.2 mg/l, and it can be used for industrial (technical) or household purposes. Calculation have shown that the selectivity of membranes during desalination was 99.11%.

As a result, on the basis of theoretical and experimental studies of seawater desalination by electrodialysis, there have been developed the principal circuits of the system of environmental safety of ballast water and water treatment facilities in the port, for environmental safety of ballast water and for obtaining industrial water.

KEYWORDS: DESALINATION, ELECTRODIALYSIS, CONCENTRATION POLARIZATION.

1. Introduction

The problem of fresh water supply for ships have been existed over the course of a history of the maritime fleet. The water on ships has always been limited. This was due to a deterioration of water quality during a long-term storage, as well as due to the limitation of fresh water tank volumes on ships. Provision of water through its obtaining from the shore cannot be considered to be economically justified, and this is carried out in exceptional cases, since its cost at the coastal provision stations increases sharply (coastal water is 5-15 times more expensive than desalinated water), and when refueling in foreign ports requires large currency spending (the cost of 1 ton of fresh water now amounts on average 10-15 USD). Therefore, the feasibility of desalination of sea water on ships is obvious and is beyond questions. It has been established that the freshwater supplies on ships depend on their type and the cruising radius and make up 2-8% of deadweight.

In recent years, both in domestic and in foreign practices, a significant number of freshwater generators have appeared, the principle of operation and methods of obtaining water in which differ significantly from the earlier design solutions. The ship power plants are more and more equipping with the reverse osmosis freshwater generators, characterized by high ecological quality. The electrodialysis type installations, especially intended for small vessels of the fishing fleet also attract attention.

We have studied the process of sea water desalination by electrodialysis and the problem of freshwater supply for ships.

Just like in any other liquid phase process, in this case, concentration polarization plays an important role as well. In presence of concentration polarization, there occurs an increase in gradient of the concentration potential on the ion-exchange membrane. At this time, diffusive ion leakage is growing in membrane. Thus, purely ionic transfer for a given electric potential is several times decreased. During such concentration polarization there is considerably increasing in the diluted solution the difference of the ohmic potential as well, since as a rule, the ohmic resistance of the electrolyte solution is inversely to its ionic concentration. Since the dissolved electrolytes flow, which is intended for separation, is approximately proportional to current density, the electric power consumed for separation of the solute's volume unit goes up proportionally to current density. On the other hand, the fixed cost of the electro-membrane module for the given quantity of solution intended for separation is often reducing with the increase in current density. In consequence of above stated,

there is always existed the optimal current density, when the total cost of power inputs and capital expenditures is minimal. At the same time, this optimal value often exceeds the highest possible value, which in practice is obtaining for diluted solution during motion at high-velocity in narrow channel. [1,4]. Thus, and so, in the first place the working current density is limited by concentration polarization, but not due to process efficiency. Proceeding from this, it is reasonable to intensify the process through the reduction of adverse effect of concentration polarization that is possible to achieve by action of pulsed pressure in the channel between membranes [2].

2. Preconditions and means for resolving the problem

The assigned task requires conduction of theoretical and experimental investigations for calculation and designing the high-performance electro-membrane devices that is of high topicality and represents scientific novelty.

A mathematical model of non-steady and non-isothermal electro-membrane process we've developed, with account for simultaneous action of gravitational and forced convections, when meeting the electrical neutrality condition, under the influence of pulsed pressure, allows for implementing electrodialysis processes on the rationally designed electro-membrane devices, with optimal regime parameters [3].

An experimental study of electrodialysis was carried out on a laboratory installation (Pic. 1) for the purpose of studying the processes of desalination, concentrating solutions, synthesis of new substances, pH correction, obtaining highly demineralized water, amino acid separation, acid and alkali extraction from solutions of the corresponding salts, removal of inorganic compounds from organic solutions.

The installation is manufactured in the form of a wall-mounted bench (1) on which there are mounted: the unit of mechanical filtration of solutions (2), electromembrane device (3), pump unit (4) with the electrical power supply sources (5), hydraulic panel with rotameters (6), manometers (7), control valves (8), sampling equipment valves (9) and an electrical power supply source for the device (10). The working tanks are (11) are with the outlet valves. In the upper part of the working tanks, it is necessary to provide the inlet holes for filling working solutions with a funnel. The device is installed on a worktable by analogy with the example of placement shown in Figure 1.

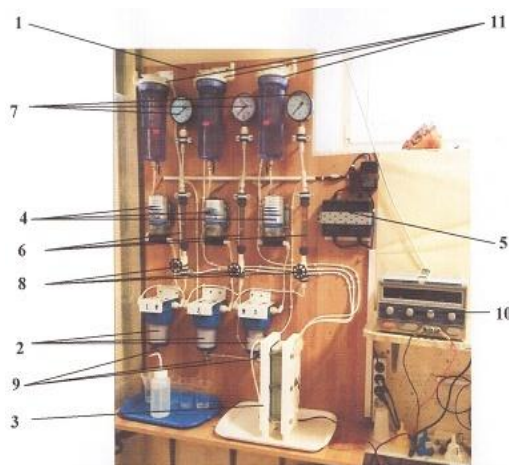


Fig.1. A laboratory installation of electrodialysis .

For the purpose of seawater desalination by membrane technology, the paper dwells on studying the electrodialysis processes of 20,10 and 1% sodium chlorine solutions. As the model solutions, we used NaCl solutions of different concentrations; the direct current source is a rectifier HY3005C, which allowed for obtaining the current density of 15 mA/cm².

The analysis of the test results shows that when the initial concentration of NaCl salt is 20.85 g/l. The NaCl solution loses 20% of NaCl during the first 15 minutes, within 20 minutes, the solution begins to clear faster, losing 70% of NaCl. In the last 5 minutes, desalination slows down again. The solution loses only 5% of salt. Current almost constantly, but suddenly starts to reduce. This is because the low-concentration electrolyte is poorer than the high-concentration electrolyte. Finally, the salt content of the concentrate is 31.0 g/l, which is close to the limit of NaCl salt dissolution. This means that the process occurs without dilution of the concentrate, and crystalline may appear in the salt solution, and it is possible to obtain two products: NaCl salt and water.

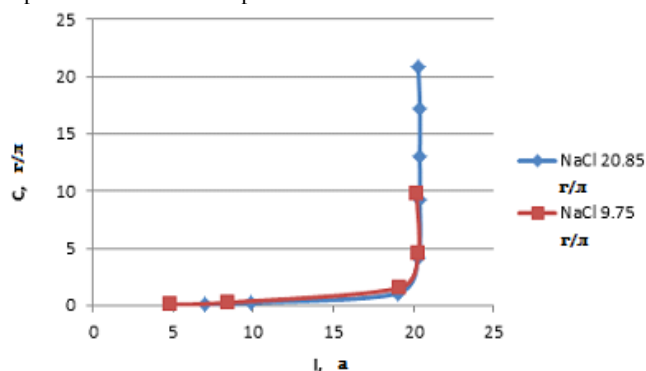


Fig.2. NaCl concentration depending upon a current intensity

When the concentration of NaCl was 9.75 g/l, for the first and last 5 minutes, the concentration was reduced to 50%, for the test from 10 to 15 minutes, the concentration was decreased by 80%. Entirely in the process of electrodialysis, the concentration of the solution was decreased from 9.75 g/l to 0.091 g/l. In addition, it can be noted that a high degree of purification is observed when the concentration is 1 g/l.

Figure 2 illustrates the dependence of the NaCl concentration on the a current intensity, from which it can be seen that the curves are practically identical. This can be explained by the fact that the chemical compositions of liquids that need to be analyzed are the same, that is. they conduct electric current in the same way.

At significantly lower concentration of the solution, the salt content in the solution is 1.09 g/l and decreases by 50% on

average every 5 minutes. Based on the results, we can say that if a salt solution with NaCl concentration is 1 g/l, in order to speed up this process, it is necessary to use less selective membranes, increase the voltage or take another new technological solution.

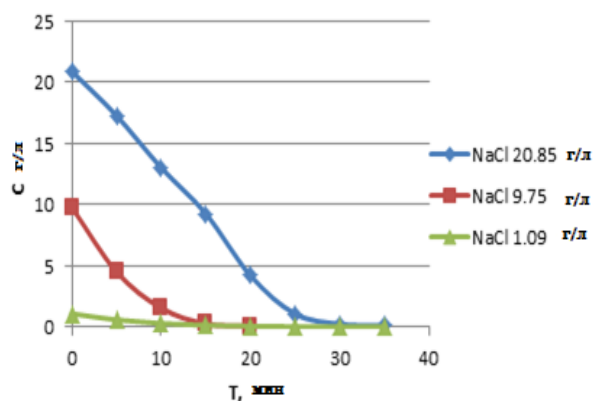


Fig.3. The rate of electrodialysis of NaCl

Figure 3 illustrates the rate of electrodialysis of a NaCl solution of various concentrations. We can see that when the initial concentration is 9.75 g/l, the solution is cleared. At this time, the first test (initial concentration - 20 g /l) of NaCl concentration in the solution reaches 10 g/l. Thus, it can be concluded that membrane is more effective, when the NaCl concentration varies from 10 g/l to 1 g/l.

Comparison of the curves presented in Figure 3 demonstrates that the experimental results are not only in a qualitative, but also in a very good quantitative coincidence with the data of theoretical calculations. This means that the mathematical models we are using, adequately describe the nonstationary isothermal processes occurring in the chambers of electromembrane systems.

3. Conclusion

Based on the analysis of the results obtained, we have studied desalination of the Black Sea water by electrodialysis. The average salt content of the Black Sea water is 15-16 g/l, in the global ocean -35 g/l, while waters of the Baltic Sea – 5,77 g/l. Water of the Black Sea was diluted with freshwater to a concentration of 5,77 g/l. The results of the desalination process of the Black Sea water by electrodialysis are presented in Table 1.

Electrodialysis is most effective in desalination of natural waters with low salinity. Thus, we took water with salt water content equivalent to the Baltic Sea water, and desalination of this water is effective and does not require much energy. To reduce salt content of sea water, the separation was carried out on reverse-osmosis membranes with selectivity of 70%, and then the penetrant was separated by electrodialysis. Every 5 minutes, the solution loses 55.8% of salt. During the treatment (45 min), water is desalinated to 51.2 mg/l concentration and can be used for the industrial (technical) purposes or domestic consumption. Calculations have shown that during desalination, selectivity of membranes was 99,11%.

The water testing results (diluted to 5,7 g/l).

On the basis of theoretical and experimental studies of seawater desalination with electrodialysis, we have developed the flow diagrams of a system environmental safety of ballast waters and water treatment facilities in the port, for obtaining industrial water and freshwater supply for ships.

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IMPACT OF TECHNICAL VALIDITY MOTORCYCLE FOR ROAD SAFETY IN THE REPUBLIC OF CROATIA

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Abstract: The road traffic safety factor is divided into three basic groups: human, vehicle, road (infrastructure). Technically defective, poorly maintained and technologically obsolete vehicles endanger road safety. The number of technically defective vehicles that are involved in traffic accidents, when checks are carried out by officers of traffic police, is 0.2%. Considering that 21.31% of vehicles are found to be defective by periodical technical inspections of vehicles (PTI), it is expected that the number of technically defective vehicles in daily traffic is considerably higher. By analyzing the data collected by PTI and comparing them with the data obtained during the conducted research "Inspection of the technical safety of vehicles involved in road traffic accidents with fatalities" the real state of the technical condition and safety of vehicles on the roads in the Republic of Croatia is presented here. Two-wheel vehicles (mopeds and motorcycles) represent a particularly risky group.

Keywords: SAFETY, ROAD TRAFFIC, INSPECTION, MOTORCYCLE

1. Introduction

Reducing the number of traffic accidents can only be achieved through active involvement of all traffic participants, optimizing the relationship between safety factors human, vehicle, road (infrastructure). Action measures to better road safety include legislation, education, information, maintenance, modernization and infrastructure construction, increasing passive and active safety, the technical safety of vehicles and the reaction speed of the emergency services. Technically defective, poorly maintained and technologically obsolete vehicles endanger road safety. The Center for vehicles of Croatia (CVH) organizes and conducts periodical technical inspection of vehicles (PTI) in the Republic of Croatia. With the aim of presenting the actual state of technical validity of vehicles on the roads of the Republic of Croatia, the CVH with the Ministry of the Interior (MUP), the Croatian Automobile Club (HAK), the Faculty of Transport and Traffic Sciences (FPZ), the Faculty of Mechanical Engineering and Naval Architecture (FSB) has initiated the research project "Inspection of the technical safety of vehicles involved in road traffic accidents with fatalities"[1]. The aim of the research project is to show the impact and frequency of technical malfunctions in traffic accidents with fatalities in the Republic of Croatia, and propose measures related to the technical validity of the vehicles to further increase traffic safety based on the results of the research. During drivers' everyday use of the vehicle, malfunctions can easily be recognized and detected on critical parts of the vehicles such as tires, suspension, braking system, steering mechanism and light signaling equipment. Although these malfunctions are relatively easy to remove in the average automobile workshop without special tools, the owners are not prone to correct them in the timely manner. Instead, the most common defects are removed just before PTI and some of them only after being identified by the PTI. Therefore, the driver's responsibility is a big gray zone when it comes to the lack of maintenance.

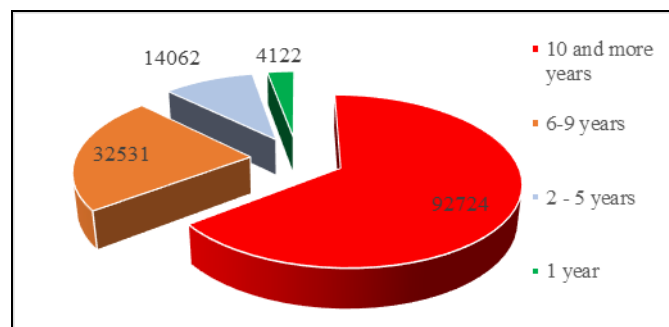


Fig. 1 Mopeds and motorcycles in the Republic Croatia

2. Periodical technical inspections of vehicles

All vehicles involved in road traffic must be without technical malfunction and it must be ensured that their use has minimal impact on the environment. In Croatia, all motor vehicles and trailer based on the Law on Road Traffic Safety are subject to PTI. The period required to conduct the review, the content and scope of the review, as well as the requirements for qualified staff and equipment, are prescribed [2]. The purpose of the vehicle's technical inspection is to detect vehicle defects that could affect the safety of the vehicle and passengers as well as other traffic participants.

2.1. Results of PTI

Vehicles, all their parts and equipment must be completely in working order, but from the safety point of view some circuits are more important than others because they directly affect traffic safety. In 2017, 2.065.038 PTI were carried out [3]. The average percentage of vehicles with malfunctions was 21.31% and the average age of the vehicles was 13.99 years (Fig. 1). Considering the high average age of the vehicle and the fact that the majority of vehicle owners prepare and remove malfunction on the vehicle immediately before the technical inspection, it is realistic to expect a significantly higher percentage of defective vehicles in daily traffic, therefore we consider these data to be the starting point of the research.

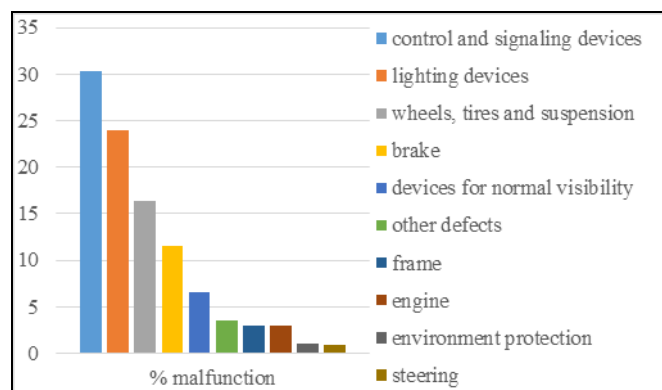


Fig. 2 Distribution of the most common malfunctions by mopeds and motorcycles

There are 143.439 two-wheeled vehicles: 79.873 mopeds, and 63.566 motorcycle. Mopeds and motorcycles in total represent 6.94% of road traffic vehicles and 8.16% of all defective vehicles the highest percentage of deficiencies on PTI of mopeds and motorcycles refer to control and signaling devices 30.28%, lighting devices 23.99% wheels, tires and suspension 16.30%, brakes

11.52%, devices for normal visibility 6.51%, other defects are represented by 3.49%, frame 3.00%, engine 2.94%, environment protection 1.05% and steering of 0.91% (Fig. 2). The age of the vehicle and its usage over time has a significant impact on vehicle malfunction. The average age of mopeds and motorcycles in the Republic of Croatia is 12.3 years, and the average annual travel time is approx. 1.400 km for mopeds and approx. 2.800 km for motorcycles.

3. Research, "Inspection of the technical safety of vehicles involved in road traffic accidents with fatalities"

According to statistical data from the Republic of Croatia, 94.8% of traffic accidents are caused by the human factor, while only 0.2% of accidents are caused by technical malfunctions [4]. In the Republic of Croatia, a technical inspection of the vehicle is not carried out after a car accident, unless there is doubt in the technical malfunction of the vehicle or the competent state authority is requiring the technical inspection. Given the large number of traffic accidents in Croatia, the research project targets groups of vehicles that participated in traffic accidents with fatalities. The technical inspection of the vehicle's technical validity after the car accident is significantly different from the PTI of the vehicle since the vehicles are usually significantly damaged and therefore disassembly, assembly and, if necessary put into operation. It gets carried out as soon as possible after an accident in the field or a workshop with the tool and equipment of an automobile workshop. The results of the inspection are noted on a specially prepared vehicle inspection form, and all collected data and photos are archived in a special application. The aim of the research project is to show the impact and frequency of technical malfunctions in motor accidents with fatalities in the Republic of Croatia, and suggest measures that impact technical vehicle correctness to increase traffic safety based on the results.

3.1. Research results

The data was collected by a team of experts who conducted a vehicle inspection after a traffic accident with fatalities. After reviewing the vehicle, based on the collected data, the members of the expert team gave their opinion on the technical condition of the vehicle and its parts and equipment - classified into three categories (Fig. 3):

- technically adequate,
- technically inadequate,
- it is not possible to determine the condition before the accident.

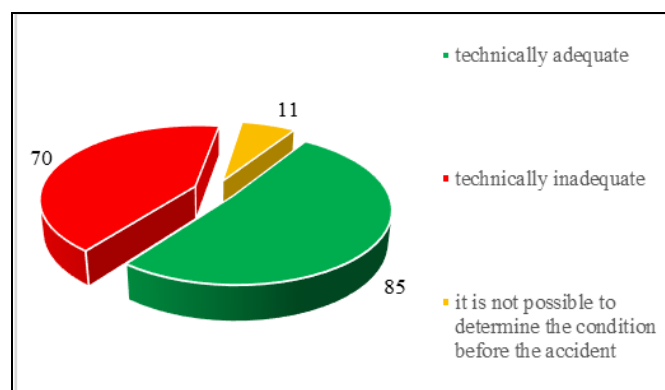


Fig. 3 Structure of vehicles involved in traffic accidents with fatalities according to technical condition.

During the research, 166 vehicles were involved in traffic accidents with fatalities and according to the procedure described, 85 vehicles or 51.20% were technically correct, while 70 vehicles of the vehicle inspected or 42.17% were shown to be technically

inadequate, which is twice as high as on a PTI of the vehicle. The average age of these vehicles was approximately the same 14.54 years, which is in the range of expected values due to the average age of vehicles in the Republic of Croatia and the fact that most vehicle owners service the vehicle before the PTI. For 11 vehicles or 6.63% it was not possible to determine the condition before the accident.

A total of 23 mopeds and motorcycles were inspected, 13 or 56.52% of which were defective and one or more malfunctions were identified on them. By comparing the proportion of mopeds and motorcycles with other vehicle categories and taking into account the extremely small average annual travel distance, these vehicles are a particularly risky group in terms of technically defectives. Although technical malfunctions can often not be identified as a direct cause of a traffic accident, some of the malfunctions are extremely serious and dangerous, the so-called "dangerous mistake". The highest percentage refers to wheels, tires and suspension, 38.46%, brakes 30.77%, engine 30.77%, frame 23.08%, lighting devices 7.69% (Fig. 4). If we compare the data on PTI of mopeds and motorcycles with data determined by research, it is shown that statistical data correlates with the data obtained during the research although there are variations in the order of frequency.

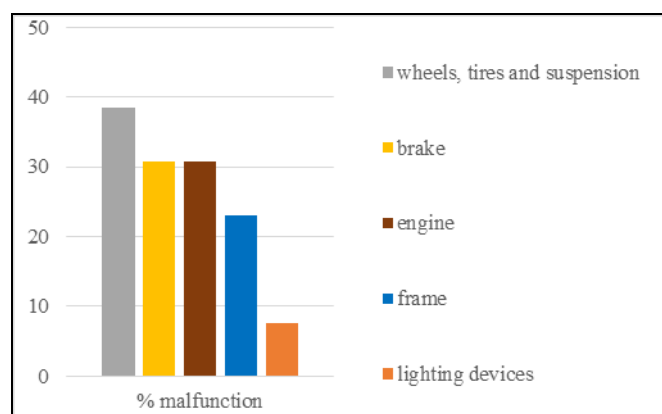


Fig. 4 Overview of "dangerous mistake" on mopeds and motorcycles

4. Conclusion

Technically defective, unmaintained and technologically outdated vehicles compromise road traffic safety. The numbers of the technical malfunctioning of vehicles involved in traffic accidents is 0.2%, when checked by traffic police officers and it is published in the bulletin of the Ministry of the Interior. Research of traffic accidents with fatalities for mopeds and motorcycles, which account for only 6.94% of road traffic vehicles, indicate that in 14.3% of traffic accidents technical failure is a possible cause of traffic accidents. The differences in the values determined from inspection carried out by traffic police officers can primarily be attributed to the different methodology of data collection and analysis, the way of keeping statistics, the conduct of the evidence, the determination of the causes of the accident, the record of the cause of the accident and due to the fact that police officers organize extraordinary technical examinations only if they doubt that there are technical defects of the vehicles involved in a car accident. The high percentage of established malfunctions through the conducted research confirms the experience and expertise of team members as well as the advantages of individual analysis of the possible technical causes of the accident. Technical malfunctions are certainly not the main cause of accidents involving mopeds and motorcycles. Much more accidents happen due to human error, however, accidents due to technical malfunctions can be avoided (or reduce the consequences) if these malfunctions were detected on time and fixed or if the vehicle is maintained in a technically correct condition. Through the research we established that mopeds and motorcycles are technically defective, which alone

with their short annual period of use and a small distance travelled makes them exceptionally risky, also enhanced by their performance and unprotected drivers. Motorcycle aging has a very negative impact, and it is very likely that a malfunctioning or insufficiently maintained motorcycle will be the cause of a traffic accident or is more likely to affect an adverse event.

The results of the research, data on the causes of the accident, the technical condition of the vehicle and the methodology of vehicle inspection should be directed towards reducing the number of accidents in road traffic. It is necessary to carry out promotional campaigns and educational actions with the aim of informing the public about the importance of technical correctness of vehicles, maintenance and control and the fatal consequences of the use of technically defective vehicles. The formation of a multidisciplinary team of professionals who will use their skills and with special equipment will be able to reconstruct the course of traffic accidents, analyze the technical validity of the vehicle, the driver's behavior when driving and the impact of the infrastructure is necessary, propose measures to increase traffic safety. It is recommended to increase the number of technical inspections of the motorcycle in everyday traffic as well as to carry out technical roadside inspections, and raise attention to critical parts and motorcycle assemblies during PTI of the vehicle. Pointing to the fact that increased age and distance traveled increase the possibility of using a defective vehicle, measures to stimulate the purchase of new vehicles should be proposed.

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COMPARISON BETWEEN THE PURSUIT GUIDANCE AND THE PROPORTIONAL NAVIGATION GUIDANCE LAWS REGARDING A PREDETERMINED SCENARIO

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Abstract: In tactical missile design, it is highly crucial to select the proper guidance method in order to meet the scenario requirements. As it is applicable in every aspect of life, trade-off conditions should be measured meticulously to reach the most advantageous and economical outcome. In this study, a particular scenario with a manoeuvring target is taken into consideration. Two of the guidance laws, namely, the pursuit guidance and the proportional navigation guidance are then implemented and compared. Lastly, the effect of the missile acceleration is examined within the proportional navigation guidance to consolidate the study.

Keywords: MISSILE GUIDANCE, PURSUIT GUIDANCE, PROPORTIONAL NAVIGATION GUIDANCE, TACTICAL MISSILE DESIGN

1. Introduction

The concept of Tactical Missile Design (TMD) is in the special interest of the Defence Industries, therefore, it should come as no surprise that the main objective is to accomplish this task with the most efficient way as possible in order to reduce the cost and development time. This design process requires a tedious analysis of various considerations, such as the scenario that is expected to be met, development and production phases of the missile, and its economical aspect to the customer.

Generally speaking, guidance laws are separated into 3 different categories. These are line-of-sight guidance (LOSG), pursuit guidance (PG), and finally proportional navigation guidance (PNG) [1]. Each of these guidance laws have trade-offs. Electronic systems of the LOS guidance missiles is relatively simple. However, LOS guidance requires commands from a control station, and therefore, susceptible to jamming. Seekers used in the pursuit guidance missiles are quite simple and durable against the noise. But their efficiency against fast moving targets is not as high as the proportional guidance missiles [2].

This study focuses on the two major guidance methods of the tactical missiles, pursuit guidance (PG) and proportional navigation guidance (PNG). In the forthcoming sections, these guidance laws are examined closely within a certain scenario, and their suitable utilizations are presented in the results and discussions section. Also, there is another section in which the impact of the acceleration of the missile is analysed in proportional navigation guidance method.

2. Prerequisites and Definition of the Scenario

Even though there are various specifications that need to be handled in designing a tactical missile, the very first step that should be considered is the threat analysis of the target. Professor Lindsley claims that experience has proven one missile cannot be designated for all types of threats without seriously compromising performance of effectiveness [3]. For this reason, PG and PNG will be performed within the same scenario, and they will be compared. For the rest of the study, subscript “M” will refer to the missile, and subscript “T” will refer to our target.

Missile that is going to be operated must meet certain functions to complete its mission. It should detect the threat, and seek it. This is achieved by the various optical instrumentations that missile includes, which will detect the target, and acquire the angular location of the target relative to a fixed system. The acquisition process provides us the radial distance between the missile and the target, r , and the angle that velocity of the target makes with the

line-of-sight of the missile, α_T . Angle ϕ which is the angle between the line-of-sight and the horizontal line and angle α_M which is the angle between the velocity of the missile and the line-of-sight are determined according to the angle α_T and to some pre-established criteria. Angles θ_T and θ_M , which are the angles between the velocity vectors and the horizontal line, can be determined from Fig. 1 and Fig. 2. For our case, the following values are selected:

- $\phi = 1.354 \text{ rad}$
- $\alpha_T = 0.750 \text{ rad}$
- $\alpha_M = 0.848 \text{ rad}$ for PNG and $\alpha_M = 0$ for PG.
- $r = 2000 \text{ meters}$
- $V_T = 300 \text{ m/s}$
- $V_M = 600 \text{ m/s}$
- Navigation ratio $k = 4$ is for PGN and $k = 1$ is for PG.

In these guidance methods, we need only one additional parameter for the sake of the simplicity of calculations and derivations. For convenience $\dot{\theta}_T$, rate of change of the angle between the target and the horizontal line, is set to value $3.2981 \times 10^{-1} \text{ rad/s}$.

3. Additional Scenario for the Effect of Missile Acceleration in PNG

Apart from the first scenario that is defined in the last section, the scenario that is going to be presented here will reinforce our previous understandings. Every value defined in the section 2 is also valid here, except the missile velocity. For the first case, the missile velocity starts with 400 m/s and it will reach to 600 m/s at the end of the propagation. The second case is the exact opposite of the first one, missile velocity decreases from 600 m/s to 400 m/s over the course. After the brief introduction of PG and PNG laws, results and discussions will take place.

4. Pursuit Guidance (PG) Law

In pursuit guidance, missile velocity vector is always directed towards the target, and the rate of turn of the missile is always equal to the rate of turn of the line-of-sight. As a result, missile constantly moves along the line-of-sight from the missile to the target whose path describes a total pursuit [4]. This is often regarded as tail-chase situation. From the Fig. 1, missile and target relationship can be visualized with the corresponding angles. Apart from the translating coordinate system, there is assumed to be an external inertial coordinate system. Leaving aside further

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comments and discussions, PG kinematics will be briefly introduced.

It is evident from the basic kinematic relationships, the velocity of the target with respect to the missile is given by [3],

$$(1) \quad \vec{V}_{T/M} = \vec{V}_T - \vec{V}_M$$

Writing absolute velocities of the target and the missile as well as the relative velocity,

$$(2) \quad \vec{V}_T = V_T \cos \alpha_T \bar{e}_r - V_T \sin \alpha_T \bar{e}_\theta$$

$$(3) \quad V_M = V_M \cos \alpha_M \bar{e}_r - V_M \sin \alpha_M \bar{e}_\theta$$

$$(4) \quad \vec{V}_{T/M} = \dot{r} \bar{e}_r + r \dot{\theta} \bar{e}_\theta$$

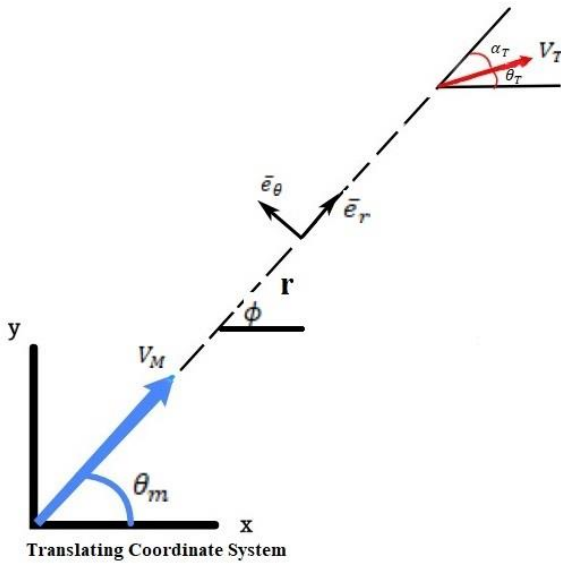


Fig. 1: Pursuit Guidance Kinematics

Inserting equations (2), (3) and (4) into the equation (1), we get our fundamental relation and the following terms [3],

$$(5) \quad \dot{r} = V_T \cos \alpha_T - V_M \cos \alpha_M$$

$$(6) \quad r \dot{\phi} = -V_T \cos \alpha_T + V_M \sin \alpha_M$$

These equations are general and can also be applied to PNG law. It can be readily seen that in PG, ϕ angle is equal to the θ_M and $\alpha_T + \theta_T$ separately. In this case, second term of the right-hand side of the equation (3) vanishes, since there is no α angle for missile. Below relations are also useful ones in the pursuit guidance law,

$$(7) \quad \theta_M = \phi \text{ and } \dot{\theta}_M = \dot{\phi}$$

Also,

$$(8) \quad \theta_M = \alpha_T + \theta_T \text{ and } \dot{\theta}_M = \dot{\alpha}_T + \dot{\theta}_T$$

Since $\dot{\alpha}_M = 0$ for PG, only time derivations of values $\dot{r}$, $\dot{\theta}_M$ and $\dot{\theta}_T$ are required. Using equations (5), (6), (7) and (8), these parameters can be achieved. With these time derivations, it is possible to find each angle at each time step, which will enable us to propagate the guidance method.

5. Proportional Navigation Guidance (PNG) Law

In Proportional Navigation Guidance method, the line-of-sight from the missile to the target does not changes direction as the distance between two objects closes [5]. In other words, if we were to connect all the positional points of the missile and the target at respective times, we would get a parallel set of line-of-sights over the course of action. Therefore, the rate of turn of the missile is proportional to the rate of turn of the line-of-sight from the missile to the target [6]. This proportionality is shown by the following relation,

$$(9) \quad \dot{\theta}_M = k \dot{\phi}$$

The multiple that is seen in the equation (9) is called navigation ratio, and it is typically between two and six. As distinct from equation (7), we have the following angular relations,

$$(10) \quad \phi = \frac{\dot{\theta}_M}{k} \text{ and } \dot{\theta}_M = \left(\frac{-k}{k-1} \right) \dot{\alpha}_M$$

It can be observed that PG can be attained by setting the ratio $k = 1$. Therefore, PNG is designed in such a way that other guidance methods can be achieved by changing this constant. Other than above equations, since equations (5) and (6) were general relations, they are also used in this method. Recalling those equations,

$$(11) \quad \dot{r} = V_T \cos \alpha_T - V_M \cos \alpha_M$$

And,

$$(12) \quad \dot{\phi} = [-V_T \cos \alpha_T + V_M \sin \alpha_M]/r$$

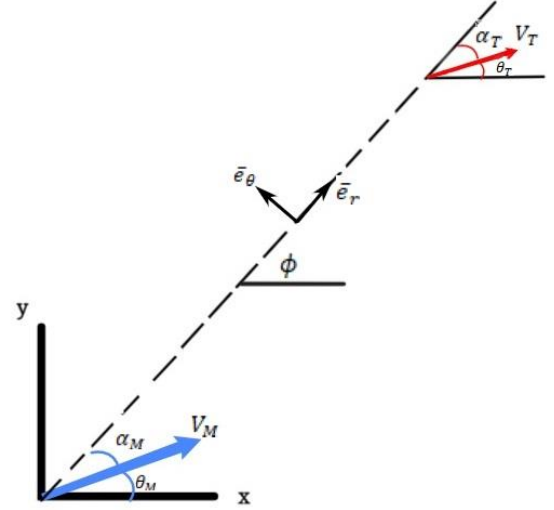


Fig. 2: Proportional Navigation Guidance Kinematics

Again, time derivations $\dot{r}$, $\dot{\phi}$, $\dot{\theta}_M$, $\dot{\theta}_T$, $\dot{\alpha}_M$ and $\dot{\alpha}_T$ are required. These parameters can be reached by utilizing equations (9), (10), (11) and (12). In the next section, these findings will be integrated into an algorithm, and that will be briefly introduced.

6. Euler's Method and Algorithm

For manoeuvring targets, the equations should be solved incrementally with time. Euler's method presents an adequate approximation for starters. Assume we have the following initial conditions, $r(0)$, $\alpha_T(0)$, $\alpha_M(0)$, $\phi(0)$, $\theta_T(0)$, and $\theta_M(0)$. Then the algorithm used is as follows [3]:

$$(13) \quad \mathbf{r}(t + \Delta t) = \mathbf{r}(t) + \dot{\mathbf{r}}(t)\Delta t$$

$$(14) \quad \alpha_M(t + \Delta t) = \alpha_M(t) + \dot{\alpha}_M(t)\Delta t$$

$$(15) \quad \phi(t + \Delta t) = \phi(t) + \dot{\phi}(t)\Delta t$$

$$(16) \quad \theta_M(t + \Delta t) = \theta_M(t) + \dot{\theta}_M(t)\Delta t$$

$$(17) \quad \theta_T(t + \Delta t) = \theta_T(t) + \dot{\theta}_T(t)\Delta t$$

Finally, we have the trajectory of the missile and the target as following:

$$(18) \quad X_M(t + \Delta t) = X_M(t) + V_M \cos \theta_M(t) \Delta t$$

$$(19) \quad Y_M(t + \Delta t) = Y_M(t) + V_M \sin \theta_M(t) \Delta t$$

$$(20) \quad X_T(t + \Delta t) = X_T(t) + V_T \cos \theta_T(t) \Delta t$$

$$(21) \quad Y_T(t + \Delta t) = Y_T(t) + V_T \sin \theta_T(t) \Delta t$$

Where the initial conditions are $X_M(0) = Y_M(0) = 0$, $X_T(0) = r_0 \cos \phi_0$, and $Y_T(0) = r_0 \sin \phi_0$. Since the algorithm have been provided with the relevant equations and the necessary information, scenario can be analysed.

7. Results and Discussions

The algorithm used in this study is implemented in the MatLab with the Euler's method, as mentioned in the preceding section. Entering the pre-determined values from the section 2, and setting the initial time and the time step to 0 and 0.1 seconds respectively will give us the following results and plots:

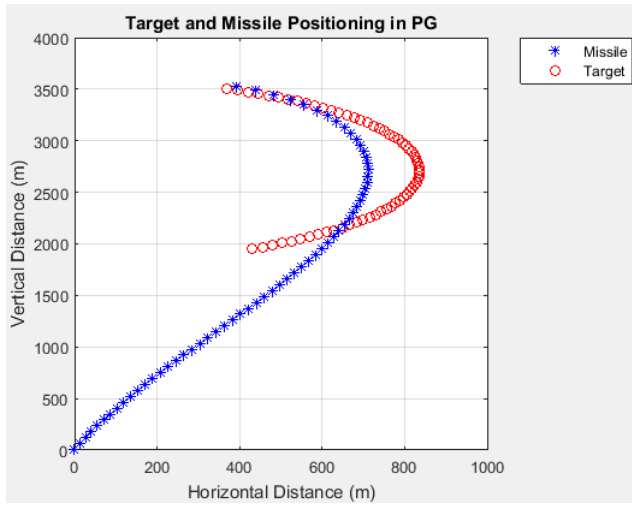


Fig. 3: Positioning of target and missile in the given scenario (PG).

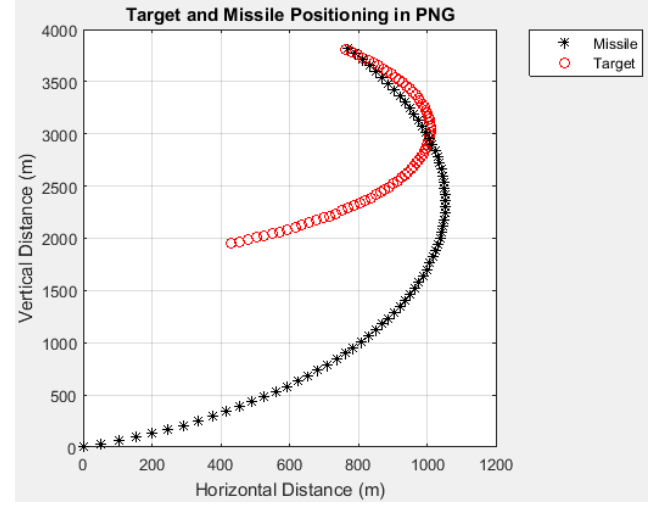


Fig. 4: Positioning of target and missile in the given scenario (PNG).

As it can be seen from the figures, even though the target movement is same, missiles have different attitudes in PG and PNG. Pursuit guidance paths are highly curved near the end of the propagation, therefore, missiles need to attain much higher accelerations. However, acceleration may reach to a point which a certain missile may not afford that specific manoeuvre. For example in Fig. 3, the maximum acceleration of the missile is calculated as $148.1 g$, and this value may not be supported by the missile structure and electronics. For this reason, the most common application of the pursuit guidance is against slow moving targets. Also, since the target position is in special interest in PG, position determining depends on looking and pointing, therefore, avionics and control is simple relative to PNG [3]. This is called target heading, and it can be considered as inexpensive and light.

On the other hand, in Fig. 4, missile propagates on a less curved path, and does not tail-chase the target. Instead, it anticipates the targets future position and tries to cut its way at all times. Maximum acceleration of the missile is calculated to be $30.03 g$ which is also in the reasonable range. The lead angle of the missile in this procedure is regulated by the navigation ratio. Moreover, since the line-of-sight changes throughout the course of action, it has to be sensed by the missile avionics. Thus, avionics required in PNG is more complex and expensive than other guidance methods.

The following figures, namely Fig. 5 and Fig. 6, present the results for the scenario that is defined in the section 3. It is seen that there is a slight difference in the terminal phase (last phase) of both cases. It is also found that the maximum magnitude of the acceleration attained in accelerated case is $10.2 g$, while the maximum magnitude of the deceleration case is $30.1 g$.

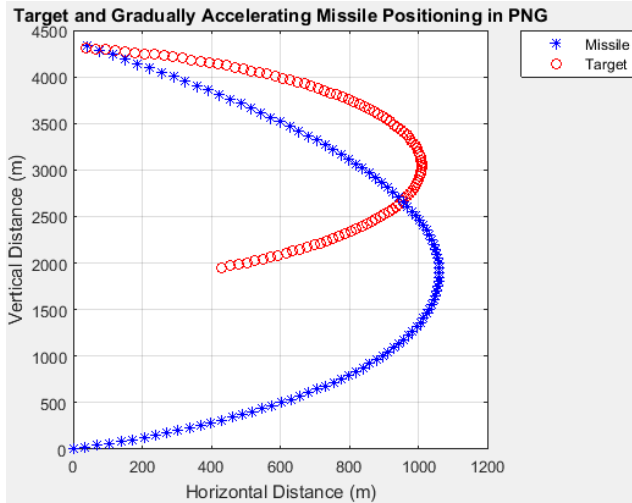


Fig. 5: Accelerated missile scenario in PNG.

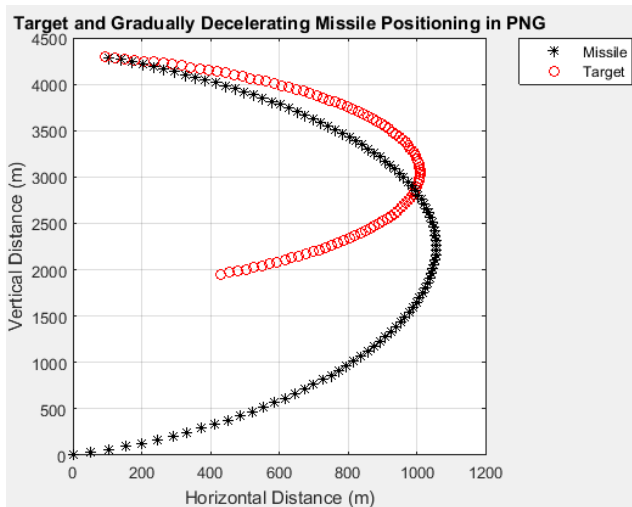


Fig. 6: Decelerated missile scenario in PNG.

As it is obvious from the figures, there is no significant visual distinction between accelerated and decelerated cases. However, this is due to small amounts of acceleration; as the acceleration increases in magnitude, the target is hit much earlier in the accelerated case with respect to the decelerated case. This is also illustrated in the Fig. 7.

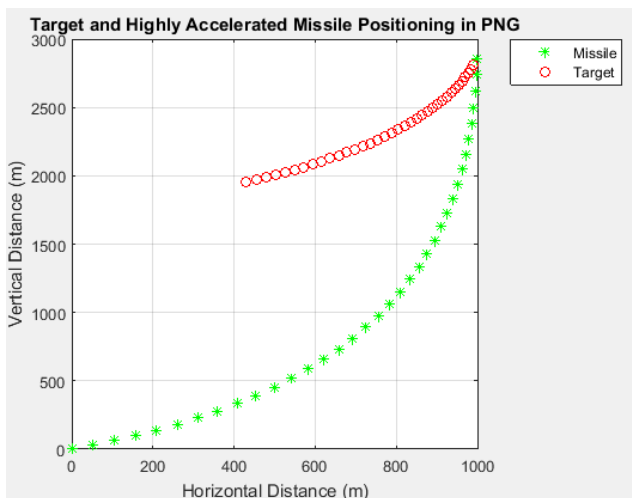


Fig. 7: Highly accelerated missile scenario in PNG.

In the case of the highly accelerated missile, magnitude of its maximum acceleration is $35.1 g$. These specifications purely dependent on the scenario and on the mission that is meant to be met. Last, but not least, these attained maximum acceleration values can be deceptive; bear in mind that that this value is the resultant magnitude of the radial and the angular components of acceleration.

8. Summary and Conclusion

In this study, PG and PNG laws are compared for the constant speed missile first, then variable speed missile is examined within the PNG method. Besides from comparisons between PG and PNG in the previous section, missile acceleration affects arrival time and miss time. It can be observed that highly accelerated missile reaches the target faster than any of the situation that are mentioned before. For gradually accelerating and gradually decelerating cases, there is no obvious distinction, there is only small change in the missile behaviour.

In the light of above findings, it can be stated that PG performs poorly against accelerated targets, while PNG is more decisive. The situation is not different with target heading accuracy. However, complex avionics of the PNG generates much more noise relative to PG. Even though these methods are examined and compared in terms of superiority in this study, there are way better guidance methods utilizing the newest technologies. However, examination of PG and PNG is vital in terms of understanding the basics and the concept of tactical missile guidance.

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EXPEDIENCY OF USING MULTIFUNCTIONAL GAS DISTRIBUTION STATIONS IN TRANSPORT INFRASTRUCTURE

ЦЕЛЕСООБРАЗНОСТЬ ИСПОЛЬЗОВАНИЯ МНОГОФУНКЦИОНАЛЬНЫХ ГАЗОРАСПРЕДЕЛИТЕЛЬНЫХ СТАНЦИЙ В ТРАНСПОРТНОЙ ИНФРАСТРУКТУРЕ

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Abstract: The article is discussing the possible options for the implementation of potential energy, which is contained in the gas pipeline in the form of pressure, which is actually lost when the gas is reduced at the GDS. Improving energy efficiency is a major challenge for Bulgaria's economic development. The extensive development of Bulgaria's gas pipeline network and the increase in the level of gasification also increases the energy that is actually released into the atmosphere. Are considered various options for the implementation of overpressure for the purpose of increasing energy efficiency, the realization of which will not only improve the efficiency of the construction of the distribution network of gas pipelines, but also will partially solve the problem of the widespread introduction of road transport on electricity and liquefied gas.

KEYWORDS: GAS DISTRIBUTION STATION, ENERGY EFFICIENCY, TURBO EXPANDERS, SMALL SCALE LNG, GASIFICATION OF BULGARIA

1. Introduction

Bulgaria is implementing a project to develop its gas transmission network, including the possibilities offered by projects of interconnection with neighbouring countries through the construction of Interconnector gas pipelines. Works on them are in different degree of readiness. The construction of the gas intersystem connection between Bulgaria and Romania was completed in the autumn of 2016, until the end of 2020 it is planned to be put into operation interconnectors Greece-Bulgaria and a similar gas pipeline with Serbia. In perspective is considered the increase in the volume of gas supplies to Bulgaria when would be implemented the projects "Southern gas corridor" and "Turkish stream".

Today, the consumption of natural gas in Bulgaria is about 3 billion m³ per year, of which about 10% is natural gas extracted in Bulgaria, and 90% is imported gas. The structure of consumption of primary energy resources in Bulgaria today is dominated by coal—37% and nuclear energy — 22%, as well as oil — 21%. Natural gas pertains about 12%, while the territory of Bulgaria is gasified by about 3% [1]. As the costs of using coal resources increases, Bulgaria's need for natural gas will increase significantly.

2. Results of discussion

The concept of the implementation of promising projects for the development of the Bulgarian gas industry, including the implementation of the gas hub project, should be based on the most effective solutions at all stages of the creation of the gas transportation infrastructure. Gas in the main gas pipelines contains a significant amount of potential energy of the excess pressure of the gas flow, which is irretrievably lost when reducing gas at gas distribution stations to pressures in distribution networks. At present time the technologies of complex use of energy of gas on GDS for power generation are known.

On GDS is made a pressure drop of the transported natural gas from 7.5 to 1.2 MPa. For use of physical energy of gas received at the expense of decrease in pressure of gas on GDS, instead of using traditional throttle devices it is supposed to use expander-generator aggregates (EGA), the schematic diagram of work is specified in figure 1.

The use of EGA provides not only a reduction in pressure, but also the generation of electricity, which is produced by an electric generator installed behind the expander. The potential for energy production due to excess pressure is directly proportional to the

energy potential of the gas, which is determined by the technical work of adiabatic expansion.

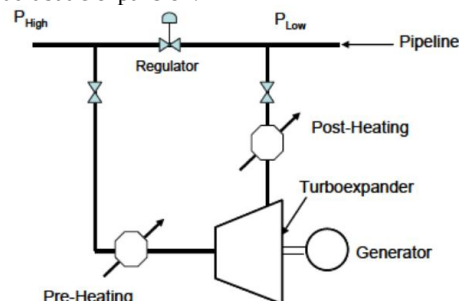


Fig 1. Schematic diagram of EGA

From the point of view of energy saving in the gas transportation system is promising the utilization of this potential energy. EGA are produced by many manufacturers, for example, ABB and Atlas Copco, Corporation "Rotoflow", the RMG company, JSC "Turbogaz", LLC "Kriokor", STC "MTT".

The first experiments on the installation of turbo expanders in Europe began in the mid-70s of the 20th century in Germany, the Netherlands and France. For the first time, a EGA was set in commercial operation in the USA in 1983 (table 1).

Table 1. The first implementation projects of EGA in the industry [3]

Location	Application	Size, Hp, (kW)	Design Flow and Pressure Drop	Year Installed
San Diego, CA (SDG&E)	City Gate	365 (260)	11 MMCF/D (810 – 390 psia)	1983
Memphis, TN (Memphic Light)	Chemical Plant	600 (450)	15 MMCF/D (450 – 87 psia)	1983
Stockbridge, GA (Transco Pipeline)	Compressor Station	400 (300)	7 MMCF/D (555 – 85 psia)	1984
Hamilton, NJ (Starmark Energy)	City Gate	3,862 (2,800)	36 MMCF/D (635 – 70 psia)	1987

In 2010 was launched in London an ambitious project to equip the main gas pipelines around the city with a mini-EGA network, the total installed capacity of the network is expected to be 20 MW [4].

Are also known technologies of complex use of gas energy from GDS for filling of vehicles equipped with engines on compressed and liquefied gas.

At low-tonnage LNG production, gas liquefaction is generated at local installations (capacity - no more than 10 t/h) located near gas pipelines, for example: gas distribution stations (GDS), automobile gas-filling compressor stations (AGFCS), gas compression stations (GCS), - with delivery to consumers (within a radius of 200 km) for use as gas motor fuel for transport or replacement of diesel fuel or fuel oil at enterprises with energy-intensive technology.

If liquefied gas is used, the natural gas with the main line pressure is supplied to the drying unit, compressed in a turbocharger located on one shaft with the turbo expander up to 41 kgf/cm², cooled in a natural gas cooler and divided into liquefied (13.5%) and expanded (86.5%) flows. The liquefied stream comes through the cleaning unit, and, further, both streams pass through the advanced and basic heat exchangers. As a result of expansion in the turbine expander gas temperature is reduced to -50 °C. Since this decrease in temperature is not enough to liquefy the gas, further throttling is performed, as a result of which the temperature of the gas decreases to -140 °C. The gas-liquid mixture enters the separator to separate the liquid from the vapor phase; the steam phase passes through the heat exchangers, and the liquid enters the storage and distribution unit. The schematic diagram of the installation for liquefied natural gas with a throttle-expander cycle is shown in figure 2, the specified scheme was implemented at GDS-4 in Yekaterinburg [5].

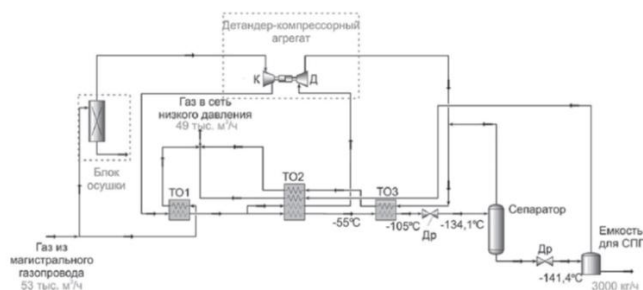


Fig 2. Schematic diagram of LNG production plant with throttle-expander cycle

In case of using compressed gas, natural gas purified from impurities and moisture comes from external networks (gas distribution substations GDSS) to the compressor inlet under pressure 0,3 – 0,6 MPa. In the compressor, the gas is compressed in series with a moisture separation. During the compressor operation, the pressure and temperature of the compressed gas are controlled by stages. After cooling, the gas is sent to the separator, where it is removed from the condensate and oil trapped in it during compression and cooling. Gas compressed to 25 MPa fills the inner cylinders (pressure compensators) in the volume of about 1120 liters. Compressed natural gas from the pressure compensator is fed to the filter connector located in the transfer column and then through the ball valve and solenoid valve, filter and enters the flow meter. After that, the gas flows through the pipeline to the filling connection and further — into the cylinders of the refueled car. The cost of production of CNG is much lower than the cost of production of fuel from crude oil: to prepare natural gas for use as a motor fuel, it does not require pre-processing, the gas is transported through pipelines directly to the gas station. According to the international natural gas vehicles association (NGVA), currently programs for the development of the gas motor fuel market are being implemented in 86 countries.

Work on liquefaction and compression of natural gas may also be executed partially or fully due to the transformation of energy of excessive pressure of main gas flow.

In principle, it is possible to implement the scheme of multifunctional gas distribution stations combined with gas filling and electric charging stations.

The use of electricity generated from autonomous sources is always faced with the problems of synchronization of these sources with existing electricity networks. In addition, in order to run a charging station on the gas station and start trading with electricity, it must enter into contractual relations with electricity supply organizations. These problems are sometimes intractable due to the expensive hardware for synchronization or unwillingness of the suppliers of electricity to prevent interference in the operation modes of their own networks. Therefore, when generating electricity by autonomous sources, it is desirable to have the same autonomous consumers. These consumers can be vehicles equipped with electric motors and the GDS itself. In this case the project of creation of the multipurpose gas-distributing stations providing not only reduction, but also complex use of energy of gas on GDS for generating the electric power for own consumption and gas station of vehicles, and also production of the liquefied and compressed gas as gas-engine fuel can be realized that will allow to utilize potential of pressure which is now bled from main gas pipelines in the atmosphere and to provide direct additional profit. A special advantage in this case have GDS, located in close proximity to industrial enterprises and large settlements, thanks to the presence of potential consumers.

Conclusions: The new construction of a network of natural gas main and distribution pipelines in Bulgaria creates unique opportunities for the implementation of promising ideas, one of which is the idea of energy saving and increasing the efficiency of primary energy resources consumption. Electric drive and natural gas used as motor fuel, reduce the consumption of liquid fuels, provide energy saving, increase the life of motor vehicles, reduce environmental pollution.

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THE PROBLEMS OF URBAN ROAD TRAFFIC MONITORING

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Abstract This article discusses the problems of urban road traffic monitoring and investigation. A brief description of a video system for the traffic observation is presented. As an illustration of its use, the density of a road traffic calculated from a video is given.

Keywords : traffic monitoring, traffic control, image processing, swarco.

1. Introduction

Road transportation plays an important role for each country. Yearly, it completes approximately 80% of freights and 75% of passenger transportation. Until recently, the problems of coordination and controlling the transport flows on the street-road network (SRN) were not used with high actuality. In conditions of not-so-high loads, the SRN functioned efficiently enough and their activity did not lead to serious shutdowns and service denials. During the last few years, the increasing number of automobiles and the mobilization of the population has led to a saturation of urban streets, which became a reason to re-evaluate the principles for controlling transportation flows [4,11] and requires special attention towards reconstructing the SRNs in order to improve their functionality. The yearly increase in transportation load of the networks leads to a decrease in the speed of the flow and the appearance of traffic-jams.

The appearance of the latter, even when there is a surplus of free passages, is due to the unclear and uncoordinated processing of traffic lights, which increases the length of vehicles in service queue at crossroads. When the conditions are similar to a traffic jam, the vehicle queue may not be able to fit into the time interval needed to traverse two consequent crossroads. This situation is known as network congestion [2], and leads to disturbances in the work regime of the previous crossroad's traffic lights. The main priorities in the organization of road traffic are the issues of controlling them in the conditions of a traffic jam [4,10]. They require special attention when developing new principles and control norms in high levels of auto mobilization and dense traffic flows, which require the solution of new civil engineering and technical tasks.

2. BASIC FLOW MONITORING INDICATORS.

Traffic monitoring plays an important role for increasing the efficiency of traffic flows through the SRN. The information received by it is of significant importance for deciding the placement of road signs, traffic lights, information labels, when evaluating the driver's behaviour, which also introduces a certain influence in the functionality of the SRN, and other factors. In order to interpret the results correctly, the classification and exploitation characteristics of the vehicles play an important role. Usually, the vehicles are divided into several categories – cars, trucks, buses, trams, motorcycles and bike. A useful criteria, which generalizes the exploitation characteristics is the mass-power ratio. It determines the rate of acceleration and stopping, which are important factors to take into account when designing the traffic lights' signal schemes, fuel economy readings and evaluating the ability of the flow to resume its movement after stopping [2].

When buses and trams are present in traffic, the time required for serving their stops also has to be taken into account. The latter varies with regard to the loading/unloading zone, the

number of passengers, the door configuration and the payment method. The presence of bicycles in traffic also requires special attention, as their drivers can execute various and often surprising maneuvers, unlike car drivers. The behaviour of pedestrians has a similar characteristic, and they are generally considered a factor in road traffic, due to the fact that the traffic light schemes have to be adjusted with regard to their mean velocity.

3. INDICATORS, DERIVED FROM THE TRAFIC FLOW MONITORING INFORMATION.

The flow load is an indicator which varies depending on the month, the day of the week and the hour. It depicts the social and economic activity in the area, served by the traffic. The variations in the load during the different days of the week depend on the type of the route on which the traffic is conducted. An important part in the process of analysing the passage ability is given to the maximum load in certain time intervals (rush hour). They are the most crucial interval of the route's function and require the greatest passage ability. The load during rush hour is not constant. It varies in different days and seasons and leads to the formation of long queues. The traffic distribution in directions and lanes in a given route is another important part in analysing the passage ability. During each hour, the traffic in a given direction can differ greatly from the traffic in another direction. A typical example is the urban radial streets, for which the level of balance of flows in directions can reach a ratio of 2:1. The directional distribution is not a statistical characteristic and varies with regard to years, hours of the day, days of the week and seasons.

As an example the one day traffic flow distribution captured among 8 till 14 o'clock from crossroad of Shipchenski prohod" blvd. and "Ivan Dimitrov" str. (in front of block 2 of IICT, BAS), is presented on figure1.

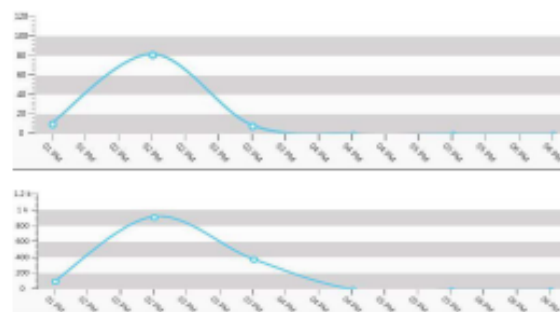


Fig.1. Distribution of the number of cars that have traversed the monitored area.

The distribution of the first week of june traffic flow passed through the same crossroad is shown on figure 2.

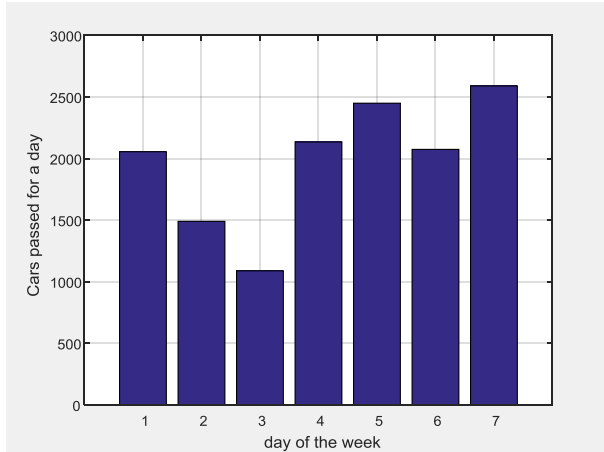


Fig. 2. The first week of june traffic flow distribution.

When the movement in one direction is conducted in 2 or more lanes, the traffic distribution varies greatly. Generally, it is dependent on the movement rules, the flow's speed and intensity, the number and placement of conduits, transportation routes and others. The passage ability is given in terms characterizing the maximum intensity of the flow, which can be served by the given road part in dominant conditions. Its direct monitoring is difficult due to the fact that fixing the maximum intensity of the flow for the given part does not guarantee that a high intensity flow will not be present at another time.

4. TRAFFIC CONTROL

In urban conditions the flow of vehicles can be considered continuous only in the segments between crossroads. A main role in the successful serving of these areas is given to traffic lights. In more cases, this mode of crossroad regulation is based on the principle of time division. Its use does not provide the necessary bandwidth, as they operate as a closed system in terms of the external environment and do not adapt to the changes of the road conditions.

A more modern and effective way to regulate intersections through traffic lights is adaptive control [3,8]. Their strategy offers a configuration according to the current road situation, depending on many factors, and allows for the introduction of a local intelligence traffic light that determines the dynamics of switching on the signal groups according to queue length and flow velocity [1,5,7]. A convenient approach to achieving optimization of a transport network according to the mode of transport traffic is the use of video information. It provides an opportunity to build an adaptive traffic control mechanism within a junction. Effective use of the obtained video information requires prior photogrammetric attachment of the observed stretch of the track with the observed image in the terms of the television broadcast standard. This ensures that correct performance of the operations intended to determine transport traffic parameters. A major drawback of video information systems is their dependence on light change and atmospheric conditions. When night or fog occurs, visibility and contrast in the image fall, which do not permits its reliable processing. The presence of rain or snowfall brings noise, which also reduces the contrast of the resulting image. Reduced

illumination can be compensated by signal amplification or an artificial illumination use. To reduce the glare from the road and the vehicles themselves, cast shadows and merging objects, the use of polarization and anti-infrared filters is a good approach. The introduction of control sections in certain areas of the frame to be analyzed also contributes to the reliability of the information retrieved from the incoming video stream.

Generally, to improve contrast and visibility, the processing of the received video sequence is done digitally within two interrelated stages.

At the first stage, an adaptive background assessment and threshold detection of fragments that have made changes that are inherent to moving objects are performed. In the second stage, the video frame is framed with fragments that have overcome a certain threshold using morphological processing. The execution of such processing is a sufficiently complex task, which can be presented in the form of several successively executable relatively independent operations:

- background assessment by tracking its changes;
- background compensation;
- threshold detection of moving fragments;
- Morphological processing using operations erosion, growth and opening;
- Fixing the crossing times of the control sections from the linked areas;

As the result of this calculation of the basic parameters of the traffic flow can be determinate. Late, based on them, the length of the traffic light cycle can be calculated. In its entirety the traffic control is a process which requires previous information. In order to achieve satisfying results in the carrying of this process, a setup was developed, which allows the monitoring and registering the traffic. The general appearance of the setup is given in Fig. 3.



Fig. 3. General appearance of the setup for traffic monitoring and registering.

As a registering device the IP Camera DCS-2330L was used[6]. The camera features a 1/4 "megapixel progressive CMOS sensor, a 3.45mm focal length and a waterproof IP65 housing, and features a built-in, infrared-free filter, a full-blown LED, and a built-in PIR motion sensor. It is equipped with H.264 compression, Motion JPEG, and 10 times digital zoom. Exposure time ranges from 1/7.5 to 1/10,000 sec. Supports a wide range of video resolutions,

interfaces to external Devices, and network protocols. It can be used with Microsoft Windows 8/7 / Vista / XP operating systems (see Fig. 4.).



Fig. 4. The IP Camera DCS-2330L

The camera is placed firmly on a vibration safe stand and connected to a PC. It is used to observe the crossroad of “Shipchenski prohod” blyd. and “Ivan Dimitrov” str. (in front of block 2 of IICT, BAS), shown in Figures 5. and 6. The images received from the camera are stored in the computer. As a main tool for their processing, the Matlab environment is used. Based on its image processing tools, the information for a current momentary condition of the traffic flow is extracted from the pictures obtained from the camera. . Later, this information is used to carry out an adaptive traffic light control. In order to improve the statistical robustity of the expected estimations, the information is averaged over a given time period. The averaged information is used to conduct an adaptive control of the traffic light connected to the swarco controller, shown in Fig. 7.



Fig. 5 Ivan Dimitrov str.



Fig. 6 Shipchenski prohod bul.



Fig. 7. ITC-2 Mini controller

5.CONCLUSIONS

This article presents a tool to monitor the density of traffic. Management of traffic light to control the measured density of traffic:

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ТРАНСПОРТЪТ В СИСТЕМАТА НА ТУРИЗМА

TRANSPORT IN THE TOURISM SYSTEM

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Abstract: This report examines the importance of transport in the tourism system. An analysis is made of the possible means of transporting tourists. Transport statistics from national statistics in Bulgaria and Eurostat are presented. Great attention is paid to water transport, which is of the greatest importance to tourism. The largest cruise ships in the world are presented and conclusions are drawn based on the data and trends examined.

Keywords: TRANSPORT, TOURIST ACTIVITIES, CRUISES

1. Въведение

Туризмът се характеризира със силна динамика на процесите както и зависимост от развитието на транспорта. Той служи за предвиждане на туристи до конкретна туристическа дестинация или транспортно средство, комбиниращо превоз на пътници и предлагащо висококачествени основни и допълнителни туристически услуги.

Тясната връзка между туризма и транспорта води до обособяването на понятието „туристически транспорт“. [6.1] Често няма много ясно разграничение между него и пътническия транспорт, но в научната литература се прави опити за това и се посочва като негова характеристика организирания характер на туристическия транспорт. Това разбира се, не е най-точното разграничение, поради силната динамика в развитието и на двете дейности.

Когато говорим за транспорт, използван в туризма, то той има различни характеристики като вид, комфорт, гориво, бързина, капацитет, ефективност и т.н. За да бъде отнесен към транспорта обслужващ туристическите пътувания, той трябва да отговаря на следните характеристики, които са свързани с обслужването, а именно то да съществува преди пътуване, по време и след пътуване. [6.1]

В настоящия доклад се прави преглед на транспортната дейност в туризма, както и най-значимите транспортни средства за туристическия бизнес.

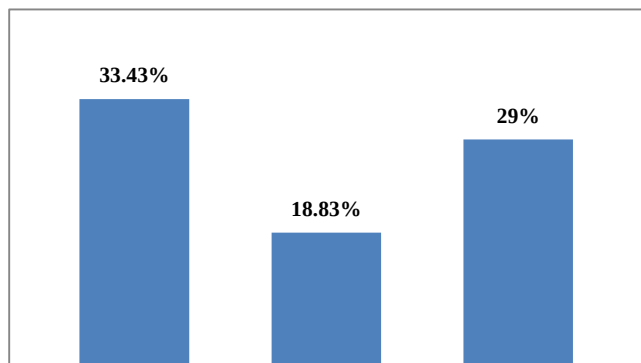
2. Видове транспорт и значението му за туризма в България

Р България има Интегрирана транспортна стратегия (май 2017), чиято основната цел е до 2030 г. да изгради система за устойчиво развитие на транспорта в страната ни. Българската стратегия е съобразена с приложенията на европейските директиви и стратегии в транспорта. [6.4]

Тази стратегия спомага цялостното развитие на транспорта в страната ни, а това от своя страна допринася за повишаване качеството на туристическия продукт. Разбира се, тук трябва да бъде отчетен реалния напредък по изпълнението на стратегията и да се работи по преодоляване на трудностите за българската страна.

В националната ни статистика (НСИ), транспортът в системата на туризма се нарежда на второ място след разходите на туристите за хранене (посочени на таблица 1).

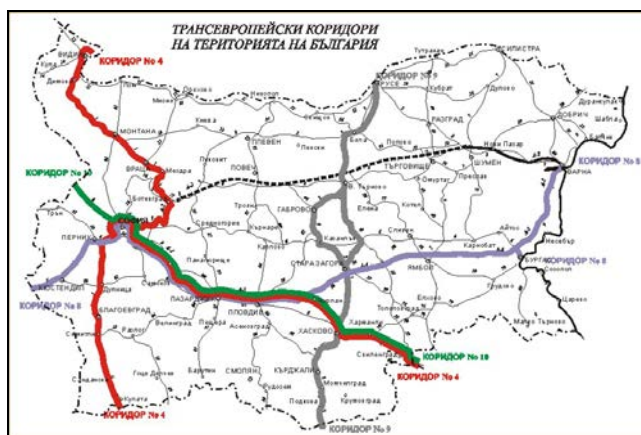
Диаграма 1. Среден разход по видове (без туристически пакет) за туристически пътувания на лица над 15 години за периода 2015 - 2017 г. вкл. за България¹



От данните в диаграмата става ясно, че туристите харчат най-много финансови средства за храна (33,43%), последвани от транспорт (29%), нощувки (18,83%) и други услуги (18,74%). Данните са обобщени за последните три години за България и са добър показател за важността на транспорта за развитието на туризма.

Друг важен показател за значимостта на транспорта в България е изградената транспортна мрежа. Поради стратегическото си географско разположение, в страната ни се наблюдава туристопоток от всички видове транспорт: авто, железопътен, воден (морски), въздушен.

Важни за **авто и железопътния транспорт** са петте Транс-Европейски коридори, пресичащи страната ни, а именно: № IV, VII, VIII, IX и X. Те могат да се проследят на фиг. 1.



Фигура 1. Транс-Европейски коридори пресичащи Р България²

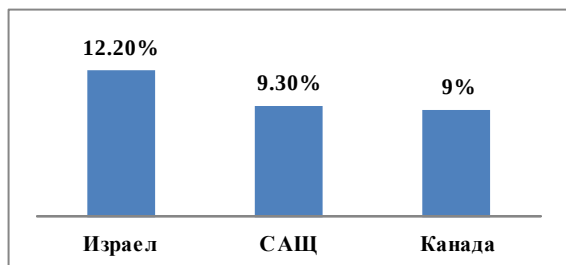
¹ Данните са обработени от информацията качена в сайта на Национален статистически институт: <http://www.nsi.bg/bg/content/1996/разходи-за-туристически-пътувания-на-населението>.

Тези транспортни коридори са със значение най-вече за туристите от съседните ни страни. По данни на НСИ през периода януари – ноември 2016 г., България е посетена общо от 7 855 145 чуждестранни граждани (без транзитно преминалите). Техният брой е с 16,1% повече спрямо същия период на 2015 г. Също така увеличение има и при посещенията с цел почивка и ваканция, като реализираните са 4 931 263 посещения, което формира ръст от 19,9% и при посещенията с цел гостуване има регистрирани 638 168 посещения и ръст от 28,3%. Посещенията с цел бизнес са 1 320 471, като техният ръст е от 18,4%. Най-много туристи в страната ни пристигат от съседните страни, а именно Румъния и Гърция, следвани от германски, руски и турски туристи (към 2016 г.). За 2017 г. данните за посещения (брой) на чужденци са от Румъния (1 943 436), Турция (1 437 276), Гърция (1 272 997) и Германия (1 046 219).

С най-малко значение за туризма в България е **железопътният транспорт**, при който се наблюдава намаляване на пазарния дял в последните над десет години, тежко финансово състояние и ниската приспособимост към новите изисквания на пазара и конкуренцията при превоза на пътници. Той остава предпочитан при превоз на товари, а не на пътници.

Въздушният транспорт на пътници от своя страна бележи ръст, който за периода 2014-2016 г. е 19,33%, което съставлява около 1,8 млн. души (по данни на Евростат към 2017 г.). По данни на НСИ, пътниците извън Европейския континент, които осъществяват най-много посещения в България (души към 2017 г.) са Израел (209 304), САЩ (90 963) и Канада (19 113). На диаграма 2, може да се проследи процентното изменение спрямо 2016 г. на пътуващите от трите дестинации.

Диаграма 2. Трите извън европейски държави с най-голям дял на туристи в България (в процентно изменение - 2016 към 2017 г.)³



Процентното съотношение отговаря на следните данни за повишение на броя на пътуващите с въздушен транспорт, а именно: Израел повишение с 25 458, САЩ с 8 498 и Канада с 1 718 души.

Водният (морски) транспорт е по-специфичен за туризма, тъй като обединява транспортна и туристическа дейност и предлага комплексна туристическа услуга.

3. Воден (морски) транспорт – транспортът с обединяващ предлагането на туристически услуги и превозът на пътници.

В туризма, водният или морския транспорт, се свързва с възможността за комбиниране на транспорт и туризма по едно

² <https://aebtri.com/Img/DBB-map-big.jpg>

³ Данните са обработени от информацията качена в сайта на Национален статистически институт: <http://www.nsi.bg/bg/content/1969/посещения-на-чужденци-в-българия-по-месеци-и-по-страни>.

и също време. Той е използван от най-дълбока древност с различни цели (търговска, завоевателна, религиозна). [6.1]

През годините до днес, средствата за реализиране на този вид транспорт бележат голяма еволюция, превръщайки комфорта на пътниците в една от основните си цели при пътуване.

Международното корабоплаване превозва повече от 80% от световната търговия на хора и общности по целия свят. Водния транспорт е най-ефикасният и рентабилен метод и евтино средство за транспорт на стоки в световен мащаб, улесняващ търговията и помагаш за създаване на просперитет сред народите.

В *Конвенцията за облекчаване на международното морско корабоплаване (судоходство)* (на английски: Convention on Facilitation of International Maritime Traffic (FAL)) от 1965 г. плавателният съд, извършващ туристически круизи се определя като „съд, предназначен за международни пътешествия с превозване на пътници, участници в групова програма и настанени на борда, с цел планирани туристически посещения на едно или повече различни пристанища...“ [6.3]

В научната литература, водния транспорт се свързва с круизните пътувания, където имаме комплексно туристическо обслужване (предлагане на основни и допълнителни услуги). Според М. Нешков, круизът може да се определи като организирано туристическо пътуване с кораб при което участниците пътуват в група, която се запазва една и съща през цялото пътуване, маршрутът е базиран на възможностите за спиране и престой на пристанищата, а също така и възможност за посещение на туристически обекти на сушата, които са в близост до пристанището. [6.2]

В началото на 2009 г. Европейската комисия публикува документа „*Стратегически цели и препоръки за политиката на ЕС в областта на морския транспорт до 2018 г.*“, в който са представени основни стратегически цели на европейската система за морски транспорт и се идентифицират ключовите области на действие за повишаване конкурентоспособността на сектора и подобряване на екологичните му резултати. [6.3]

Стратегията е насочена основно за създаването на концепцията „Морски магистрала“, която цели въвеждане на нови морски логистични връзки в Европа, които ще осигурят подобряване на достъпа до пазарите на континента и ще облекчат натоварената пътна мрежа. Като приоритетна дейност, стратегията посочва „използване на пълния потенциал на морския транспорт на къси разстояния и на морските транспортни услуги за бизнеса и гражданите в Европа“.

Значителният потенциал на речния транспорт предстои да бъде обхванат до голяма степен. Ако бъде предпочетен, трафикът по пътищата ще намалее, а възможността за предлагане на туристически услуги по вода ще се увеличи многократно.

От своя страна, пристанищната система в България е съставена от морски и речни портове, като основните морски пристанища са разположени във Варна и Бургас, а най-големите речни са в Русе, Видин, Лом и Оряхово.

Към април 2018 г., заявки за посещения на круизни кораби на пристанищата Варна и Бургас няма. През 2017 г. година същите записаха рекордно слаб круизен сезон. Като сравнение за негативната тенденция, може да се даде 2014 г., когато българските пристанища са посетени от 36 круизни кораба, а с тях и хиляди високо платежоспособни туристи, които с престоя си подпомогнаха българската икономика. Сред специалистите по круизни пътувания, се разглеждат различни причини за тази негативна тенденция. Ето някои от тях:

- материално-техническа база и инфраструктура - липсва цялостно подновяване на съоръженията за обработване

на контейнери, както и липса на стратегия за повишаване интересът на круизните компании;

- сигурност в региона – упоменат е украински конфликт, вътрешно-политическа обстановка в Турция, както и бежанския поток;

- пристанищни такси – високи за качеството на предлаганата услуга. Конкурентни пристанища в региона като Констанца (Румъния) и Солун (Гърция) влагат средства за модернизация и разширяване на основни търговски портали за страните от Югоизточна Европа. Показателен е фактът, че Констанца обработва повече товари годишно в сравнение с всички български пристанища, взети заедно.

След като се установи значението на водния транспорт за туризма, следва да се разгледат и най-големите круизни кораби, предлагани понастоящем в света.

4. Най-големите круизни компании в света

За да бъдат идентифицирани най-големите круизни кораби в света, се провежда онлайн проучване. В таблица 1 са представени световните лидери в круизните пътувания, мято и година на основаване, най-големият им кораб и година, от която той функционира. Данните са събрани и обобщени към април 2018 г.

Таблица 1. Световни круизни лидери към април 2018 г.

№	Корабна компания/ Корабна линия*	Основана	Най-голям кораб**	Година***
1.	Royal Caribbean International	Норвегия, 1968 г.	Symphony of the Seas	2018
2.	MSC Cruises	Неапол, Италия, 1987 г.,	MSC Meraviglia	2017
3.	Norwegian Cruise Line	N/A, 1966 г.	Norwegian Bliss	2018
4.	Genting Hong Kong Company	N/A, 1993 г.	Genting Dream	2016
5.	Cunard Line	N/A, 1838 г.	Queen Mary 2	2004
6.	Princess Cruises	N/A, 1965 г.	Majestic Princess	2017
7.	P&O Cruises	Саутхемптън, Англия, 1837 г.	Britannia	2015
8.	Carnival Cruise Line	Маями, САЩ, 1972 г.	Carnival Vista	2016
9.	Costa Cruises	Генуа, Италия, 1854 г.	Costa Diadema	2014
10.	Disney Cruise Line	Лондон, Англия, 1996 г.	Disney Fantasy	2012
11.	AIDA Cruises	Рощок, Германия, 1960 г.	AIDAprima	2016
12.	Celebrity Cruises	Гърция, 1988 г.	Celebrity Reflection	2012

*Това са корабни компании, станали дъщерни на по-големите корпорации в круизния бизнес, но запазили наименованието си.

**Корабите са класирани според брутния тонаж с обем над 120 000 бруто тона.

***Начална година на експлоатация. В круизните пътувания, първото пътуване на кораба е известно като „maiden voyage“.

Интересен факт от проучването е, че в класация за корабите според брутния тонаж, съществуват 47 с обем над 120

000 бруто тона като всички те са собственост на описаните в таблицата корабни компании.

От направено изследване, може да се обобщят някои основни факта, а именно:

- круизните пътувания са най-ярко изразение на туристическия транспорт;

- в световен мащаб се наблюдава окрупняване на круизните компании;

- в круизните кораби се инвестират големи финансови средства, което е показател за повишено туристическо търсене;

- круизните компании увеличават периметърът си на дейност и от регионални, голяма част се превръщат в световни оператори по вода;

- всеки следващ кораб е много по-модернизиран във всички аспекти (технически, технологично, обемно и т.н.);

- пристанищната система е от голямо значение, създавайки подходящи условия за престой и спиране на корабите.

Това са част от възможните изводи, но е факт е този вид транспорт е с най-голямо значение в туризма.

5. Заключение

В заключение може да се обобщи, че прогресът в транспорта оказва силно влияние върху развитието на туризма. Този факт намира изразение в популяризиране и на не много известни места с туристически потенциал, което води до появата на нови дестинации.

От друга страна, туризмът влияе на транспорта като стимул за модернизация и усъвършенстване на пътища, техника, технологии, нови видове транспортно обслужване и предлаган комфорт. В научната литература се установява тенденция на повишение на пътуванията с цел туризъм, които са по-чести, но за по-малък период от време. [6.1]

Туризмът и транспортът са две взаимосвързани системи, които със своята дейност си оказват голямо влияние.

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THE NUMERICAL INVESTIGATION OF HIGH SPEED TRAIN-TUNNEL INTERACTION AT ENTRANCE AND EXIT

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Abstract: In the study, the flow pattern due to the interaction between a high-speed train and the tunnel at the model scale was analyzed. Six different tunnel entry geometries were used variably for a single train speed. The most important issues as a condition of comfort in high speed trains are noise and vibration. In particular, flow-induced noise is triggered by pressure changes in the flow. For each geometry, the pressure changes at the tunnel entrance and at the tunnel exit are plotted with depending on time. As a result, the least amount of pressure change was found in the tunnel entrance model with openings in the side walls.

Keywords: COMPUTATIONAL FLUID DYNAMICS, HIGH SPEED TRAINS, OVERSET MESH, PRESSURE CHANGES

1. Introduction

In recent decades, with the increase of international economic activities, transportation have become an important issue all over the world. The amount of passengers and goods that can be carried in a single time and duration of transportation are critical parameters in economic transportation systems. For this reason, railway transportation is an important alternative by being faster than sea transport and having more load carrying capacity than airlines. Although the cargo capacities of the vehicles used in railway are high, as well as marine transport, the transportation time is not short enough. Thus, there is an increasing afford to speed up the vehicles on the sea and railway transport. However, the increase of the speed of vehicles causes some problems, which are mainly drag, noise and vibration. Especially in high speed rail systems, most of the energy wasted to overcome the drag of the air with the speed up of the vehicle. Besides, when the rail systems are considered, the vibration and the noise are important issues due to the interaction of vehicles with non-vehicle elements such as tunnels. This problems creates an undesirable environment considering the passenger comfort.

In the literature, it is possible to reach some studies examining this problem. Ogawa and Fujii [1] numerically studied the flow induced by a high-speed train moving in a tunnel using three-dimensional compressible Navier-Stokes equations. In time-dependent solutions, the focus is on the compression wave that causes the noise burst at the entrance and exit of the tunnel. The calculated pressure increments in the tunnel are compared with the measured data. It is stated that the compression wave in the tunnel depends on the tunnel position. Kwon et al. [2] studied the effect of the high-speed train nose geometry on explosion in their work and optimized the nose geometry using axial symmetric Euler equations and response surface methodology. By using the results of the study, they have examined the mechanism of train-tunnel interaction. Shin and Park [3] investigated the compression wave, which is similar to the piston effect, created at the tunnel entrance of the high speed train. They have modeled the problem with three-dimensional, time-dependent Navier-Stokes equations and the movement of the train with the multi-block slider approach. At the entrance of the tunnel, the pressure that induced by the piston effect was increased on region around train nose, and the drag force acting on the train was 2.7 times higher than the value outside the tunnel. Xiang et al. [4] have numerically investigated the compression waves that high-speed trains creates at tunnel entrances. They have seen that the compression wave is caused by the development of a large number of waves. Three equations have been proposed to understand the train Mach number, the ventilation rate and the effect of the ventilation zone on the compression wave.

When these studies are examined, it is seen that most of these studies considering the high speeds with compressible fluid. In this study, the effect of different tunnel entrance geometries on pressure gradient in train-tunnel interaction at low speed voyage was

investigated. In this context, six different entrance concepts were determined and flow analyzes were made for each geometries. The results were analyzed in terms of pressure changes.

2. Mathematical Model

The equations that model the three-dimensional, incompressible, time-dependent turbulent flow around the high-speed train, which are Navier-Stokes equations, are given below. The k-epsilon turbulence model is used to model the turbulent behavior [5].

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0 \quad (1)$$

$$\frac{\partial \rho u}{\partial t} + \frac{\partial}{\partial x}(\rho u^2 + p - \tau_{xx}) + \frac{\partial}{\partial y}(\rho uv - \tau_{xy}) + \frac{\partial}{\partial z}(\rho uw - \tau_{xz}) = \rho f_x \quad (2)$$

$$\frac{\partial \rho v}{\partial t} + \frac{\partial}{\partial x}(\rho uv - \tau_{xy}) + \frac{\partial}{\partial y}(\rho v^2 + p - \tau_{yy}) + \frac{\partial}{\partial z}(\rho vw - \tau_{yz}) = \rho f_y \quad (3)$$

$$\frac{\partial \rho w}{\partial t} + \frac{\partial}{\partial x}(\rho uw - \tau_{xz}) + \frac{\partial}{\partial y}(\rho vw - \tau_{yz}) + \frac{\partial}{\partial z}(\rho w^2 + p - \tau_{zz}) = \rho f_z \quad (4)$$

$$\frac{\partial k}{\partial t} + U_j \frac{\partial k}{\partial x_j} = \tau_{ij} \frac{\partial U_i}{\partial x_j} - \varepsilon + \frac{\partial}{\partial x_j} \left[\left(\nu + \nu_T / \sigma_k \right) \frac{\partial k}{\partial x_j} \right] \quad (5)$$

$$\frac{\partial \varepsilon}{\partial t} + U_j \frac{\partial \varepsilon}{\partial x_j} = C_{\varepsilon 1} \frac{\varepsilon}{k} \tau_{ij} \frac{\partial U_i}{\partial x_j} - C_{\varepsilon 2} \frac{\varepsilon^2}{k} + \frac{\partial}{\partial x_j} \left[\left(\nu + \nu_T / \sigma_\varepsilon \right) \frac{\partial \varepsilon}{\partial x_j} \right] \quad (6)$$

$$\nu_T = C_\mu k^2 / \varepsilon \quad (7)$$

$$C_{\varepsilon 1} = 1.44 \parallel C_{\varepsilon 2} = 1.92 \parallel C_\mu = 0.09 \parallel \sigma_k = 1.0 \parallel \sigma_\varepsilon = 1.3 \quad (8)$$

3. Numerical Method

The model train and model tunnel cross-sections used in the numerical study are shown in Fig. 1 Model height $H_{\text{train}} = 980$ mm, width $B_{\text{train}} = 900$ mm and is length $L_{\text{train}} = 16000$ mm, model tunnel main dimensions are tunnel diameter $D_{\text{tunnel}} = 1250$ mm and tunnel length $L_{\text{tunnel}} = 47900$ mm. Scale factor is chosen 1/10.

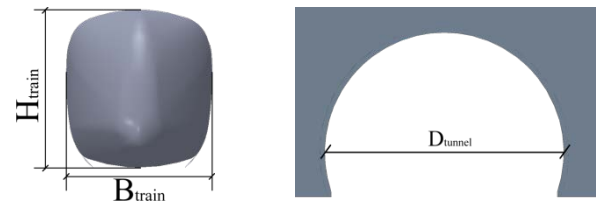


Fig. 1 Model train and model tunnel cross-section views

The speed of the model train is taken as 3 m / s which is equal to the 108 km/h for full scale. Fig. 2 shows tunnel entrance geometry variations.

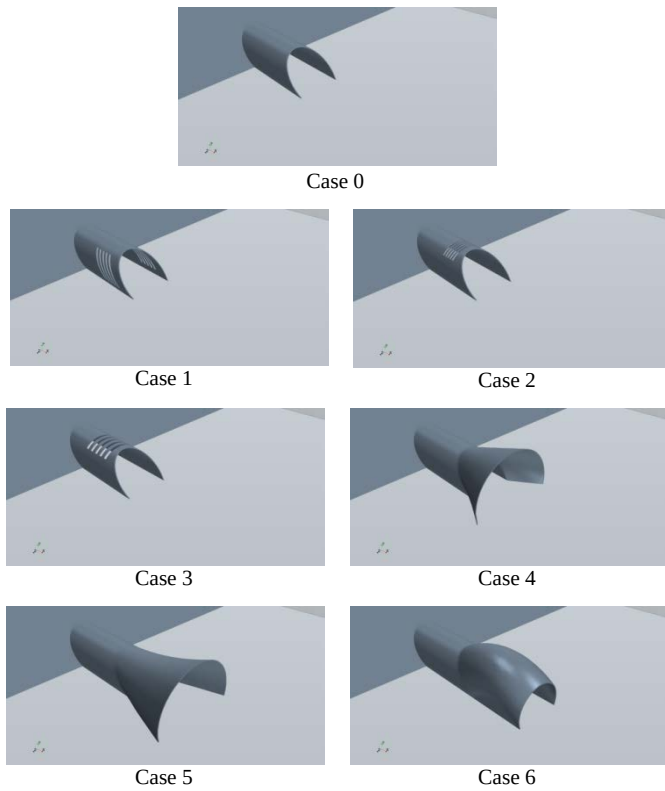


Fig. 2 Tunnel entrance geometry variations

Fig. 3 shows the solution grid for the domain used in the study. Solution domain is created by using unstructured hexahedral elements. As a result of solution grid dependency study, 1378300 grid elements were used in domain solution grid. Movement of the train is modeled with overset meshing technique. All computations are carried out via commercial code, CD ADAPCO Star-CCM+.

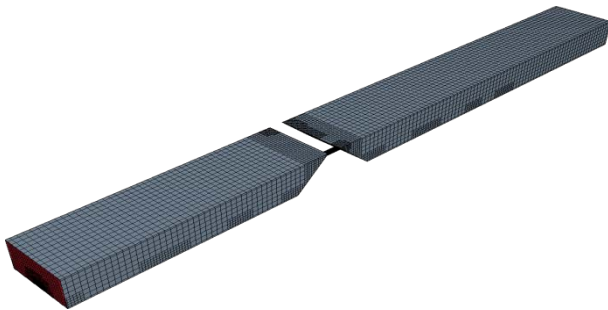


Fig. 3 Domain solution grid scene

4. Results

Fig. 4 shows the time-dependent pressure measurement locations at the inlet and outlet of the tunnel.

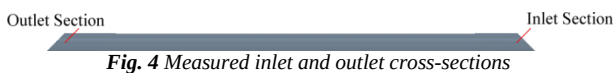


Fig. 4 Measured inlet and outlet cross-sections

The solution is completed with the voyage of the train, which is started from the outside of the tunnel, passing through it and going out of the tunnel again. The train's nose was entered the tunnel at the sixth second of the solution, while the tail was entered at the eleventh second. Besides, the nose and tail of the train was come out of the tunnel at the twentieth and twenty-fifth second of the solution, respectively. Fig. 5 shows the time-dependent pressure values for all geometries in the tunnel entrance section.

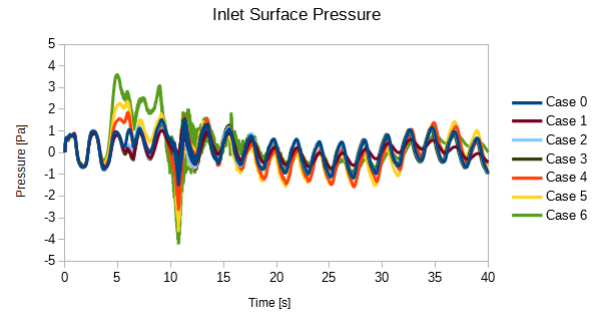


Fig. 5 Time-dependent pressure values for all geometries at tunnel entrance section

As can be shown in Fig.5, the same pressure values are obtained for all geometries at the beginning of the movement at the outside the tunnel. When the train gets closer to the tunnel entrance, it is seen that the pressure values are varying for different entrance geometries. The lowest pressure change was obtained in the "Case 1", by considering the entrance of both the nose and the tail of the train. Besides that, when the entrance effects of the nose and tail regions of the train are compared, it is seen that the pressure variation is much higher in the tail zone. The maximum pressure variations were obtained in the "Case 6" geometry. Fig. 6 shows the time-dependent pressure values for all geometries in the tunnel exit section.

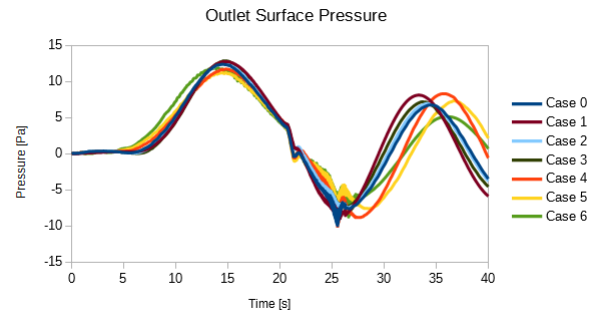


Fig. 6 Time-dependent pressure values for all geometries in the tunnel exit section

The tunnel exit pressure values are quite different from the tunnel entrance pressure values. A two-peaks curve is obtained at the outlet while an oscillatory pressure distribution is obtained at the inlet region. As mentioned before, at twentieth second, the train's nose region, and at twenty-fifth second, the tail region of the train came out from the tunnel. In contrast to the inlet zone, the minimum pressure variation is found in the "Case 5" geometry. However, it was observed that the maximum pressure change was obtained in the "Case 1" geometry.

5. Conclusion

Six different tunnel entrance geometries have been investigated in the study in order to investigate the high-speed train-tunnel interaction and to show the effect of different tunnel entrance geometries. The pressure values against time at entrance and exit of the tunnel are presented. When the results are examined, the lowest pressure variation for the tunnel entrance is obtained by the "Case 1" geometry, which has large openings on the top surface. On the other hand, the lowest pressure change for the tunnel exit is observed in the "Case 5" geometry, which is a parabolic nozzle. These sudden pressure variations may be explained by the aerodynamic structure formed by the movement of the train into a narrower area. When the optimal cases are considered, at the entrance of the tunnel, the high-pressured air in the nose region of the train is balanced by atmospheric air and the pressure change is reduced by the openings at the tunnel entrance. At tunnel exit, pressure variations are reduced, by the gradual movement of the high pressured air at the inside of the tunnel through the atmospheric pressure level, using the nozzle geometry.

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VEHICLE PRODUCTIVITY IN NEW OPERATED RAIL-SERVICES

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Abstract: *For newly introduced transport services, there's not only the transport aspect that matters what the new service will bring to passengers, but also the operating costs are very important. In this area the systematic timetable planning plays an important role. Total costs of the transport system are significantly affected by the fixed costs, deriving from the number of regular deployed vehicles and drivers, related to the overall transport performance and total operational productivity. Advanced timetable engineering means a strong link between timetables, vehicles and infrastructure. The article demonstrates this approach on the example of the introduction of new express trains Praha - Plzeň - Cheb / München in the timetable 2017/18.*

KEYWORDS: RAILWAY TRANSPORT, PUBLIC TRAFFIC, RAILWAY TECHNOLOGY, TIMETABLING, OPERATION PRODUCTIVITY

1 Introduction

According to the data from Czech Ministry of Transport, passenger rail transport in the Czech Republic has been experiencing a great renaissance in recent years. The increase of passenger transport in passenger kilometers in 2010-2017 is 44%.

The main cause for this sustainable growth is in particular long-distance rail transport and suburban transport around great Czech cities (Praha, Brno, Ostrava, Plzeň).

Several factors contribute to the growth of demand. The first is improvement of the offer of connections, when the structural changes associated with the implementation of IPT (Integrated Periodic Timetable) between 2005-2009 brought about a fundamental change in the structure and frequency of supply, as well as in the creation of systematic links in IPT nodes. The second is undoubtedly shortening travel times associated with the modernization of transit railway corridors. The third major factor is the improvement of the fleet quality and the improvement of rail carrier services, which is also reflected in the liberalization of the passenger rail market.

Due to the increasing demand for transport and the progressive modernization of the infrastructure, the orderers of public transport react by expanding of timetable links and connections.

Czech Ministry of Transport, the orderer of long-distance passenger trains, has in the timetable 2016/17 introduced new express train segment between Praha - České Budějovice (- Linz) and follows in current timetable 2017/18 new express trains between Praha - Plzeň (- Cheb / München).

Increasingly, expanding transport performance requires productivity and efficient deployment of vehicles, so that these increases in traffic performance were generally financially manageable - both for carriers and for public authorities.

This approach to achieving operational productivity is demonstrated in the article on the example of newly established express trains on the line Praha - Plzeň.

2 Prerequisites for solving the productivity problem

In the Czech Republic, over a period of more than 20 years, intensive renewal of railway infrastructure, primarily transit railway corridors, has taken place. One of these cases is III. transit corridor leading from Cheb via Praha to Ostrava and to the border with Poland and Slovakia. Between Praha and Plzeň, the corridor is already completed at 62% of its length, including the longest newly built railway tunnel in the Czech Republic between Rokycany and Plzeň (tunnel Ejpvovice), which is 4.15 km long and should be completed and put into operation this year. Czech Ministry of Transport decided to order new express trains between Praha and Plzeň in the Timetable 2017/18, which

will be a new additional passenger service to the current fast trains.

The task was to prepare such an operational concept on the railway line, which would achieve the highest operational efficiency while respecting the boundary operating conditions.

These boundary conditions consist of the demand for reaching IPT nodes, the attraction travel time of newly introduced trains, the lack of travel time on existing trains and, last but not least, the current state of infrastructure. The final timetable is thus generated by repeated iterative steps associated with fine minute tuning, taking into account transport and operating parameters while maintaining the IPT principles.

At beginning, there's necessary to define the transport concept. Until timetable 2016/17, the operation of long-distance trains on the line Praha - Plzeň consisted only from fast trains, in which the Praha - Cheb trains were operated in 2-hour interval, in the 4-hour intervals trains Praha - München and in 4-hour interval trains Praha - Klatovy - all these lines together formed regular 1-hour interval between Praha - Plzeň.

All possible schemes of train paths have been verified as part of the search for acceptable variants. Under the terms of the periodic timetable, a solution that is symmetrical by minute 00 has always been sought.

The timetable constructional principle of the express train path was:

- 1) Examine the shortest travel time on infrastructure conditions with all constraints due to the reconstruction
 - 2) Time binding to a time position agreed for passing trains on the border with Germany
 - 3) From the above to derive the latest possible minute arrival to Plzeň (from Praha) and for this time to find the closest path, realizable periodically and symmetrically
 - 4) Overlapping of the time scheme of express paths (Ex trains) with the scheme of fast trains paths (R trains) and identification of technological collisions
 - 5) Solving the collisions primarily by adjusting the fast train (R) paths so, that the constraints of the existing connections in the IPT nodes are respected - the aim of the step was to make as few changes as possible for existing trains and linkages
 - 6) control of turn-over times of long-distance trains in end stations, prediction of turn-over times according to the planned works on corridor track, stabilization of the route
 - 7) Minute fine-tuning of express (Ex) and fast trains (R) paths in the Praha - Beroun section, within the exact time spacing of 30 minutes for collision-free timetable construction of suburban regional transport
- In the search for variants, it was always proceed first theoretically, by examining the mathematical conditions of the edge time lengths (in this case, the edge between the IPT nodes was replaced by an imaginary edge between the crossing stations) in the presence of both periodical segments in 1-hour period, by applying the edge equation

over the sums of 30 min within one segment and over the sums of 15 min within a combination of both segments.

Proposal of operational concept was verified by FBS - tool for timetable planning.

The new operating concept preserves only the line Praha - Plzeň - Klatovy as a fast train line with a larger number of train stops, while the lines Praha - Plzeň - Cheb and Praha - Plzeň - München are transformed into a new segment of express trains.

Classical long-distance fast trains (train category R) are operated in a basic interval of 120 minutes between Praha - Plzeň - Klatovy, and for most of the working day it is completed for 60 minutes interval between Praha - Plzeň. The long distance trains R are reaching wider IPT node 00 in Praha, the complete IPT node in Rokycany in the minute 30 and are bounded to IPT node 00 in Plzeň (from Plzeň to Klatovy is depart before the whole node). The suburban regional transport service at Praha is operated in a basic interval 30 minutes between Praha and Beroun. At the nearest agglomeration section between Praha and Řevnice the interval is concentrated in peak hours of working days to 15 minutes. The paths for long-distance fast trains are in the timetable so designed, to avoid overtaking regional trains in the section between Praha and Beroun, i.e. to avoid the loss of time for passengers in suburban transport. From this constraint it follows logically, that for the new express trains (train category Ex), the only path which could be used between Praha and Beroun is shifted exactly 30 minutes to the current fast trains. There should be found such path for the express train, which enables as possible to reach IPT node 00 in Plzeň. Thus, the entire timetable interval scheme of the Ex and R trains with regional trains had only such a time-manipulation space, to avoid disturbing current IPT nodes while avoiding overtaking regional trains. The conditions for the timetable construction of the path for new express trains were such, that a path with the smallest technological conflicts had to be found, which at the same time fulfilled the time conditions for passing trains on the border with Germany (for reaching transfer connections in stations Schwandorf, Regensburg and München). By express trains to Cheb, there were necessary to keep the existing IPT node 30 in Cheb. In total, there were introduced a 2-hour interval of direct express trains Praha - München and 2-hour interval of direct express trains Praha - Cheb, where both these 2-hour interval make together 1-hour interval of express trains between Praha - Plzeň.

Overall, this represents an increase of 55% transport performance, which is about 600 000 trainkm / year.

3 Operational productivity and efficiency

Productivity is generally defined as the ratio between the output of the enterprise and the necessary inputs. Since each output arises from a larger number of input variables, there is used in measuring the productivity of a larger number of partial indicators "partial productivity." Changes in output can not always be assigned to only one factor, and pursued partial productivity can not be seen as isolated endpoints and there should be monitored more parameters.

High productivity can be achieved through high efficiency and effectiveness. The effectiveness can be defined as a measure of how strongly the system output is produced in accordance with the desired output.

The efficiency can be described as the ratio between the produced output and input needed for its implementation (produced output / input). Some sources describe this difference clearly as "doing things right" (effective venue) and "doing the

right thing" (effective action). Effective action means: do the right thing at the right moment in time, while effective venue allows you to do these things with minimal resources.

Typical input quantities in the measurement of productivity in rail passenger transport are for example engines, engine-drivers or passenger cars. The offer in the timetable, expressed by train- or seat-kilometres means the produced output.

To assess (includes future) success of the TOC (rail carrier - Transport Operating Company), there is important to monitor important indicators for the assessment of productivity - there is seat km/car, train km/engine, train km/staff, train km/engine driver, seat km/train staff. They display, how well available resources are used to create an offer in the schedule.

Rail transport is specific to a generally high proportion of fixed costs. Variable costs are in terms of the Czech Republic about 60% of the level, when approaching a vehicle operating utilization of 80% (due to low travel speeds and thus small run over of vehicles). Such utilization in the Czech Republic is achieved usually on such lines, where it is consistently applied the IPT.

Certain costs of rolling stock, such as maintenance depend on the vehicle run over. These costs may be changed due to the implementation of measures to increase the productivity, although in comparison with the investment costs would be their impact rather small. These problems tend to magnify during major investment in the rolling stock. The acquisition cost of new rolling stock is comparable in the Czech Republic and abroad.

So the current approach described in chapter 2 applied by creating new transport concept is focused to offensive offer, where the existing resources in the field of rolling stock and staff are used to create higher level of service, while the growth of variable cost components must be covered by additional revenues.

4 Results

To ensure the original timetable concept, there were needed 9 engines with an average daily run of 683 km / day.

In the new timetable concept with considerable increase of the the transport volume, there had to be planned 4 additional engines, with enhanced productivity of the circulation, increasing the average daily run of the locomotive to 745 km / day. However, this state is only temporary, because after the opening of the Ejovice tunnel, the travel time of fast trains between Praha - Plzeň will be shortened by 7 minutes in each direction. The structure of the operational concept is so prepared, that at the same time will allow a quick turnaround of the engines in Praha. Average daily run of locomotives will thus rise to 806 km / day.

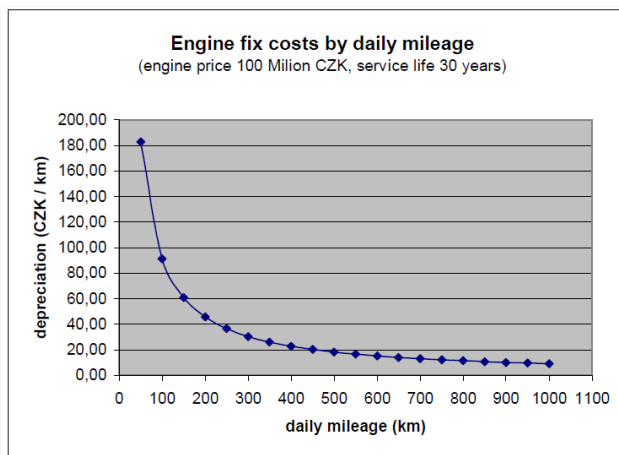


Fig. 1 Influence of the depreciation cost of the vehicle on transport performance depending on the traffic enforcement

Modern rail vehicle with a small mileage represents for each carrier an economic trap, since its operation by the usual amount of compensation (in the CR average 130 CZK / train km) isn't long financeable. The growth in vehicle productivity thus contributes to lowering the unit price of transport performance.

On fast trains and express trains, two-system locomotives of the type ČD 362 of the 1980s are currently deployed, but they will have to be gradually replaced in the following years by new engines. Even with regard to this future investment, it is still necessary to monitor the productivity of vehicles and to make any adjustments to the operational concept to interact between the timetable - vehicle - infrastructure.

From the point of view of reached travel times, the straightening looks as follows:

- travel time of fast trains (R) in periodic path in timetable 2016/17: Praha - Plzeň: 1 hour 37 min; Praha - Klatovy 2 hours 40 min; Praha - Cheb 3 hours 11min

- travel time of fast trains (R) in periodic path in timetable 2017/18: Praha - Plzeň: 1 hour 42 min; Praha - Klatovy 2 hours 38 min

- travel time of new introduced express trains (Ex) in periodic path in timetable 2017/18 Praha - Plzeň: 1 hour 25 min; Praha - Cheb 2 hours 54 min

It is obvious, that the only time-penalized passenger frequency is in the fast trains Praha - Plzeň, but in this relation the passengers are reaping the newly introduced express trains running every hour.

In the case of the fast trains Praha - Klatovy, the current travel time was hold. Connection to Cheb has become as part of new express service, and therefore there is significant time saving in this relation.

In the case of the international connection Praha - München, which is newly part of the introduced express segment between Praha - Plzeň, there was an increase in direct trains from 4 pairs to 7 pairs per day. Travel time in timetable 2016/17 ranged between 5 hours and 50 minutes to 6 hours, while in the 2017/18 timetable it was unified for 5 hours and 45 minutes.

5 Conclusion

This paper has presented, how timetable technological combinations could influence engine productivity in passenger rail services. All technological timetable processes and variants have been reviewed in the software FBS.

Since the beginning of creating the timetable concept, it is necessary to plan within the limits of interactions of the triangle timetable - vehicle - infrastructure and outside of it the transportation linkages take into account technological linkages and possible engine circulation between trains too. So an increase of the average daily run and of the productivity of the vehicles could be achieved.

This approach applied by introduction of a new express train segment between Praha - Plzeň led on one side to shorter travel times, on other side to increasing operational productivity.

From the point of view of travel times, there was found such solution, which by introducing new express trains (Ex) did not damage existing fast train segment (R), including its transfer links.

With further construction works, the constraints for train paths will also change and the technological solution founded for timetable 2017/18 is only temporary. While in the timetable 2017/18 the average daily run of the locomotives increased by 9%, the operational concept is prepared so, that by applying the same approach and methods will result in next increase of the average daily run in timetable 2018/19 by another 9% and in saving of one locomotive.

Advanced timetable engineering brings a strong contribution for an effective use of resources of TOC. Practical application of these tools makes necessary link between theory and praxis.

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INTERACTION BETWEEN ROLLING STOCK AND RAILWAY TRACK WITH OF THE ELASTIC PROPERTIES OF THE BASE

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Abstract: *The main trend in considering the interaction of the railway track and the rolling stock is the studying of the parameters of the rigidity of the interaction. For the study, a model of the track design, described using the basic concepts of the theory of elasticity and the propagation of elastic waves was developed. The study of the peculiarities of the interaction of the rolling stock and the track, taking into account the elastic properties of the base, allows to expand the possibilities of solving the problems of ensuring their functionally safe operation with a certain level of operational efficiency.*

Keywords: DYNAMIC PROCESS, OSCILLATIONS, POWER WAVE, PHYSICAL AND MECHANICAL FEATURES OF THE INTERACTION

1. Introduction

The main trend in considering the interaction of the railway track and the rolling stock is the studying of the parameters of the rigidity of the interaction. It is necessary to use not only equivalent parameters obtained in the experiment, but also parameters related to specific interaction conditions. The parameters of the railway track and the rolling stock, are the key to obtaining effective solutions in the tasks of ensuring their functionally safe operation with a certain level of efficiency taking into account the real constructive physical and mechanical features of the interaction.

All the issues related to determining reliable, functional and safe railroad track operation imply the exploration of dynamic processes in the track design that occur under the influence of the rolling stock.

A study of the dynamic process interconnects the following tasks: determining the types and magnitudes of the forces acting on the track depending on the position of the wheelset in a track, location and types of the contact between wheels with rails which depend on the condition of the wheels and rails, as well as a change in the stressed-strained state of the track over time. When describing the dynamic process, the magnitudes of vertical forces that act on the track were determined as functions of the longitudinal compressive forces [1]. The magnitudes of transverse forces – by dependences of the calculation of the rolling stock aligning with the track [1, 2]. The question on the types of contact between wheels and rails required separate consideration. Typically, when analyzing the contact between a rail and a wheel, a rail is considered either new or with a side wear of 3.5 mm, at which the rail is believed to be little worn-out, and a side wear of 7.8 mm, at which the rail is considered to be medium worn-out. Papers [3, 4] present modern analysis of the wear of wheels for different profiles. A separate research was conducted by the results of these articles, the outcomes of which are given in [5].

The time of influence of the rolling stock on the railroad track depends on the motion speed. The duration of these processes depends on the physical and structural characteristics of the elements of design of the railroad track. The existing methods for the calculation of parameters of the stressed strained state of the track by the influence of the rolling stock by canons of the method of finite elements or boundary elements describe physical and structural characteristics of the track design elements in full. But they do not take into account such phenomena as the period of the load passage over the elements of the track, the time of occurrence of reactions to the load from these elements, and the correlation of load action time and the duration of processing of this load by elements of the track design. The lack of a temporal component does not allow to describe the dynamic processes in full. The use of quasi dynamic methods changes the essence of dynamic processes. Thus, the application of quasi dynamic forces causes the track deformation, at which the sagging of rails and anchor system shifts

along with the motion of the train despite the divergence of occurrence, over time, of maximum sagging in the elements of track design.

In the course of such studies, the calculations are performed for different values of frequency of quasi dynamic excitation, defined as the ratio of speed to the magnitudes of distances between the wheels of one bogie and adjacent bogies, or distance between the supporting elements of the track. And though all acknowledge that the speed of motion affects the frequency of excitation but the magnitude of frequency of excitation, determined by the ratio of the length of the contact area of the rail with the wheel to the duration of dynamic load action on the track (motion speed to length of the contact area) is not used in these calculations. In the physical essence, excitation frequency, inversely proportional to the geometric lengths of position of the wheels in the train, characterizes the recurrence of load occurrence in the examined track intersection. And for static calculations, it characterizes part of the force that acts in the examined track intersection in a certain point in time. When moving the load, the distance between the force application place and the examined intersection changes. Thus, not only the part of the magnitude of forces that acts in the examined intersection also the vector of force changes. And the frequency of excitation, inversely proportional to the period of action of the load by physical essence is characterized by an impulse of load, which acts on the track and allows to apply the basic equation of dynamics.

Thus, in order to examine the dynamic processes of deformability of the track, it is necessary to take into account the differences between static and dynamic characteristics of loads. The changes proposed will make it possible to evaluate the work of a railroad track under the influence of the rolling stock depending on the design features of the track structure over particular period of time. This will allow us to compare characteristics of the track operation, obtained by actual parameters, to characteristics of its work and to determine actual period of its operation. The changes proposed will also provide for the possibility under the assigned operating conditions to define, by the criteria of reliability, the design of the track or measures related to its strengthening with the provision of certain resource of its work.

2. Problem discussion

Currently, many research have been devoted to the study of the mathematical description of the impacts acting from railway track to the rolling stock. In all studies it was believed that the reaction of the railway track to the impact of the rolling stock is instantaneous. In addition, the results of the recorded disturbance obtained on the rolling stock in the experiment are not classified according to the constructions characteristics of the railway tracks. It is assumed that the elastic and dissipative characteristics of the path determine the amplitude-frequency characteristics of the oscillations. But they are yet not classified according to the physical-mechanical and

geometric characteristics of railway track construction elements. To create such classification, it is necessary to study the mechanism for transferring force from the rolling stock to the elements of the track in time. This problem will be theoretically investigated within this work. The problem can be formulated as follows: how do the physic-mechanical properties of railway track elements affect the process of propagation of force from the rolling stock to the construction of the track?

3. Objective and research methodologies

The main purpose of this work is to study the process of transferring force from the rolling stock to the elements of the track in time.

For the study, a model of the track design, described using the basic concepts of the theory of elasticity and the propagation of elastic waves was developed [6, 7].

The mechanism of action of the rolling stock on the track is represented by pulses that excite the contact areas of the rails with wheels located along the track. The excitation of contact areas takes place taking into account the time of occurrence and the effect of loads in them. The specified intervals of the action time of the pulse depend on the speed of the trains. The impulse along the construction of the path is propagated by the power waves. The propagation of a power wave in the elements of the track structure is described as the process of excitation and propagation of volume longitudinal and transverse spherical waves, taking into account their properties.

These introductions made it possible to obtain analytical dependencies to determine the features of dynamic load propagation. These include: two types of transmission frequencies of dynamic load, variable directivity in time, the relationship between the amplitudes of oscillations both within the elements and during the transition from one element to another. That allows us to describe the process of propagation of a power wave in the construction of a track in time, taking into account the inverse reaction of the elements on them.

Underlying this modeling is the existence of wave processes that are caused by both external and own oscillations.

All oscillations generated by the contacting surfaces, which, up to the given point, have not touched or have renewed their contact after a break, propagate by spherical waves. They characterize the main direction of propagation of the wave process from a new or renewed contact between surfaces and account for the contact and local concentrations of stresses and deformations.

All oscillations generated by the contacting surfaces, which, up to the given point, have touched and established contacts, propagate by quasi spherical waves. They characterize the basic direction of propagation of the wave process from the contact point of the surfaces and account for the non-uniformity of oscillating. But one spherical wave of incidence that carries the longitudinal and transverse mode causes four quasi spherical refracted waves: two longitudinal and two transverse. Each of them is heterogeneous, as it has vivid dependence of the change in characteristics in its direction and carries the consequences from the neighboring refracted waves in other directions.

Since in the process of propagation there is the superposition of waves, it characterizes the non-uniformity of the whole process of oscillating. Thus, in every point of the design in a certain period of action, one will observe either homogeneous spherical and (or) non-uniform quasi spherical waves. In general, the oscillations that propagate by quasi spherical waves cannot be predicted based on approximation.

The use of wave properties in the propagation of force in the elements of the track structure allows:

a) to establish that the deformability process in the design of the track is due to the presence of wave processes, the nature of which depends on the physic-mechanical and geometric properties of the track elements.

In order to consider the transfer of force between the elements, let us consider the contact pair of a rail-gasket with the characteristics given in Table 1.

Table 1. Physical-mechanical characteristics the contact pair of the rail - gasket

Element	Density, $\kappa\Gamma/\text{M}^3$		Poisson's coefficient		Young's module E, MIIa		$C_{\text{I}}, \text{M/c}^1$		$C_{\text{I}}, \text{M/c}^2$	
rail	7830	7830	0,24	0,3	$2,1 \times 10^5$	$2,1 \times 10^5$	5622	6008	3288	3211
gasket	918	935	0,3	0,485	100	200	382	1572	204	268

1 - the speed of longitudinal; 2 - the speed of transverse waves in the material.

Angles characterizing the process of transmission of power waves for the contact rail-gasket pair are given in Table 2. Where p-inc – longitudinal wave of incidence and s-inc – transverse wave of incidence, p-refl – refracted longitudinal wave and s-refl – transverse refracted wave, p-refl – longitudinal wave of reflection and s-refl – transverse wave of reflection.

Table 2. Characteristics of the angles of the wave process in the contact pair of the rail - gasket

rail - gasket								
Contact pair	Angles, degree							
	inc ide nc e	reflection		refraction		critical		
						I	II	III
longitudinal wave								
	p- inc	p-refl	s-refl	p-refl	s-refl			
rail - gasket	10	10	5,33-5,83	0,68-2,788	0,34-0,47	-	-	-
	20	20	10,53-11,54	1,33-5,49	0,67-0,94			
	30	30	15,50-17,00	1,95-8,04	0,98-1,37			
	40	40	20,10-22,08	2,51-10,36	1,25-1,76			
	50	50	24,17-26,62	2,9-12,379	1,50-2,10			
	60	60	27,58-30,43	3,38-14,02	1,69-2,37			
	70	70	30,15-33,34	3,67-15,24	1,83-2,57			
	80	80	31,76-35,17	3,85-15,99	1,92-2,69			
transverse wave								
rail - gasket	s- inc	s-refl	p-refl	p-refl	s-refl	-	-	32,3 - 35,8
	10	10	17,27-18,96	1,16-4,88	0,62-0,83			
	20	20	35,79-39,78	2,28-9,64	1,22-1,64			
	30	30	58,74-69,30	3,3-14,174	1,78-2,39			
	40	40	-	3,88-16,52	2,07-2,78			
	50	50	-	5,12-22,03	2,73-3,67			
	60	60	-	5,79-25,09	3,09-4,15			
	70	70	-	6,28-27,39	3,35-4,50			
80	80	-	6,58-28,83	3,51-4,72				

The results shown in Table 2 demonstrate the collecting ability of the gasket. That is, if different forces act on the same surface at angles of 10-80°, the gasket processes them and combines them, directing the common beam characterizing the p-refl angles (0,68-28,83°) for longitudinal waves and s-refl (0,34-4,72°) for transverse waves further. These angles characterize the angles of the reflection process from the edge of the gasket. Knowing the values of the reflection angles at the boundary of the gasket-sleeper contact and the thickness of the gasket, it is possible to form a geometric pattern on the surface of the gasket to improve its damping properties and extend the service life.

For example, Poisson's coefficient for the material (Table 1) of the gasket can vary from 0.3-0.485. If the value of the Poisson coefficient is less than 0.4, the transverse waves will not affect the

work of the gasket. Consequently, with values of the Poisson coefficient, less than 0.4 rail will accept loads transmitted by reflected transverse waves, and the gasket will perceive loads carried only by longitudinal waves. The loads transmitted by longitudinal and transverse waves will be transmitted to gaskets when the values of the Poisson factor are more than 0.4. Consequently, the characteristics of the gasket material will impact the possibility of the destruction of the gasket. In addition, the consideration of these questions in time allows us to predict the concentration of waves in the middle of the gasket, characterizing the concentration of its stress-strain state in time.

b) to determine the direction and amplitudes of oscillations in the elements of the track and their displacement from the impact of the rolling stock considering in time.

The oscillation direction of the particle depends on the direction of propagation and the type of wave (Fig. 1). If the wave is a longitudinal P , it forces a particle to move in the direction of its propagation. If the wave is transverse to the vertical mode of SV , then it forces the particle to move in the plane of propagation, but perpendicular to the direction of propagation. If the wave is transverse to the horizontal mode of SH , a particle oscillates in a plane that is perpendicular to the propagation plane.

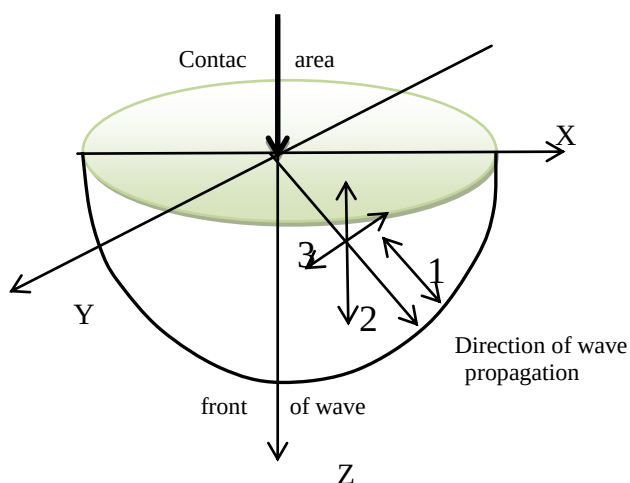


Fig. 1 The scheme of the front of the wave propagation and the directions of oscillation of the particles relative to the direction of propagation of the wave: 1 - direction of propagation of longitudinal waves P ; 2 and 3 - directions of propagation of transverse waves S , respectively SV and SH

Thus, the direction and amplitude of oscillation of particles in time are formed.

The results shown in Table 3 demonstrate coefficients of reflection and refraction of the wave process in a contact pair of rails with gaskets. The values of the coefficients characterize the change in the magnitude of the amplitudes of the reflection and refraction of the wave processes relative to the amplitude of the wave process of the incidence.

Table 3. Coefficients of reflection and refraction of the wave process in a contact pair of rails with gaskets

longitudinal wave				
Angles p- inc, degree	K p-refl	K s-refl	K p-reflr	K s-reflr
10	0,941	0,392	1,950	0,380
20	0,820	0,727	1,852	0,732
30	0,646	0,963	1,701	1,047
40	0,450	1,081	1,512	1,302
50	0,272	1,085	1,302	1,482
60	0,148	0,997	1,083	1,558
70	0,131	0,835	0,855	1,485
80	0,318	0,573	0,569	1,120
transverse wave				

Angles s- inc, degree	K p-refl	K s-refl	K p-reflr	K s-reflr
10	0,847	0,389	0,378	1,943
20	0,467	0,712	0,722	1,824
30	0,029	0,968	0,965	1,725
40	0,708	5,656	0,064	6,964
50	0,799	5,960	0,383	4,774

As indicated above, if the value of the Poisson coefficient is less than 0.4, the transverse waves will not affect the work of the gasket. According to the results shown in Table 3 these conditions correspond with angles s - inc more than 50° .

c) to regulate energy transfer and the process of oscillation in the elements of the track design by adjusting the physic-mechanical and geometric characteristics of the elements of the track design.

The results shown in Table 3 prove that the ratio of the amplitudes of reflection and refraction amplitude varies depending on the angle of incidence for one and the same material.

Since the energy transferred by the wave is proportional to the square of the amplitude, then the ratio of energy values in the reflected and refracted waves is different at different angles of incidence. This fact provides the possibility of directed forecasting of the deformability of the elements of the railway track by changing the characteristics of materials and the construction of the elements of the railway track by studying the process of the origin and propagation of power waves.

4. Conclusion

The study of the peculiarities of the interaction of the rolling stock and the track, taking into account the elastic properties of the base, allows to expand the possibilities of solving the problems of ensuring their functionally safe operation with a certain level of operational efficiency.

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WAYS OF IMPROVING THE EFFICIENCY OF WIGON PARK USE WITH ACCOUNTING QUALITY INDICATORS

ПУТИ ПОВЫШЕНИЯ ЭФФЕКТИВНОСТИ ИСПОЛЗОВАНИЯ ВАГОННОГО ПАРКА С УЧЕТОМ ПОКАЗАТЕЛИ КАЧЕСТВА

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Abstract: Ways to improve the efficiency of the car fleet in the present time is an urgent task for the Azerbaijan Railway. The importance of the car industry in the improvement of freight traffic in the Republic of Azerbaijan is great. In the article, the current state of the car fleet and the tasks assigned to the carload economy are investigated. In the Azerbaijan Railway, the tasks for the future development of the carload economy are investigated. Examining the qualitative and quantitative indicators of the car fleet, the tasks of ensuring the efficient and efficient carriages of the transportation process on the railway are defined.

KEYWORDS: RAILWAY CARRIAGE, SERVICE CENTER, TECHNICAL SERVICE, POINT, DEPOT, PARK, AGRICULTURE, TECHNOLOGY, CIRCLE OF A RAILWAY CARRIAGE, PRODUCTIVITY, REPAIR, QUALITY.

Пути повышения эффективности вагонного парка в настоящем времени является актуальной задачи передАзербайджанской железной дороги. Важное значение в совершенствовании перевозочного процесса Азербайджанской железной дороги принадлежит вагонному хозяйству, который объединяет вагоны и материально-техническую базу для их эксплуатации и ремонта.Вагонное хозяйство является одной из ведущих отраслей железнодорожного транспорта. Основные фонды вагонного хозяйства (вагоны, здания, сооружения, технологическое оборудование) составляют примерно 15% всех основных фондов железнодорожного транспорта. На его долю приходится около 12% всех эксплуатационных расходов, а численность работников составляет примерно 7% всего контингента, работающего на железнодорожном транспорте, основная часть расхода металлопроката и других материалов. В своей работе вагонное хозяйство взаимодействует с другими отраслями и хозяйствами (движение, локомотив, путь, грузовая и коммерческая работа, служба информатизации и связи, служба безопасности движения и др.)[1,2].

Для сохранения вагонного парка в исправном состоянии вагонное хозяйство выполняет следующие направления деятельности: оздоровление вагонного парка,

обеспечение безопасности движения поездов, техническое обследование вагонов, направленные под грузовые операции.Назначение вагонного хозяйства состоит в выполнении плановых видов ремонта и технического обслуживания вагонного парка железной дороги и компаний-операторов для соблюдения требований безопасности движения, сохранности перевозимых грузов, а также в создании удобства при перемещении пассажиров. Для этого необходимо постоянно поддерживать вагоны в работоспособном состоянии, выполнять установленный план ремонта вагонов, при этом рационально использовать имеющиеся технологические средства, экономно расходовать потребляемые материалы и запасные части, повышать эффективность работы ремонтно-эксплуатационных подразделений.

В настоящее время на Азербайджанской Железной дороге эксплуатируются около 10 тысяч грузовых и более 500 пассажирских вагонов. Из них около 2090 вагон цистерна. По сети железнодорожного транспорта руководство вагонным хозяйством осуществляется Департаментом «Грузовая перевозка»[1,3]. Структура инвентар-ного парка грузовых вагонов показана на рис.1. В инвентарном парке имеется около 10000 грузовых вагонов.



Рис.1 Структура инвентарного парка грузовых вагонов

Основными инфраструктурными объектами вагонного хозяйства Азербайджанской железной дороги являются следующие производственные предприятия:

- Кешлинское вагонное депо по ремонту контейнеров
- Баладжарское вагонное депо
- новое Алятское рефрижераторное вагонное депо
- Гаджигабулское вагонное депо
- Гянджинское вагонное депо
- Ширванское экс. вагонное депо
- Имишлинское экс. вагонное депо
- Баладжарская промывочно-пропарочная станция

- Бакинский ВРЗ.

Вагоноремонтные депо в основном расположены в Апшеронском экономическом районе, эксплуатационные депо расположены в разных уголках Республики. В данное время в вагонном хозяйстве работают около 2000 человек, из них в основном около 73% работают в эксплуатационных участках. Основной функцией вагонного хозяйства является бесперебойное обеспечение перевозочного процесса исправным и работоспособным подвижным составом. На рис. 2 показано количество ремонтируемых грузовых вагонов.

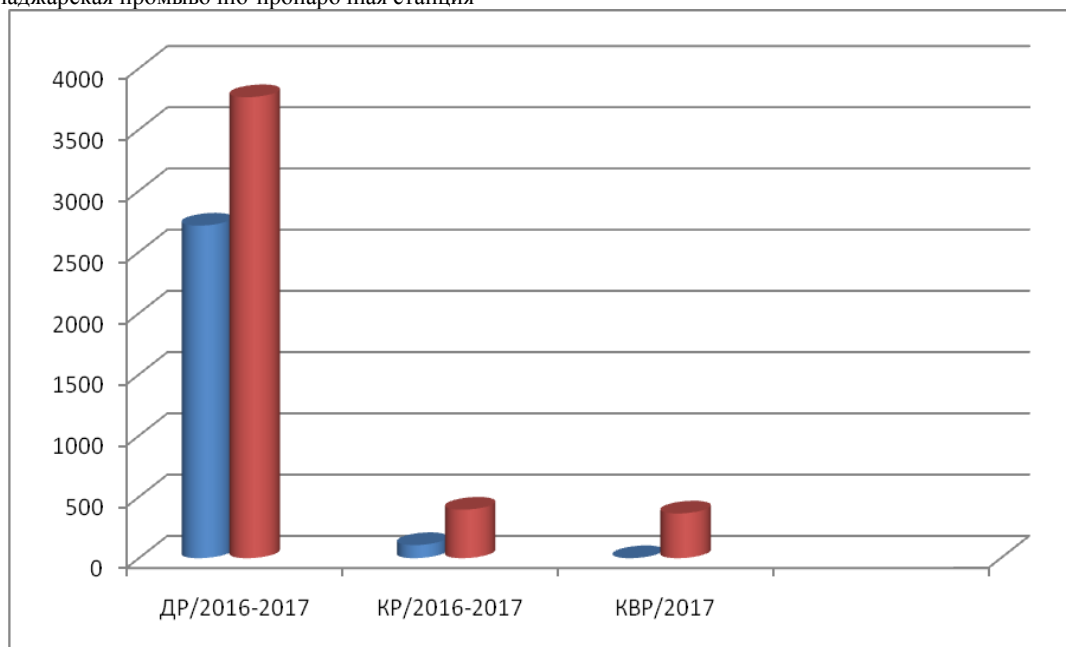


Рис. 2. Количество ремонтируемых вагонов в 2016-2017 гг.

В частных фирмах и компаниях имеется около 3200 грузовых вагонов, из которых около 82% (1850 вагонов) является вагон-цистерна.

Открытие в 2017 году международного проекта Баку-Тбилиси-Карс и эксплуатация транспортного коридора «Север

Юг» увеличило потребление грузовых вагонов, в настоящее время число эксплуатируемых вагонов достигает около 6400 штук. Возрастной состав грузовых парк вагонов (табл. 1) постепенно изменяется[3,4].

Таблица 1: Возрастной состав грузовых вагонов

Года	Количество вагонов	Года	Количество вагонов
1985	4424	1995	14
1986	880	1998	4
1987	385	1999	9
1988	426	2000	4
1989	469	2001	46
1990	364	2002	51
1991	217	2003	61
1992	28	2015	3031
1993	39	2016	70
1994	2	Итого:	10016

Из таблицы видно, что около 4500 вагонов должны быть исключены из инвентарного парка. Сейчас ведутся работы для получения новых грузовых вагонов, около 48% вагонов построены до 1988 года, и их нужно исключить из парка.

Хорошее техническое состояние вагонного парка, его надежная работа в условиях рыночной экономики являются сегодня одним из основных факторов обеспечения бесперебойного функционирования транспортного конвейера. С учетом этого, в рамках отраслевых научно-технических программ должен быть реализован широкий комплекс мер по дальнейшему совершенствованию и развитию вагонного хозяйства сети. Вся эта трудоемкая и многоплановая работа ведется по нижеследующим главным направлениям: первое –

создание совместно с промышленностью более совершенных по параметрам грузовых вагонов, удовлетворяющих требованиям высокой надежности и прочности несущих узлов, повышенной грузоподъемности и вместимости, обеспечивающих увеличение перевозной способности железных дорог, гарантированную безопасность движения и экономически эффективные показатели работы; второе – комплексная модернизация вагонов эксплуатационного парка с целью приближения их технических параметров к современным требованиям и реализации на этой основе имеющихся резервов за счет увеличения загрузки вагонов; третье – совершенствование системы и организации ремонта и технического обслуживания вагонов, создание ремонтной базы с широким использованием индустриальных методов труда,

средств комплексной механизации и автоматизации, технического диагностирования; четвертое – обновление экономики вагонного хозяйства, внедрение хозяйственного расчета, укрепление финансового положения предприятий, усиление материальной заинтересованности в улучшении содержания вагонного парка и увеличении объемов ремонта; пятое – обеспечение сохранности подвижного состава; шестое – проведение реформы отрасли с целью изменения системы

управления железнодорожным транспортом, в том числе и вагонным хозяйством – отделения функций государственного управления. Поэтому для развития и модернизации грузовых вагонов приняты новые предложения по вагонному хозяйству: создание комплекса технопарка вагонов, применение инновационной технологии. Состав технопарка показан в следующем рис.3.



Рис. 3. Структура состава технопарка

Центр ремонта вагонов состоит из следующих основных цехов и участков, которые показаны в рис.4. Промывочно-пропарочное предприятие предназначено для массовой подготовки цистерн к наливу нефтепродуктов и

для производства их текущего ремонта, а также для подготовки цистерн к плановому ремонту. Учитывая увеличение добычи и перевозки нефти и нефтепродуктов,



Рис. 4. Структура центра ремонта вагонов

Азербайджанская железная дорога в этом области внес большой вклад в развитие техники и технологии[3]. Поэтому создание нового промывочного и пропарочного

сервисного центра является актуальным. В создаваемый новый центр входит следующее (табл.2).

Таблица 2: Технические характеристики сервисного центра цистерны

№	Наименование	Показатели	Количество
1	Мощность предприятий	вагон	3650
2	Количество работников	человек	50
3	Расход эл. энергии	кВт/час	75166
4	Расход воды	м ³	16600
5	Расход топлива (мазут)	тон	140

Инновационная технология в вагонном хозяйстве применяется в следующем порядке:

1. Применение контрольной системы КТСМ буксового узла вагонов
2. Автоматизированная система акустического контроля подшипников
3. Автоматизированный диагностический комплекс для определения герметических параметров колесной пары грузовых вагонов.

Таким образом, вагонное хозяйство железных дорог, развивая современную техническую базу для обслуживания и ремонта вагонов, приобретает прочную научную и индустриальную основу для обеспечения высокого уровня работоспособности вагонного парка в современных и

перспективных условиях его эксплуатации.

Качество

использования вагонного парка, планирования и финансирования расходов по перевозке и оценке качества эксплуатационной деятельности предприятий и подразделений вагонного хозяйства, т.е. использования его во времени и пространстве, определяется следующими показателями: оборотом, среднесуточным пробегом, производительностью вагона, статической и динамической нагрузкой. Эти показатели характеризуют качество труда работников под одной грузовой операций и среднее время нахождения вагонов под одной грузовой операций. Все работники, участвующие в перевозочном процессе, в том числе работники вагонного хозяйства, должны способствовать уменьшению величины

этого показателя посредством сокращения времени обработки вагонов нахождения вагона под одной грузовой операцией и среднего времени нахождения транзитного вагона на одной технической станции[4,5].

Оборот вагона является основным качественным показателем, характеризующим уровень организации работы железных дорог и снижение числа задержек в пути. Оборот вагона в пределах сети железных дорог выражает время,

$$\theta = \frac{\sum nT}{24U_p} = \frac{1}{24} \left(\frac{L}{v_{уч}} + K_m t_{zp} + \frac{L}{l_{mp}} t_{mex} \right) = 3,42 \text{ сутки},$$

где $\sum nT$ -суммарная затрата вагоно-часов в течение и оборотов или единиц работы вагонов,

вагонов или единиц работы вагонов.

L -полный рейс вагона, км;

U_p -число

оборотов

$V_{уч}$ -участковая скорость $V_{уч} = 30,4 \text{ км/час}$;

t_{zp} -время нахождения вагонов под одной грузовой операцией, час;

l_{mp} — среднее расстояние между техническими станциями, км;

t_{mex} -время нахождения вагонов на одной технической станции, час.

Коэффициент местной работы K_m - это количество грузовых операций, приходящихся на единицу работы, определяемое по формуле:

$$K_m = \frac{u_n + u_e}{u},$$

где u_n, u_e - соответственно число погруженных и выгруженных вагонов на железной дороге в сутки;

u - работа железной дороги в сутки, вагон.

Оборот вагона является основным качественным показателем, характеризующим уровень организации работы железных дорог и снижение числа задержек в пути. Все работники, участвующие в перевозочном процессе, в том числе работники вагонного хозяйства, должны способствовать уменьшению величины этого показателя посредством сокращения времени обработки вагонов нахождения вагона под одной грузовой операцией и среднего времени нахождения транзитного вагона на одной технической станции;

Из графика (рис. 5) видно, что в результате проведенных технико-экономических мероприятий Азербайджанской железной дороги изменился оборот грузового вагона.

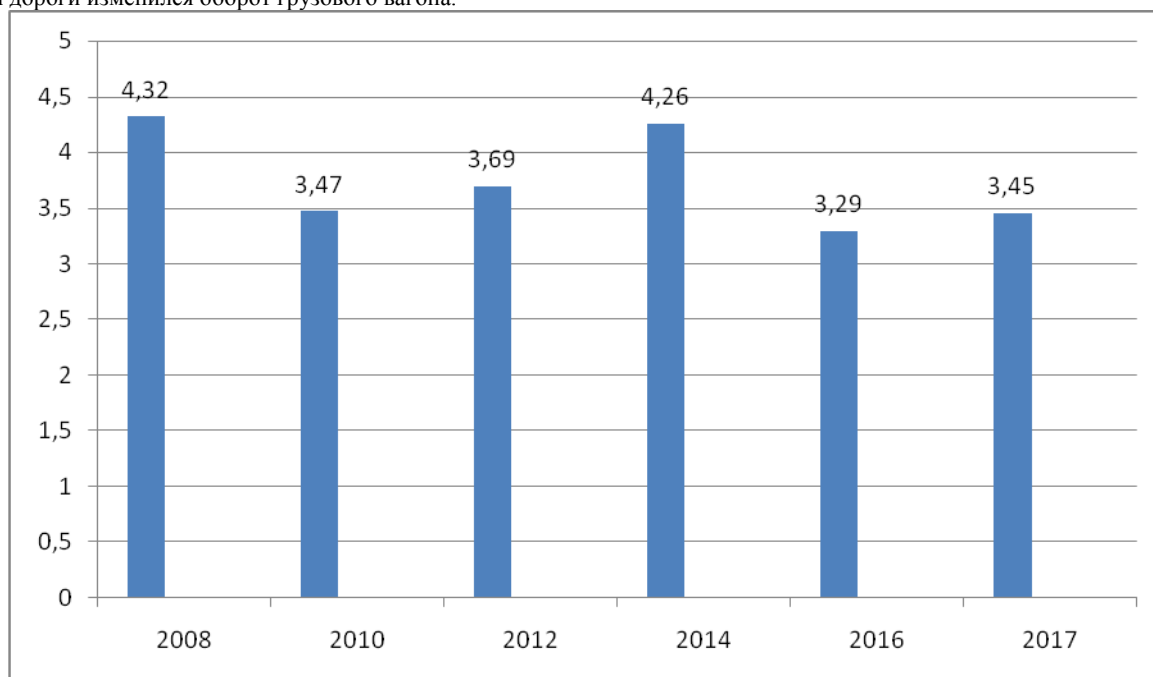


Рис. 5. Динамика изменения оборота грузового вагона

Обобщающим показателем использования грузовых вагонов является среднесуточная производительность $F_{\text{с}}$, которая измеряется в тонно-километрах ($m \cdot км$), нетто $\sum Pl$, приходящихся на один вагон рабочего парка:

$$F_{\text{с}} = \frac{\sum Pl}{\Pi_p} = \frac{11058,7 \cdot 10^6 m \cdot км}{10016 \text{ вагон}} = 1104033,5 m \cdot км.$$

К основным показателям, характеризующим степень использования грузовых вагонов, относятся статическая и динамическая нагрузка.

Статическая нагрузка $P_{\text{ст}}$, тонна, показывает, какая масса груза приходится в среднем на один вагон при погрузке:

$$P_{\text{ст}} = \frac{\sum P}{u_n \cdot 365} = \frac{11850000 \text{ тон}}{698 \text{ вагон} \cdot 365} = 46,5 \text{ тон}.$$

u_n - число погруженных вагонов на железной дороге в сутки.

Динамическая нагрузка груженого вагона $P_{\text{д.з}}$, тонн, показывает, какое количество груза приходится в среднем на один груженный вагон в движении

$$P_{\text{д.з.}} = \frac{\sum Pl}{\sum n_{\text{зр}} \cdot S_{\text{зр}}} = \frac{11058,7 \cdot 10^6 m \cdot км}{212,6 \cdot 10^6 \text{ вагон} \cdot км} = 52,1 \text{ тон}.$$

Итак, рассчитывая качественные и количественные показатели вагонного парка, определены задачи обеспечения исправными и работоспособными вагонами перевозочного процесса на железной дороге. С учетом показатели качества вагонного парка можно повысить эффективности вагонного хозяйства.

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ПОВЫШЕНИЕ НАДЕЖНОСТИ КАНАЛОВ ЖЕЛЕЗНОДОРОЖНОЙ ПОДВИЖНОЙ РАДИОСВЯЗИ

INCREASE OF RELIABILITY OF RAILWAY MOBILE RADIO COMMUNICATION CHANNELS

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Abstract: Based on the results of experimental studies, an improved statistical model for the propagation of radio waves in conditions of the influence of the railway infrastructure has been proposed. An improved method for calculating the service areas of the channels of the railway technological radio communication in the frequency bands 150-1500 MHz is proposed. The calculation of the channels is made directly on the basis of the determination of the energy indices of the radio link without a transition to the field strength indicators and the propagation curves of the radio waves. The use of a single analytical form of calculations simplifies the procedures for automating the design of radio networks and provides an increase in the accuracy and reliability of forecasting service areas.

KEYWORDS: RAILWAY RADIOCOMMUNICATION, PROPAGATION OF RADIO WAVES, OKUMURA - HATA MODIFIED MODEL, SERVICE AREAS

1. Введение

Технологическая радиосвязь на железнодорожном транспорте играет исключительно важную роль в обеспечении безопасности движения поездов и повышение эффективности управления перевозочным процессом. Технологическая радиосвязь является ответственной системой специального назначения и должна обеспечить высокую надежность каналов связи в любых условиях функционирования. Применение современных радиотехнологий позволяет существенно повысить надежность технических средств. В тоже время каналы подвижной радиосвязи, в силу сложных условий распространения радиоволн и условий эксплуатации, являются наиболее уязвимым элементом систем.

В результате влияния инфраструктуры железных дорог уменьшается напряженность электромагнитного поля в при экранировании зон распространения радиоволн и ухудшаются энергетические характеристики. Кроме того, объекты на трассах распространения радиоволн являются эффективными переизлучателями электромагнитной энергии, что создает многолучевой характер радиоканала и вызывает интерференционные пространственные флуктуации напряженности поля. В результате создаются области пространства, в пределах которых уровень принимаемого сигнала может быть недостаточным для обеспечения уверенного приема.

В таких условиях наиболее эффективно применение мер повышения надежности систем на этапах проектирования и эксплуатации. При определении зон обслуживания радиосетей необходима разработка методов расчета каналов, которые бы обеспечивали высокую надежность прогнозирования.

2. Предпосылки и средства для решения проблем

В настоящее время для решения практических задач прогнозирования уровней сигналов в каналах подвижной радиосвязи наиболее широко используют модель Окамура-Хата и методику расчета по рекомендации ITU – R P.1546, которая является базовой [1,2]. В то же время остается актуальным исследование распространения радиоволн с целью уточнения параметров моделей для конкретных условий организации радиосетей [3,4]. Но использование методик расчета сетей радиосвязи общего пользования не обеспечивает требуемой точности проектных расчетов сетей технологической радиосвязи на железных дорогах, что связано с особенностями распространения радиоволн в условиях влияния инфраструктуры железных дорог.

Действующие ведомственные нормативные документы не предусматривают расчет каналов в перспективных для

железнодорожного транспорта полосах частот 460 и 900 МГц и используют графоаналитические методы расчета, что затрудняет автоматизацию проектирования радиосетей [5].

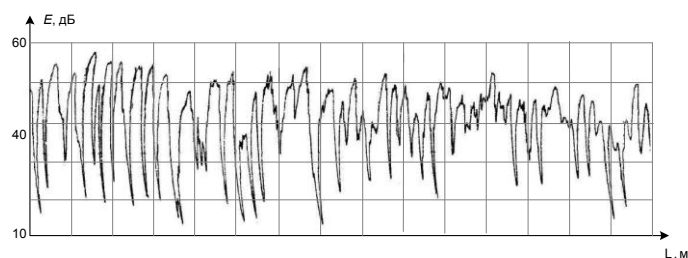
Необходимая точность прогнозирования может быть достигнута при использовании моделей с экспериментально определенными параметрами для конкретных условий функционирования радиосвязи.

3. Решение рассматриваемой проблемы

В работе приведены результаты экспериментальных исследований распространения радиоволн в новых для железнодорожного транспорта полосах частот 460 и 900 МГц, которые проводились в рамках комплексных исследований выполненных в Украинском государственном университете железнодорожного транспорта (г. Харьков).

Измерения напряженности поля выполнялись на ряде станций и перегонов железных дорог в условиях электрифицированных и не электрифицированных участков. Измерялась напряженность поля сигналов при вертикальной поляризации. Образец записей флуктуаций напряженности поля на коротком отрезке пути в условиях электрифицированной железнодорожной станции приведен на фигуре 1. Пространственные флуктуации напряженности поля носят случайный характер, однако наблюдается регулярное чередование смежных максимумов и минимумов, что подтверждает их интерференционное происхождение.

Измерения выполнялись с помощью сертифицированной аппаратуры для измерения напряженности поля, которая обеспечивает выполнение метрологических требований при исследованиях распространения радиоволн [6]. В качестве источников излучения использованы типовые радиосредства в соответствующих полосах частот.

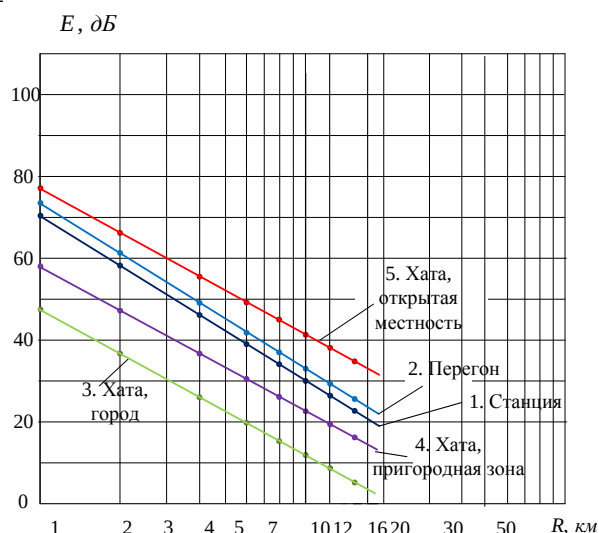


Фиг. 1. Флуктуации напряженности поля на электрифицированной железнодорожной станции

Средние значения напряженности поля определялись по дискретным некоррелированным выборкам объемом более 100 значений в каждой точке измерения. Для определения

аппроксимирующих зависимостей напряженности поля от расстояния были усреднены результаты измерений для типовых условий железнодорожных станций и перегонов.

По экспериментальным данным на фигуре 2 построены кривые зависимости медианных значений напряженности поля от расстояния для условий станций (кривая 1) и перегонов (кривая 2) на не электрифицированных участках железных дорог. Для сравнения кривые 3,4,5 построены по модели Окамуры – Хата для условий: город, пригородная зона, открытая местность. Все кривые построены для одинаковых условий передачи на частоте 900 МГц - при мощности передатчика 1 Вт и высотах установки антенн стационарной $h_1 = 20$ м и антенны приемной (локомотивной) радиостанции $h_2 = 5$ м.



Фиг. 2. Зависимость напряженности поля от расстояния для разных моделей распространения радиоволн

Экспериментальные результаты отличаются от кривых рассчитанных по базовой модели Окамуры – Хата. Международный Союз железных дорог предлагает вести расчёты зон радиопокрытия по модели Окамуры – Хата для условий городов, однако при этом будет создаваться излишний запас мощности [7], что ухудшает технико – экономические показатели сетей.

На основе экспериментальных кривых определены параметры модифицированной модели Окамуры – Хата для условий перегонов (формула 1) и станций (формула 2):

$$(1) E_{пер} = 79,25 - 26,05 \cdot \lg f + 13,82 \cdot \lg h_1 + (1,1 \cdot \lg f - 0,7) \cdot h_2 - (44,9 - 6,55 \cdot \lg h_1) \cdot \lg R^{1,15} + 4,78 \cdot (\lg f)^2$$

$$(2) E_{ст} = 57,01 - 7,22 \cdot \lg f + 13,82 \cdot \lg h_1 + (1,1 \cdot \lg f - 0,7) \cdot h_2 - (44,9 - 6,55 \cdot \lg h_1) \cdot \lg R^{1,15} + 2 \cdot \left(\lg \frac{f}{28}\right)^2$$

где h_1 - высота установки антенны стационарной радиостанции, м; f - рабочие частоты радиосетей, МГц; h_2 - высота установки антенны мобильной радиостанции, м; R - відстань від передавача до точки оцінювання втрат, км.

Расчеты зон обслуживания радиосетей удобнее вести на основе определения энергетических параметров сигналов и потерь при распространении радиоволн без перехода к кривым напряженности поля. Формулы для расчета основных потерь мощности сигналов для условий распространения радиоволн на станциях $L_{осн,ст}$ (формула 3) и перегонах $L_{осн,пер}$ (формула 4):

$$(3) L_{осн,ст} = 52,35 + 27,22 \cdot \lg f - 13,82 \cdot \lg(h_1) - (1,1 \cdot \lg f - 0,7) \cdot h_2 + (44,9 - 6,55 \cdot \lg h_1) \cdot \lg R^{1,15} - 2 \cdot \left(\lg \frac{f}{28}\right)^2$$

$$(4) L_{осн,пер} = 30,11 + 46,05 \cdot \lg f - 13,82 \cdot \lg(h_1) - (1,1 \cdot \lg f - 0,7) \cdot h_2 + (44,9 - 6,55 \cdot \lg h_1) \cdot \lg R^{1,15} - 4,78(\lg f)^2$$

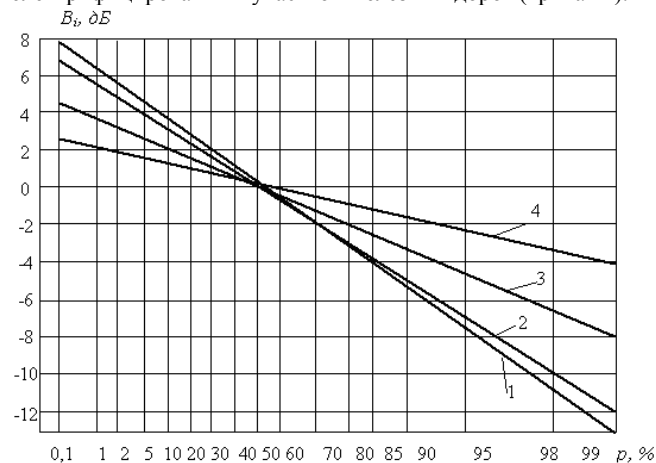
При расчетах каналов необходимо учитывать флуктуационные процессы, которые вызваны различными факторами, поскольку значение напряженности поля является случайной величиной по месту и времени [2]. Но именно величина интерференционных пространственных флуктуаций является определяющей при расчетах значений напряженности поля с заданной надежностью. Наиболее полно флуктуационные процессы характеризуют интегральные функции распределения. Они позволяют определять вероятность превышения определенных уровней сигналов, которая может характеризовать надежность радиоканалов по полю.

На фигуре 3 приведены экспериментальные интегральные функции распределения значений напряженности поля в различных условиях распространения радиоволн. Кривые построены на основе статистической обработки обобщенных результатов исследования. По оси ординат приведены уровни сигнала в относительных единицах

$$B_i = 20 \lg \frac{E_i}{E_{ср}}$$

По оси абсцисс нанесено количество точек приема p в процентах, в которых принимаемый сигнал превышает уровень, указанный на оси ординат. Графики могут характеризовать распределение вероятностей амплитуд напряженности поля на любом расстоянии от передающей антенны.

Наиболее глубокие флуктуации наблюдаются на железнодорожных станциях (кривая 1) и перегонах электрифицированных участков железных дорог (кривая 2). На не электрифицированных железнодорожных станциях глубина флуктуаций напряженности поля уменьшается (кривая 3). Наименьшая глубина флуктуаций наблюдается на перегонах не электрифицированных участков железных дорог (кривая 4).



Фиг. 3. Распределение уровней сигналов в зависимости от надёжности радиоканала по полю

4. Результаты и дискуссия

Результаты экспериментальных исследований могут быть положены в основу усовершенствованной методики расчета зон обслуживания радиосетей с необходимой надёжностью. На границе зоны обслуживания должно выполняться условие:

$$L_{мережі} \leq L_{доп},$$

где $L_{мережі}$ – реальное значение потерь сигналов в конкретных условиях организации радиосетей, которое определяют с учетом дополнительных потерь;

$$(5) L_{мережі} = L_{осн}(f, h_1, h_2) + B_{трас} + B_{імов},$$

$L_{оснс}$ – основные потери на трассах распространения радиоволн, определяемые по формулам 3,4, полученными для условий станций или перегонов;

$B_{трас}$ – дополнительные потери, которые зависят от конкретных особенностей трассы распространения радиоволн в различных условиях организации радиосвязи;

$B_{лмов}$ – дополнительные потери, учитывающие пространственные и временные флуктуации напряженности поля сигналов, определяют исходя из требуемой надежности связи по полю;

$L_{дон}$ – максимально допустимый уровень потерь на трассе распространения радиоволн, при котором обеспечивается необходимое качество и надежность каналов радиосвязи на границе зоны обслуживания;

(6) $L_{дон} = P_{прд} - P_{прм} + B_{пар}$, дБ;

$P_{прд}$ – мощность передатчика, дБм;

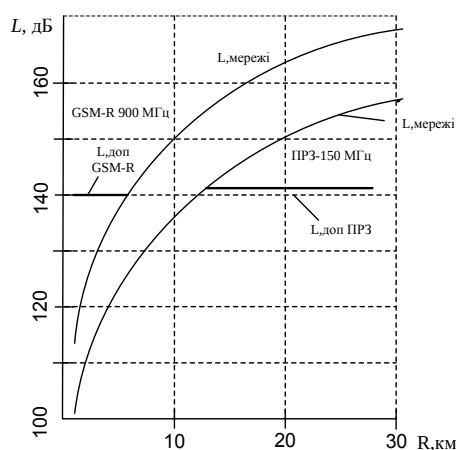
$P_{прм}$ – минимально допустимая мощность сигнала на входе приемника, дБм;

$B_{парам}$ – сумма поправочных коэффициентов, зависящих от параметров антенно-фидерных устройств передатчика и приемника.

Необходимое значение поправки $B_{лмов}$ определяют по графикам на фигуре 3. При значительных дальностях радиосвязи дополнительно учитывают влияние флуктуаций, вызванных изменением условий передачи сигналов на трассах распространения радиоволн и рефракционными изменениями в тропосфере, которые можно определить по рекомендациям ITU-R.

С использованием предложенной методики, на фигуре 4 приведены примеры расчетов дальности действия сети поездной радиосвязи метрового диапазона на частоте 150 МГц на и сети GSM-R 900 МГц, организованной на территории крупной железнодорожной станции для электрифицированного участка железной дороги.

Мощность передатчика в системе поездной радиосвязи $P_{прд} = 10 \text{ Вт}$ (40 дБм), в системе GSM-R $P_{прд} = 20 \text{ Вт}$ (43 дБм); высоты установки антенн базовых станций $h_1 = 20 \text{ м}$ и локомотивных антенн $h_2 = 5 \text{ м}$. Поправка $B_{лмов}$ определена для надежности радиоканала по полю 95 %.



Фиг. 4. Результаты розрахунку дальності радіозв'язку

Другие составляющие в формулах (5,6) определены с учетом ведомственных нормативных документов [5] и рекомендаций МСЖД по внедрению GSM-R [7].

Дальность радиосвязи определяется точкой пересечения кривых $L_{трас}$ и $L_{дон}$ и при надежности радиосвязи по полю 95% для условий перегонов составляет 12,1 км, а для сети GSM-R составит 5,8 км.

Результаты исследований распространения радиоволн важны не только для расчета сетей технологической радиосвязи, но и для организации сотовых сетей общего пользования, которые должны работать вдоль железных дорог для обслуживания пассажиров поездов.

5. Заключение

1. Экспериментально определены зависимости медианных значений напряженности поля от расстояния в условиях железнодорожных станций и перегонов и уточнены параметры пространственных флуктуаций радиосигналов.

2. Предложена усовершенствованная статистическая модель расчета энергетических характеристик каналов подвижной радиосвязи в условиях влияния инфраструктуры железных дорог.

3. Использование модели, обеспечивает повышение точности и надежности прогнозирования энергетических характеристик радиоканалов в условиях железнодорожных станций и перегонов на 8-11 дБ по сравнению с рекомендациями Международного союза железных дорог.

4. Предложен метод розрахунку каналів рухомого радіозв'язку, який забезпечує визначення зон обслуговування радіомережі з необхідною надійністю по полю, що дозволяє оптимізувати проектні рішення.

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OPERATING LONG DISTANCE RAIL TRANSPORT ON BRATISLAVA – BANSKA BYSTRICA LINE BY PRIVATE RAILWAY UNDERTAKING

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Abstract: *The competition between operators in the public tender in ordering process of train paths in long-distance rail passenger transport is very significant. The partial liberalisation of the rail market in the European Union was already underway in 2010, when all European railway companies with the necessary licenses gained access to railway infrastructure. One of the current objectives of the common transport policy laid down in The fourth railway package is to open up the market for national rail passenger services in all Member States from 2019. In 2009, the EU Regulation No. 1370/2007 came into force, which sets out the selection procedures for the award of contracts in public rail transport. There are two forms of contracts for transport services in the public interest, either by tendering the competition for traffic performance, or by directly entering the selected railway company. The aim of this article is to analyse steps of the Slovak government in the first public tenders to provide subsidized transport of a selected line and to determine conditions for this tender. This is a significant moment in the railway market in the Slovak Republic, preparing the opening up of the market for domestic long-distance passenger rail transport.*

Keywords: PUBLIC PERFORMANCE, LIBERALIZATION, RAILWAY PASSENGER TRANSPORT, PUBLIC TENDER, COSTS

1. Introduction

The partial liberalisation of the rail market in the European Union (EU) was already underway in 2010, when all European railway companies with the necessary licences and safety certificates gained access to railway infrastructure in all Member States. One of the current objectives of the common transport policy laid down in The fourth railway package is to open up the market for national rail passenger services in all Member States from 2019, while making public tenders for transport service contracts compulsory, in the public interest.

A fundamental step in the liberalisation of the rail freight market has been the separation of railway infrastructure managers from railway companies and consequently providing non-discriminatory access to railway infrastructure to the railway companies in all Member States. [1]

The biggest problem in the opening up of domestic passenger transport is that the tracks upon which traffic is controlled is also subsidised by the State, because it is impossible to create a natural competitive market. The situation has improved because of the impact of European reforms, although the operation of these lines remains costly, so it is not possible to create transparent competition. For this reason, the State continues to control and subsidise traffic performance but the possibility of public competition to secure operations on selected routes followed by their state subsidies is increasingly coming to the fore. [2]

In 2009, the European Parliament and Council Regulation EC No. 1370/2007 came into force, which sets out the selection procedures for the award of contracts in public rail transport. The Slovak Republic's Ministry of Transport and Regional Development (MTRD) contracted with the best railway company operating rail services (Železničná spoločnosť Slovensko, a.s., The Railway Company Slovakia Inc., or ZSSK) to carry out transport services in the public interest for a period of nine years (2011 to 2020). This contract also includes operations in regional transport, which are agreed together with operations in long-distance transport. [2]

1. The opening up of the market for domestic passenger rail transport services in the Slovak Republic

There are two railway companies with which the State has concluded contracts for transport services in the public interest for domestic passenger transport in the Slovak Republic: ZSSK and the private railway company, RegioJet, Inc. At present, there are two options of providing transport services in the Slovak Republic. The first is when a railway company provides transport services at its own business risk and this principle is applied to lines with sufficient capacity and performance, where there is less risk of potential financial loss to the company. Currently this type of provision of transport service is used by RegioJet Intercity on the Bratislava to Košice line. The second type is when a railway company provides transport services in the public interest. [3]

In January 2012, there was a change on the Bratislava to Košice line because of a sufficient number of services and passenger traffic flows. ZSSK started to operate its Intercity trains as commercial trains from a contract on traffic performance in the public interest. For these trains, there is a separate tariff policy, they are not subsidised by the State and the railway company operates at its own business risk. In December 2014, RegioJet started providing the same transport services on the same line, with the result that ZSSK stopped operating its InterCity trains in January 2016. In December 2016, ZSSK starts again to operate the InterCity trains.

2. Call for public tenders in railway transport in the Slovak Republic

There are two forms of contracts for transport services in the public interest, either by tendering the competition for traffic performance following the end of a contract, or by directly entering the selected railway company. A contract for transport services in the public interest by direct assignment to a railway company was realised on the Bratislava to Komarno line. MTRD carried out a tender and awarded the transport service to a specific railway company, RegioJet. The contract was agreed in December 2010 for a period of nine years from March 2012 to December 2020 and the contracted transport performance was stipulated at 1.3 million train kilometres. [4]

The analysis by MTRD showed that, after RegioJet took on the railway passenger transport March 2012, there was visibly increased train traffic on this track (from Dunajska Streda to Bratislava there is a one hour period during the day, and half an hour period during peak time), and as a result there is a significant increase in transport performance. Year on year, in the period October 2012 to October 2013, there was an increase of 74% in train kilometres, 146% in passenger kilometres, and 115% in the number of passengers of. It was also noted that there was a reduction in the cost per train kilometre of 5.7€, which represents a cost reduction of 16% when compared with a national carrier. [6]

In September 2015, the first competition for subsidised services in the public interest started, when advance notice of invitation to tender for the long-distance Bratislava to Banská Bystrica line was published and, in November, the tender was declared without publication of the estimated value of services. The price of the services, however, is estimated at over 10 million euros. The deadline for this competition was January 2016 and eight candidates enrolled. As at November 2016, the competition had not yet been evaluated. [7]

3. Characteristic of the long-distance Bratislava to Banská Bystrica line

During 2015, MTRD began to take steps towards the liberalisation of the long-distance domestic rail passenger service on the Bratislava to Banská Bystrica line, which opened up the market for domestic passenger services to a new railway company. The Bratislava to Banská Bystrica line was chosen because of the provision of sufficient transport performance and passenger flows. The liberalisation process of the Bratislava to Banská Bystrica line is still ongoing, and has entered competitive conditions and criteria stage, although the tender had yet to be concluded in 2015. [5]

The object of the competition was to ensure safe, effective and quality transport services to passengers between the cities of Bratislava and Banská Bystrica by long-distance trains. The contract for transport services in the public interest will be concluded with an eventual candidate under the Act of Railroad No. 514/2009. Annual transport performance is expected to be in the range of about 1.5 million train kilometres and the extent of transport operations for the year will be specified by a special addition to the contract. For realised traffic performance, the State will reimburse verifiable losses to the railway companies. In 2016, the extent of total transport performance at ZSSK represented 31,304 million train kilometres, thus the competitive amount represents 4.79% of train kilometres operated by ZSSK. [4]

The Ministry declared that one of the objectives of the competition was to generate the most favourable economic conditions for both the State and the passenger, while ensuring the operation of services achieved the required quality. The State currently reimburses around 6.7€ per train kilometre to ZSSK. Provisionally in this contest it envisaged the inclusion of eight pairs of express trains, which runs daily, and two pairs of extra trains running on Friday and Sunday.[8,9]

The new 2016/17 timetable on the Bratislava to Banská Bystrica line operates nine direct express trains, including eight trains in a two-hour period during the day. Also in the opposite direction there are nine direct express trains, including three trains in the morning one-hour period and the remaining six trains in a two-hour period. The transport has a length of 230 kilometres, achieved travel time is three hours 24 minutes and the average cruising speed is 67.6 kilometres per hour.

4. Proposal for ensuring rail passenger transport on Bratislava - Banská Bystrica line

When creation proposal of long-distance rail passenger transport of Bratislava – Banská Bystrica line we take into account the conditions, which were set out in the Notice of public tender

announced by the MTRD. The total extent of the services is defined as the minimum level. To fulfil the object of the contract it is required at least 7 trains or train units with a minimum capacity of 530 seats for each train or train unit. It is also required the creation of at least one operational reserve (one train or train unit). For ensuring long-distance transport on the Bratislava - Banská Bystrica line was selected the bi-current locomotive type 363. This locomotive has four axles, a box shape and it's design speed is 140 kilometres per hour. It is designed for trains on electrified lines, where the electricity supply system is changing. To ensure rail passenger transport in required quality services, they were also selected second class carriages (Bmpeer type) for passengers. These wagons are intended for long-distance transport and designed to meet the requirements of international transport and interoperability. Bmpeer carriage has open-space interior and the automatic sliding entrance doors, which speed up passengers boarding. [5]

5. Calculation of total costs when ensuring rail passenger transport at the Bratislava – Banská Bystrica line

Calculation of total costs, which may be incurred when providing passenger rail transport at the selected relation, is based on the average costs calculated per year.

Railway infrastructure costs

When calculation railway infrastructure costs, it is needed to find out the gross train weight according to the formula (1):

$$Q = Q_R + Q_V + n_m * 0.08 [t] \quad (1)$$

where Q is gross train weight [t], Q_{rus} is locomotive weight [t], Q_{voz} is carriages weight, n_{miest} is number of seats available and then the gross train weight calculation is:

$$Q = (87 + 7 * 43 + 7 * 76) * 0.08 = 430.56 \cong 431 t$$

Railway infrastructure costs are calculated according to the Decree of the Railway Regulatory Authority No. 3/2010 setting the charges for the access to railway infrastructure. These costs include charge for the minimal access package and charge for the access to the service devices. There are six line categories in the Decree, and because of this, lines have to be divided into categories. There is the first category line Bratislava Palarikovo with its length 81 kilometres and the second category line Palarikovo – Banská Bystrica with its length 149 km.

First, it is needed to calculate charge for the minimal access package, according to the formula:

$$U_{mp} = U_1 + U_2 + U_3 \quad (2)$$

where U_1 is charge for ordering and allocation of the capacity, U_2 is charge for the management and organization of traffic, U_3 is charge for ensuring the infrastructure serviceability. Second, there is needed the calculation of charge for the access to the service devices, following the formula:

$$U_{tp} = U_{tp1} + U_{tp2} \quad (3)$$

where U_{tp1} is charge for using of electrical supply device and U_{tp2} is charge for using railway stations. Charges for the access to railway infrastructure according to track category are shown in the Table 1.

Table 1: Charges for the access to the railway infrastructure

Category	Track section	U_1	U_2	U_3	U_{tp1}	U_{tp2}
1.	Bratislava - Palarikovo	1.6767	77.598	45.76832	25.774	25.929
2.	Palarikovo – B. Bystrica	2.831	131.269	80.98016		

Source: authors

Total charges for the access to railway infrastructure is 391.826 € per one train and 2 823 754.71 € per one train per one year.

Costs of rolling stocks

It was not possible to determine an exact rent of rolling stocks (because of trade secret) then the rent was based on acquisition cost of locomotive and carriages. Rental price was set at 60 € per hour per locomotive and 27 € per hour per carriage. In proposal, there is one locomotive and seven carriages to ensure the condition of 530 seats available in each train. The cost of the carriages and locomotive are both calculated by the following formula [6]:

$$N_{R,V} = P_{R,V} * n_{rok} * t * n_{R,V} [\text{€/year}] \quad (4)$$

where $N_{V,R}$ are total rolling stock costs, $P_{V,R}$ is rent for locomotive/carriages, n_{rok} is number of days per year, t is hours per day, $n_{V,R}$ is the number of locomotives/carriages in all trains. Then the calculation of locomotive costs is:

$$N_R = 60 * 365 * 24 * 8 = 4\,204\,800 \text{ €}$$

$$N_V = 27 * 365 * 24 * 56 = 13\,245\,120 \text{ €}$$

The total rolling stock costs (for locomotives and for carriages together) are 17 449 920 € per one year.

Costs of locomotive and train crews

Costs of locomotive and train crews are calculated by using the gross wage of train drivers and conductors. The high of gross wage is based on analysis of the costs of operating the trains on the relation Bratislava – Komarno. These data were recalculated by index. The gross wage is set on 920 € for the train drivers and 750 € for the conductors. Indirect costs for train drivers is set 500 € and 300 € for the conductors. When formation the working turn for employees, the number of train drives was set on 22 people and the number of conductors was set on 88 people. Employer's contributions are at 35.2 % of gross wages. Costs of locomotive and train crews are calculated by the following formula:

$$N_{RC,VC} = P_{RC,VC} * (CCP + N_n) * I_{inf} [\text{€}] \quad (5)$$

where $N_{r,s}$ are costs of train drivers/conductors, $P_{r,s}$ is the number of train drivers/conductors, CCP is the total labour cost (gross wage + employer's contributions) and N_{nep} are indirect costs of train drivers/conductors. Then the final calculations of locomotive and train crews are:

$$N_{RC} = 22 * (1317,94 + 500) * \left(1 + \frac{11,33}{100}\right) = 44\,526 \text{ €}$$

$$N_{VC} = 88 * (1014 + 300) * \left(1 + \frac{11,33}{100}\right) = 128\,733.1 \text{ €}$$

Total costs of all locomotive crews are 512 534.11 € per year and for locomotive crews are 1 544 797.27 € per year.

Costs of energy

$$N_E = \frac{1}{1000} * Q * L * m_e * S_e [\text{€}] \quad (6)$$

where Q is total gross weight of train, L is the length of crossing electrified tracks, m_e is energy consumption for specific type of locomotive and S_e is rate of energy (price for 1 kWh of electricity). Then the calculation costs of energy are:

$$N_E = \frac{1}{1000} * 431 * 230 * 25 * 0,15 = 371.7 \text{ €/per one train}$$

Energy consumption for the locomotive type 363 is 25kwh/1000 hrtnkm according to the Study of the Transport research centre in the Czech Republic. Total costs of energy are 2 678 527.08 € per year.

Total costs

Total costs are comprised of direct and indirect costs. Direct costs are calculated above, it means the summation of railway infrastructure costs, costs of rolling stocks, costs of locomotive and train crews and costs of energy. Indirect costs include costs of the tickets selling, costs of services for passengers in railway stations, insurance costs etc. and comprise 20 % of direct costs. The high of direct and indirect costs is shown in the Table 2.

Table 2: Calculation of total costs

Total costs [€/year]	
Direct costs	25 019 133.16
Indirect costs	6 254 783.29
Total costs	31 273 916.45

Source: authors

Revenues

The high of revenues was determined based on the current occupancy of all connections on the relation Bratislava – Banská Bystrica last year. The occupation is divided into three track sections on this relation (Bratislava – Sala, Sala – Levice, Levice – Banská Bystrica). There are two tables for occupancy because of considerably different number of passengers during the peak and off-peak hours. The occupation, which we consider when calculating average revenues, was decreased of the number of passengers using complimentary transport. It was considered the average rate 0.066 € per one kilometre when calculating the revenues. The occupancies (with and without the complimentary transport passengers) and revenues during the peak and off-peak hours on selected track section are shown in the Table 3 and the Table 4. Then total average revenues for all trains on the Bratislava – Banská Bystrica line according to current occupancy are 17 205 828.34 € per one year.

Table 3: Revenues during the peak hours

Track section	Occupancy [%]	Occupancy by paying passengers [%]	Distance [km]	Revenues for one train [€]
Bratislava – Sala	95	54.15	60	1 085.79
Sala – Levice	65	37.05	72	891.49
Levice – B. Bystrica	50	28.50	98	933.40
B. Bystrica – Levice	60	34.20	98	1 121.08
Levice – Sala	70	39.90	72	960.07
Sala – Bratislava	85	48.45	60	971.50

Source: authors according to [6]

Table 4: Revenues during the off-peak hours

Track section	Occupancy [%]	Occupancy by paying passengers [%]	Distance [km]	Revenues for one train [€]
Bratislava – Sala	40	22.80	60	457.18
Sala – Levice	35	19.95	72	480.03
Levice – B. Bystrica	45	25.65	98	840.06
B. Bystrica – Levice	30	17.10	98	560.04
Levice – Sala	45	25.65	72	617.19
Sala – Bratislava	60	34.20	60	685.76

Source: authors according to [6]

The difference between revenues and costs is shown in the Table 5. The amount of compensation for provided services on the Bratislava - Banská Bystrica line ranges from 13.8 to 16.3 million € per year by available information.

Table 5: Revenues and costs

Revenues	18 278 923.22 €
Direct costs	25 019 133.16 €
Indirect costs	6 254 783.29 €
Total costs	31 273 916.45 €
Difference	-12 994 993.23 €

Source: authors

There will be new modern and well equipped trains or train units on selected line, which will provide good conditions for passengers while travelling and also ensure the higher quality and comfort ability [10]. New selected railway undertaking has to ensure more train connections (in both directions), what will probably increase the number of passengers. Based on this, there are expected higher revenues about 10 % in future. Increasing of revenues will reduce the amount of compensation of economically justified costs.

6. Conclusion

Nowadays it is expected arrival of a new railway undertaking that will provide its transport services on selected line. Therefore, it is important to design appropriate solutions that would be beneficial not only for new provider of transport services, but also for all the travelling public. This is a significant moment in the railway market in the Slovak Republic, preparing the opening up of the market for domestic long-distance passenger rail transport for competition in the provision of transport services in the public interest. This is a comprehensive process that achieves the desired effect only if it is well prepared. The priority, from the perspective of the passenger, is transit time and it should be noted that the line for competition already has a significant competitor in the form of road traffic, with the completion of the highway R1, where travel time is two hours and 50 minutes by bus and two hours and five minutes by car.

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METHODOLOGY FOR RATING QUALITY STANDARDS IN REGIONAL PASSENGER RAIL TRANSPORT

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Abstract. *Quality has a fundamental influence to the services in passenger transport. The main objective of transport is to satisfy customers' (passengers') requirements on the qualitative, flexible, fast and safe carriage of people and goods. Organisers of transport (public authority), providers of transport services and their customers have a different view on the perception of quality. This fact is influenced by unsystematic assessment to the quality measurement as well as by ignorance of the interaction of the transportation the peoples with the transport system. A basic element of transport service is the movement of the rolling stock with the passenger or goods from the start to end destination. In this point of the technological process of transport, the main bearer of the quality of transport services are the vehicles and the transport infrastructure. From the perspective of the vehicle, its operation-technical and utility properties are very important. From the perspective of transport infrastructure, the operating ratios and conditions are important. Due to the content of the quality concept it is not possible to focus only on the interaction of carriage and transport infrastructure. The paper is focussed on the quality evaluation of performance in regional passenger rail transport in relation to other modes of public transport. Hereby it is necessary to know the perception of quality services as well its value for the client (passenger). Consequently it is needed to set a permanent process of quality evaluation of the provided transport services. The paper is based on the premise that the customer interests present the public ordering body (authority) of the public transportation services.*

Keywords: QUALITY, RAILWAY TRANSPORT, PASSENGER TRANSPORTATION

1. Introduction

The task of quality standards for services in the regional rail passenger transport are intended to establish a uniform level of provided services, while drawing inspiration from EN 13816. The quality standards have to be set according to the strategic needs of passengers, so that they can be set as a basis of a contract with a customer to a minimum uniform level of quality of service provided. Measuring and evaluating the quality of services in regional passenger rail transport also need to be compared in relation to other modes of public transport. It is necessary to know the perception the quality and value of provided services for the client (passenger) and set the functioning with a permanent process of evaluation provided services. Important is the view on the quality provided services in passenger transport by the subject under the transport market. The role of public authorities is regulation given the impact of the transport process on the society and environment. The main aim of clients public services is established on a mutually intertwined and customer quality and sufficiently simple comprehensive public transport system while minimizing financial claims. The intention of the public passenger transport is to build a competitive system to motorized individual transport. On the support of these aims it is necessary to establish new methodology on the definition of quality requirements in the regional rail passenger transport. This methodology currently does not exist.

2. The proposal of methodology for rating quality standards

The basic principle of policy quality of services in regional passenger transport is to satisfy the customer's requirements, therefore, focus on compliance with the established quality standards. The role of the order body of the transport services is to ensure optimal transport accessibility of regions with the effective use of resources and to implement the principles of transport policy. The task of the coordinator undertake to fulfil the requirements of standard EN ISO 9001: 2009 and STN EN 13816. Based on the above coordinator shall establish and maintain a quality management system. Next is necessary to apply the principles of improvement of all processes affecting the quality of services provided in public passenger transport. The effective providing of

quality services requires introducing control processes for the any activity, which affects the fulfilment of customer requirements.

The task of the provider of the service is to ensure all activities associated with the provision of transport services in the appropriate quality to meet all established standards of service quality. The carrier (railway undertaking) must ensure the safe, convenient, fast and affordable transport for passenger (customer) at a maximum fulfilment of their requirements. Railway undertaking (carrier) must provide the services for passengers in accordance with approved quality standards at European level in order to retain existing customers potentially increase the demand for transport services. The carrier must also ensure the high quality standard of its staff and technical resources. The most valuable asset of the company is the professional qualifications and skill of staff. For this reason it is necessary to monitoring constantly the increasing proficiency as well career development of employees and in relation to the fulfilment of defined quality criteria relating to staff and their approach to customers.

The proposed methodology is based on premise to provide the maximum value for customers. Realisation of transport services is the responsibility of the carrier. Ensuring transport service is public service that must satisfy the transport needs of the population in the region. The requirements of passenger (costumer) defines subject, which ordered transport performance. In the proposed methodology is rated the level of provided services in regional passenger transport that are ordered by transport body (state or region). This body is responsible for evaluating customer (passenger) requirements and coordinating transport performances.

Methodology integrates the solution for the evaluation of quality standards in regional passenger rail transport on two levels [1]:

- relationship between order body of transport services and carrier
- relationship between order body of transport services and customer (passenger)
- relationship between order body of transport services and infrastructure manager.

This relationship must be evaluated separately. For drawing up overall evaluation of quality standards in the regional rail passenger transport was designed a flowchart. This flowchart is on Figure 1.

As the first step to create the flowchart was necessary to define the core of the process. The next step was to define the roles of the process.

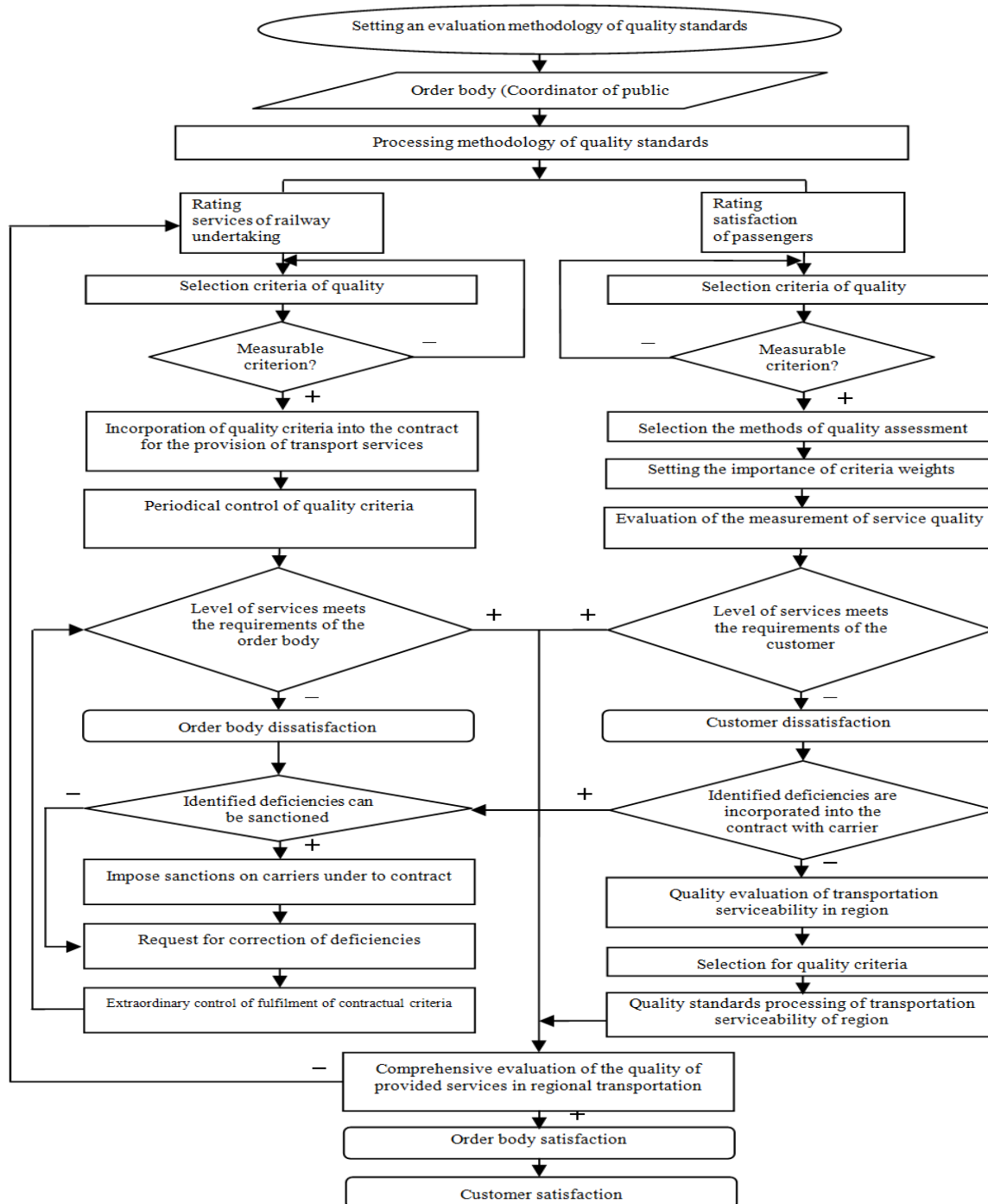
3. Evaluation services of rail carriers

Evaluation of service rail undertaking is based on quality standards setting and subsequent evaluation of its fulfilment.

Selection criteria of quality – search for measurable quality criteria, which will be part of the contractual obligation of the

carrier in providing the ordered transport services. Especially are oriented on transport processes.

Incorporation quality criteria in the contract for the provision of transport services – implementation the defined quality standard that is measurable in the contract. Defining the standard must be accurate and must contain defined penalties. This activity includes the overall concept of the contractual relationship between the order body and carrier. It comes to the entire agreement and all its terms.



Source: authors

Figure 1 The methodology of rating quality standards in the regional passenger rail transport

Periodical control of fulfillment the quality criteria, which are incorporated into contract - submitter checks at regular intervals compliance with agreed quality standard. Usually physical check shall be made in the form of "hidden buying" staff of submitter. The carrier has to tolerate control, which is also enshrined in the agreement. The carrier has duties making of traffic statistics, mainly statistic of selling travel tickets, passenger flows, the number of cancelled trains and compliance of timetable.

Level of services meets the requirements of the order body – the order body based to control submitter compares the level of provided services and according to the contract. In case the submitter find out failure to comply with the defined quality standards, can impose the carrier sanctions.

Submitter dissatisfaction: identified deficiencies can be sanctioned – order body shall examine, whether it is possible to penalize unfulfilled the quality standards. Deficiencies can be found based to control of order body or from the realized quality assessment based on customer survey.

Impose sanctions on carriers under to contract – submitter imposes sanctions based on identified deficiencies that can be sanctioned under the contract.

Request for correction of deficiencies – when is impossible to penalize identified deficiencies, order body invites carrier for remedial action to restore of quality standards provided services.

Extraordinary control of fulfilment of contractual criteria – order body shall realize a random controls that are oriented on the quality standards provided by railway undertaking.

4. Evaluation of passenger satisfaction

Evaluation of passenger satisfaction (customers) with provided transport services is based on the realization of regular traffic survey, which also includes quality assessment. This process implements the proposed steps according to the proposed methodology for measuring of provided quality services. The proposed methodology for examining the quality of the customer and determines the value of the transport service perceived transport users.

- Selection for criteria of quality – search for measurable criteria of quality, which are part of the quality assessment transport services. Is the most important step that allow to get perception of service quality and to determine customer expectations. It is realized by survey.
- Selection of the method quality assessment – choice of objective assessment methods (Saty's method, benchmarking etc.). On these methods we can obtain concrete and objective results.
- Set the importance weights of criteria – setting the weights for proposed criteria by choosed approach.
- Evaluating the measurement of quality provided services – it is necessary put the accent on the methodically correct procedure when we evaluate measurement of quality provided services.
- Level of service meets the requirements of the order body – there is assessed perceived satisfaction and maximum value of customer satisfaction. There can be used approach of multi-criteria analysis. In case the quality level of provided services meets the customer's perspective, then is processed an comprehensive assessment. In case when customer is not satisfied with quality level of provided services, is need to check the finding dissatisfaction according to the concluded contract. Then carrier must make remedies for improve standards of quality.

- Identified deficiencies are incorporated in the contract with the carrier – after finding that the customer are dissatisfied with the criteria of quality standards the procedure continues as in the case of previous step. It is searching possibility how this deficiencies to penalise.
- Quality evaluation of transportation serviceability in region – task of this activity is quality evaluation of rail transport and its impact to transportation serviceability assessment of region. It is an activity of order body who responds to the transport needs of the population. The transport needs of the population come up from order body's surveys also from customer transport surveys.
- Selection criterion of quality – task of this activity is set quality criteria of rail transportation serviceability in selected region. Selection comes out from previous activities and from basis assessment results. Then are choosed a relevant quality standards, which are measurable.
- Quality standards processing of transportation serviceability of region – task of this activity is a concretization a detailed elaboration of quality standards processing in regional transport.

5. Comprehensive evaluation of the quality of provided services in regional transportation

Methodology of evaluation quality standards in regional rail passenger transport assesses from point of view of order body and at some time evaluates request for carrier and includes the evaluating the measurement of quality provided services. The generalized methodology is based on successive steps. Task of this methodology is searching measurable quality criteria.

Quality standards allow monitoring, evaluating and comparing single criteria of provided services. The evaluating the measurement of quality provided services brings to measures and help to continuously improve the quality services. Quality standards of regional rail passenger transport shall be binding for all railway undertakings that provide rail passenger services. Infrastructure manager must participate on fulfil the same standards. Update of quality standards should be implemented as a rule once a year, after consultation with all stakeholders.

Method of evaluating must respect requirements of multi-criteria background, for example if customers (passenger) demand from carrier fulfilment of a number of quality characteristics at once.

By providing the transport service is necessary to define service specifications, evaluation process and then regularly measure and control the process of providing services.

Part of the methods evaluation of quality must also be creating a rating scale. A rating scale gives the possibility to compare measured values and then reconsider quality of provided services. [3]

Task of comprehensive evaluation is the harmonized assessment quality of services as from the customer's perspective as well as from the perspective submitter. Customer satisfaction is achieved if the level of quality of service provided meets the requirements of the customer and also corresponds to the required level of perceived quality from the customer's perspective. These facts could mean satisfied the submitter and cycle of evaluating should be end in that period.

In the event that the quality of provided services does not satisfy the requirements of the customer, it is necessary to take corrective measures to improve quality standards. It is necessary to repeat the evaluation process of quality services on the part of the carrier (railway undertaking).

The task of order body (coordinator of transport performances) as a key player in the assessment of quality standards, measuring the quality of services and control contract standards is to represent the interest of customers by providing the public transport services.

6. Conclusion

At present the offer of provided services in regional rail passenger transport oriented only on their ordering and financing. It represents the quantitative view. Quality of provided services is not monitoring and evaluating systematically. This fact causes inadequate quality level of provided services. The aim is creating of transport system with high quality of provided services. High quality of provided services not only fulfils the expectation of present customer, but could get new customer.

Quality standards of regional rail passenger transport are indented for one level of quality. These standards are based on European's norms – concrete STN EN 13 816 and respects strategic requirements customers. Their direct applicability is possible in the submitter's contract. Application of quality standards to praxes does mean makes a new subject – coordinator. Coordinator will be to work on the ordering performance in the public services. Than is necessary accept the new contract between the submitter, coordinator and provider of transport services (carrier).

Proposed methodology of quality assessment can be used for comparing integrated transport systems by the quality level. The methodology can be used also as a evaluating of provided services in the relationships submitter and supplier (railway undertakings, infrastructure manager). The methodology does not exactly define the role and mission submitter from coordinator of an integrated transport system – It perceives their same level.

The proposal of methodology full accept the transport policy of EU specifically the White paper 2011 - Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport system, also quality norms and transportation operational programme in horizon 2020. These facts creating a space to meet the objective of promoting the development of public railway passenger transport by increasing its quality level.

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EXPRESSION OF RISK THROUGH TARIFF POLICY IN RAIL PASSENGER TRANSPORT

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Abstract: Risk analysis is a process with a detailed identification of risks, determine their range and examines the interaction of these risks. Each process or human activity are influenced by many risks. As well as in rail transport there are many risks which hare accrue from the operation. Risk is defined as the chance that something will happen what will affect the goals and is measuring by results or estimate. We can also risk defined as the product of the likelihood of an adverse event (phenomenon) and consequences (outcomes). On one side is the risk connected with the hope of achieving a good financial results, but on the other side with the danger of business failure that brings losses. The aim of this paper is the proposal of a tariff taking into account the risk from unoccupied capacity of passenger trains. Pricing of selected risk we will eliminate this adverse event.

Keywords: RAILWAY PASSENGER TRANSPORT, RISK, TARIFF POLICY, COSTS

1. Introduction

The term "risk" has many meanings, and is differently defined in the scientific literature, legal norms and various dictionaries. The meaning of this term depends on the field of activity, for which it is defined, on the purpose of the risk definition, and on its subsequent use.

Rail transport as a whole is affected by a number of risks that may arise in different parts of the process and may diversely affect various entities involved in the transport. Risk is defined as an opportunity that it will become something that has an impact on the goals, and is measured by the consequences or an estimate of the probability [1 and 2].

2. Risk from Unoccupied Capacity of a Selected Passenger Train

Risk from unoccupied capacity is one of many risks in the rail passenger transport which may cause a reduction in profit to the carrier, even the incomplete payment of its costs and subsequent loss. This is the risk, when the carrier shares the loss in the operation of passenger rail transport arising from circumstances that can occur before the transport or during the process of transport and that are not included in the final price of transport [3 and 2].

3. Cost Analysis for a Selected Train

Knowing the costs of operations and processes is an essential tool of economic management in the company. In the market environment it is necessary to monitor the costs in several ways. Calculation of own costs in the company should be adapted to the opportunity to analyse and plan the costs for individual activities and processes. Currently, the cost calculations are assigned to the controlling system and are known as cost controlling. It is a broader term which includes not only the monitoring of the costs actually incurred in the activities and processes, but also their planning and control, i.e. we can talk about the cost management in the company [4 and 5].

Total own costs for transport by rail can be calculated according to the formulas that take into account indicators of transport work and relevant cost rates. The basic formula may have the form [4 and 6]:

$$C_t^{total} = C_{\pi} + C_i + C_{ic} + C_{lc} + C_{ri} + C_e + C_i$$

where:

C_{total} - Total costs of a train

C_w - Costs of carriages

C_l - Costs of locomotives

C_{lc} - Costs of the train crew

C_{lc} - Costs of the locomotive crew

C_{ri} - Costs of the rail infrastructure

C_e - Costs of energy

C_i - Indirect costs

In the introduction of the analysis of risk from unoccupied capacity of the selected passenger train its identification is important, i.e. detection of all possible effects that cause this risk. For the proper identification of the risk the detailed analysis of the costs which enter this process is significant. The risk identification and analysis of the costs are applied to a model example for the session Bratislava - Trenčín - Žilina - Poprad - Košice with the configuration of the train: locomotive 131 + Ampeer + WRRmeer + 6x Bmpeer [7,8 and 9]. All needed parameters of the model train are in Table 1.

Table 1 Basic Parameters of the Model Passenger Train

Configuration of the train on the session BA - KE	Weight [t]	Places for seating
1x Ampeer	49	54
1x WRRmeer	46	0
6x Bmpeer	44	76
Locomotive 363	87	
Total gross weight	446	510
Distance [km]	445 km	
Infrastructure fee *	€461.47	

* calculated with a calculator ZSR [10 and 11]

Division of costs is often modified by a calculation formula. The transport company may use more these formulas (e.g. for individual organisational units or for individual business areas). An essential aspect of the division of costs in the calculation formula is their division into direct and indirect costs [12 and 13]. Cost analysis for the model train is shown in Table 2.

Table 2 Calculation of the Costs for the Model Train

Σ carriage kilometres : 3,560	Costs of the carriages : €2,848
Σ train kilometres : 445	Costs of the locomotive : €289.25
Σ hourly rates for locomotive crew : 6	Costs of the locomotive crew: €84
Σ hourly rates for train crew : 6	Costs of the train crew : €330
Σ gross tonnage kilometres (GTKM) : 105,198	Costs of the energy : €287.19
Specific consumption (kWh/1,000 GTKM) : 18.2	Indirect costs : €1,842.82
Travel time (hour) : 5	Total costs of the train : €6,142.73

The total costs of the model train from Bratislava via Zilina to Kosice are €6,142.73.

4. The Proposal of the Tariff Taking into Account the Diverse Occupancy of the Train

The proposal of an optimal tariff (100% occupancy of seats) can be obtained based on the proportion of the total costs and total number of seats when we get the costs of one seat in the whole session. After rounding up the result to an integer, which constitutes a reasonable profit, and from the resulting price for transport over the entire session we will derive prices for transport in individual sections. This will be the basis for creating the relational tariff. The price for individual sections is formed with regards to the distance, but like with the entire session, the results are rounded up, and that should mean a reasonable profit for the carrier. Another form of profit growth is to propose a surcharge to the ticket in the first class, which would mean €4 / one seat.

Revenues are calculated through multiplying the number of occupied seats in the second class with the price for the transport throughout the whole session, plus revenues from the first class (the same way). At the formation of a tariff policy we take into account the fact that not all passengers do travel across the entire session; but the price for transport in the individual sections is higher, and thus the revenues of the carrier will not be reduced. The revenues are calculated as the lowest possible revenues at a given occupancy. Profit is calculated as the difference between revenues and costs (Table 3).

Table 3 The Proposal of a Tariff on the Session Bratislava - Kosice for 100% Occupancy of the Model Train and the Costs of One Seat €12.0446 in the Entire Line

100% occupancy	TN		ZA		PP		KE	
	2. class	1. class	2. class	1. class	2. class	1. class	2. class	1. class
Bratislava	5	9	7	11	11	15	13	17
Trencin	.	.	3	7	8	12	10	14
Zilina	.	.	.	.	5	9	8	12
Poprad	.	.	.	.	.	.	3	7

Costs of one seat in the entire line are €12.0446.

Revenues: €6,846

Profit: €703.27

The prices for transport in individual sections are necessarily to be adjusted (raised) in order to cover the total costs also in case the occupancy is not 100%. Total costs are unchanged with respect to occupancy. The calculations with variable occupancy of the train are shown in the following Tables (Tables 4 - 9).

Table 4 The Original Tariff on the Session Bratislava - Košice for 80% Occupancy of the Model Train and the Costs of One Seat €15.0557 in the Entire Line

Original tariff with a lower occupancy (80%):

80% occupancy	TN		ZA		PP		KE	
	2. class	1. class	2. class	1. class	2. class	1. class	2. class	1. class
Bratislava	5	9	7	11	11	15	13	17
Trencin	.	.	3	7	8	12	10	14
Zilina	.	.	.	.	5	9	8	12
Poprad	.	.	.	.	.	.	3	7

Revenues: €5,476.8

Loss: €-665.93

Table 5 The Changed Tariff on the Session Bratislava - Kosice for 80% Occupancy of the Model Train and the Costs of One Seat €15.0557 in the Entire Line

Changed tariff with a lower occupancy (80%):

80% occupancy	TN		ZA		PP		KE	
	2. class	1. class	2. class	1. class	2. class	1. class	2. class	1. class
Bratislava	6	10	8	12	11	15	16	20
Trencin	.	.	4	8	10	14	12	16
Zilina	.	.	.	.	6	10	10	14
Poprad	.	.	.	.	.	.	4	8

Revenues after the change of rates: €6,700.8

Profit after the change of rates: €558.07

Table 6 The Original Tariff on the Session Bratislava - Kosice for 60% Occupancy of the Model Train and the Costs of One Seat €20.0743 in the Entire Line

Original tariff with a lower occupancy (60%):

60% occupancy	TN		ZA		PP		KE	
	2. class	1. class	2. class	1. class	2. class	1. class	2. class	1. class
Bratislava	6	10	8	12	11	15	16	20
Trencin	.	.	4	8	10	14	12	16
Zilina	.	.	.	.	6	10	10	14
Poprad	.	.	.	.	.	.	4	8

Revenues: €5,025.6

Profit: €1,117.13

Table 7 The Changed Tariff on the Session Bratislava - Košice for 60% Occupancy of the Model Train and the Costs of One Seat €20.0743 in the Entire Line

Changed tariff with a lower occupancy (60%):

60% occupancy	TN		ZA		PP		KE	
	2. class	1. class	2. class	1. class	2. class	1. class	2. class	1. class
Bratislava	7	11	11	15	11	15	21	25
Trencin	.	.	5	9	13	17	15	19
Zilina	.	.	.	.	7	11	13	17
Poprad	.	.	.	.	.	.	5	9

Revenues after the change of rates: €6,555.6

Profit after the change of rates: €412.87

Table 8 The Original Tariff on the Session Bratislava - Košice for 40% Occupancy of the Model Train and the Costs of One Seat €30.1114 in the Entire Line

Original tariff with a lower occupancy (40%):

40% occupancy	TN		ZA		PP		KE	
	2. class	1. class	2. class	1. class	2. class	1. class	2. class	1. class
Bratislava	7	11	11	15	11	15	21	25
Trencin	.	.	5	9	13	17	15	19
Zilina	.	.	.	.	7	11	13	17
Poprad	.	.	.	.	.	.	5	9

Revenues: €4,370.4

Loss: €-1,772.33

Table 9 The Changed Tariff on the Session Bratislava - Košice for 40% Occupancy of the Model Train and the Costs of One Seat €30.1114 in the Entire Line

Changed tariff with a lower occupancy (40%):

40% occupancy	TN		ZA		PP		KE	
	2. class	1. class	2. class	1. class	2. class	1. class	2. class	1. class
Bratislava	11	15	16	20	11	15	31	35
Trencin	.	.	7	11	19	23	22	26
Zilina	.	.	.	.	11	15	19	23
Poprad	.	.	.	.	.	.	7	11

Revenues after the change of rates: €6,410.4

Profit after the change of rates: €267.67

The carrier may also modify tariff rates with respect to each day of the week according to the occupancy of the train, recapitulation is show in Table 10. From the analysis it is clear that if about 500 people travel in one train from Bratislava to Kosice, the price for transport would be around €13 per one person.

Table 10 Comparison of the Ticket Price on the Session BA – KE

Comparison of the Ticket Price between BA - KE	Own proposal								
	100% occupancy		80% occupancy		60% occupancy		40% occupancy		
	1. class	2. class	1. class	2. class	1. class	2. class	1. class	2. class	
	17	13	20	16	25	21	35	31	
	RegioJet								
	Purchase of a ticket one day in advance*			Purchase of a ticket on Friday*			Purchase of a ticket a week in advance*		
	Standard	Relax	Business	Standard	Relax	Business	Standard	Relax	Business
	12.1-14	15.9-18.7	20.6-25.3	12.1-21.5	15.9-28.1	20.6-33.7	12.1-14	15.9-18.7	20.6-25.3
	ZSSK, a.s. (state carrier)								
	2. class	CLASIK RAIL PLUS							
18.76	14.07								

*Ticket price depends on the time of travel during the day (5:33 AM, 11:33 AM, 5:33 PM)

5. Conclusion

Own costs in the railway sector are similarly as in the case of other modes of transport influenced by external and internal factors. Among the external factors we can include mainly fees for the use of railway infrastructure, energy prices, rental (lease payments) of locomotives, carriages and so on. Good predictions on the number of transported passengers and the occupancy of seats on the train are necessary in order to eliminate the risk from unoccupied capacity of the train and then it is possible to propose the tariff which can effectively eliminate this risk. The carrier may also modify tariff rates with respect to each day of the week according to the occupancy of the train. From the analysis it is clear that if about 500 people travel in one train from Bratislava to Kosice, the price for transport would be around €13.

The ticket price for the session BA - KE with the state carrier is currently €18.76 (full price, which is subsidised by the state); private carrier RegioJet offers the price from €12.1 to €33.7 for this session, however this price depends on three factors (the day of ticket purchase, travel time and the class of a carriage). In our proposal, which takes into account the risk from unoccupied capacity of a train, the ticket price is dependent on the occupancy of the train. In the case of 40% occupancy of the train, the ticket price in own proposal is lower than the price level with a private carrier in the highest class during the rush hour. At formation of the tariff policy it is important to take

into consideration the forecast of development of the number of passengers.

Acknowledgement

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LOW-TEMPERATURE DISTRICT HEATING WITH DECENTRALIZED GENERATION BY HEAT PUMPS AT A RAILWAY STATION: OPTIMIZING THE SYSTEM AND CALCULATING GREENHOUSE GAS EMISSIONS

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Abstract: This paper discusses a heat pump subsystem within an existing high-temperature DH system located at a railway station in Omsk, Russia. The goal is to increase the efficiency of an existing high-temperature DH system by describing decentralized heat generation from an environmental point of view. We obtain a balance method whereby the heat loss (or the thermal energy loss) is expressed dependent on the supply and return temperatures so as to reduce operating costs of heat supply. The outcome of calculating the heat loss by this method is a relation that is valid typically for all DH networks. Findings beneath show that switching to a low-temperature DH can decrease operating costs and increase overall heat production efficiency. The reason for the latter is a known logarithmic heat flux-temperature correlation. This paper concludes that the idea of decentralized generation has a great potential for the future, as the implementation of this concept is closely related to a low-temperature DH.

Keywords: DISTRICT HEATING; NETWORK; OPERATION; TEMPERATURE

1. Introduction

Although district heating networks have a key role to play in tackling greenhouse gas emissions associated with urban energy systems, little research has been carried out on district heating (DH) networks expansion and integrating decentralized thermal energy generation[1].

Ideas of low-temperature DH [2] with decentralized generation by means of heat pumps [3] are running high. Nevertheless, Bolonina et al. [4] found some reasons to increase network temperature curves. Albeit the paper [5] figures out a leak detection method based on the idea of total metering, which suits well the concepts of 4th generation DH, it emphasizes hydraulic rather than thermal concerns. Zarin Pass et al. [6] contributed the industry a lot by putting effort into a thermodynamic analysis of a novel bidirectional district heating and cooling network. Petrovic et al. [7–9] studied heat demand (load) fluctuations. On the one hand, Petrichenko et. al. [8] have developed a model for short-term thermal load prediction. On the other hand, Verrilli et al. [9] made longer-term forecasting possible.

Guy et al. [10] have made publicly available their development forecasts for a certain DH system (Hague), which is similar to what we are doing. Latosov et al. [11] solely address the issue of parallel energy use with no emphasis on parallel energy production. See Ref. [12] for an overview of fast simulation of district heating and cooling networks. Wu et al. [13] proposes that DH systems consist of CHP units, electrical boilers, and thermal storage facilities, but excludes heat pumps. Akhmetova et al. [14–16] describe existing high-temperature systems though being helpful with heat loss calculation.

The resulting optimization problem shown below is a Linear Programming (LP) problem that can be generalized to become a Mixed Integer Linear Programming (MILP) for which lots of general, robust and scalable approaches exist. The framework presented in this article is particularly based on a Microsoft Office Excel sheet and the Visual Basic for Applications macro language. By way of contrast, Austrian-Swedish researchers [17] have based their solution on the Modelica simulation language and the Python scripting language.

Refs [18] и [19,20] do not seem well matched to key topics of European science, namely advanced engineering and environmental technologies. Like in our research, Operation & Maintenance (O&M) is the topic of [21], but that paper dwells upon building-scale heat distribution systems. Simonovic et al. [22] and Geysen et al. [23] present a sophisticated but promising approach utilizing Artificial Neural Networks (ANN) and using machine learning and expert advice respectively.

2. Materials and Methods

We first discuss the use of a heat pump in a centralized DH system (fig. 1).

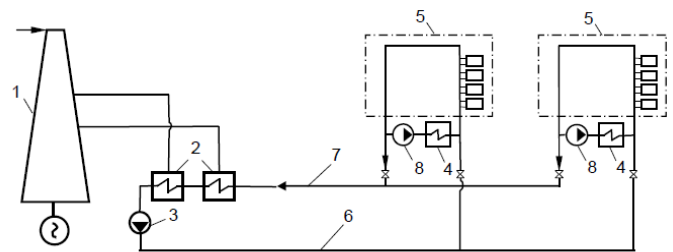


Fig. 1 Illustration of the district heating network configuration used in this research: (1) steam turbine with an off-take, (2) main heat exchangers, (3) DH network pump, (4) local heat sources, (5) consumer interconnection, (6) heat network supply, (7) heat network return, (8) consumer pump

A heat-pump system configuration can be categorized as open-loop or closed-loop. In an open-loop system, water is withdrawn from a surface water body, passed through a heat exchanger, and then returned to the surface water body. Closed-loop systems circulate the same water between a heat exchanger and the environment. Open-loop systems may be used in almost any application including urban construction, and sub-urban buildings, both DH and district cooling systems. However, we dwell upon economics of scale and therefore consider four ground-source heat-pump systems integrated into urban infrastructure. Georg K. Schuchardt [24] applied similar concept but his system consisted of decentralized thermal storages.

Such implementation creates a low-temperature concept [2] ensuring heat pump operation with the most efficient coefficient-of-performance values. Historically all DH systems have been “unidirectional”, meaning that the water in each pipe segment only flows in one direction. Separate circuits are needed for heating and cooling. In this paper we refer to a ‘bidirectional distribution’ system [6] as one in which water in each pipe segment can flow in alternating directions, depending on the net thermal fluxes on the system. In this case, there is a single network for both DH and district cooling.

For the sake of simplicity, we consider all the buildings being Thermostatically Controlled Loads (TCLs) as in [25] or [26] thus the amount of heat produced matches the amount of heat required at each moment of time t . A consumer interconnection (fig. 1, 5) is assumed to be typical even though simulation results show that controllers tuned to specific operating conditions can’t ensure operation stability of heating substation if operating conditions vary in a great range [27].

The minimization problem is solved by means of Mixed Integer Linear Programming (MILP). Numeric values are obtained by means of a Microsoft Office Excel sheet and the Visual Basic for Applications macro language. See Ref. [17] for an overview of different numerical optimization methods. The only operating costs are heat losses and electricity consumption, others are neglected.

What is crucial is the rate of heat flow through the pipe at the position x , and the moment of time t . There are the two terms on the right-hand side of the equation related to the thermal energy loss corresponding to the advective contribution (which may also be called mass or hydraulic contribution) and convective contribution (the turbulent one) [16]. M. Chertkov and N. Novitsky measured heat-flow rate in Watts, however we represent a heat loss measured in Gcal/h. Heat carrier fluid density and the area of the pipe cross-section are taken into account. We also make a comprehensive assessment of the heat carrier (water), eventually re-using their method. For the present paper as in [23] a certain area (fig. 2) was used as a case study.

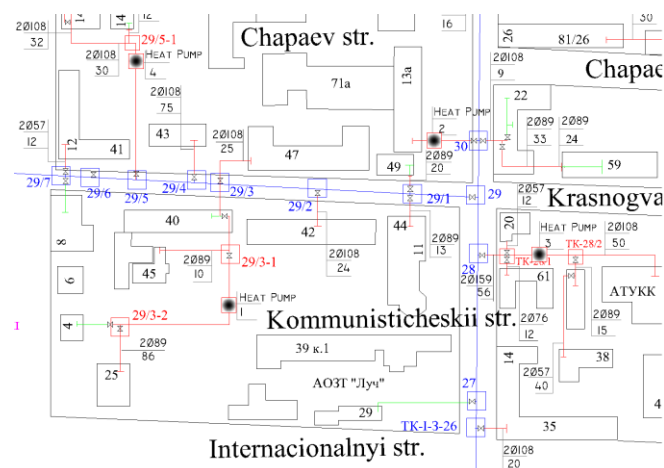


Fig. 2 Chart of the investigated district

Hereafter we describe a 41.2 MW district heating system at a railway station in Omsk, Russia, that utilizes a heat pump and coal-fired CHPP to supply heat to a heating district. With ammonia as the refrigerant, the three-stage heat pump is able to supply hot water for a maximal heat output of 10 MW and a designed heat pump coefficient of performance of 3, using groundwater as its source.

The piping in the network is about 392 m in length, with a total volume of about 64 m³. The transmission lines (the blue ones in the figure) became operational in 1988 and are currently fed by CHPP #5 with a coal burner. In 2004, the main part (the red one in the figure) was retrofitted to work with lower operating temperature. Another (green) part is to be installed this year with a capacity of 0.7 MW.

The supply temperature used was based on a conventional linear relationship of the outdoor temperature [21] taken from a data set with actual data [28]. A supply temperature of 78 C was first used to simulate the conventional high-temperature DH system in our calculations. Then we studied the energy efficiency of a multisource system where supply temperatures of 62 and 57 C were used for modeling. For the simulation of an ultra-low-temperature DH system, supply temperatures of 41 and 39 C were used. [21] The given approach is still being modified: ANN [22] and using machine learning and expert advice [23] are probably coming in the future.

3. Results and Discussions

Figure 3 shows the investigated relation of operating costs (thermal energy losses) and environmental impact of pollutions that could be served with DH at a given constraints in a commercially mature way.

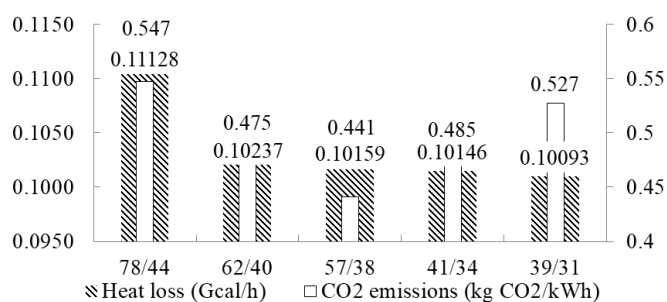


Fig. 3 Spectrum of heat losses and CO₂ emissions vs. supply/return temperature

The 57/38 curve ended up being the optimal solution because lower temperatures force heat pumps to operate with a coefficient of performance (COP) outside its best range. This results in greenhouse gas emissions increasing up to 0.527 kg CO₂/kWh in case of 41/34 and 39/31 curves; moreover, heat losses stop to decrease significantly at such curves. The reason for latter is a known logarithmic heat flux-temperature correlation. These results are in good agreement with other studies which have shown that heat losses in Russia [14] are basically higher than, for instance, in Europe and Czech Republic [15]. Moreover, calculation of GHG emissions outlines that the values obtained are similar with the average European CO₂ emission factor.

4. Conclusions

Calculating heat losses by the approach herein presented has resulted in a relation that is valid typically for all DH networks. We have considered the technical aspects such as the energy performance of a heat pump as well as the environmental ones (e. g. the evaluation of the greenhouse gas emissions for this or that temperature performance). Findings beneath show that switching to a low-temperature DH can decrease operating costs and increase overall heat production efficiency. Therefore, in the situation where Thermostatically Controlled Loads (TCLs) are introduced, the novel DH system (with lower temperature) becomes the most efficient option due to heat losses dropping from 0.11128 to 0.101159 Gcal/h in the optimal case. We have tried to show that the idea of decentralized generation has a great potential for future, because the implementation of this concept is closely related to a low-temperature DH. With the development of energy efficient networks and renewable-energy facilities at railway stations, railway companies will be definitely interested in lowering the temperature parameters of a distribution system, as it can decrease CO₂ emissions by more than 23% as in the case study.

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LINE TRACK CAPACITY - ANALYSIS OF THE IMPLEMENTATION OF THE UIC 406 METHODOLOGY IN ŽSR CONDITIONS

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Abstract. A variety of A variety of methodologies are used across Europe for the estimation of railway infrastructure capacity. This paper introduces the basic principles of the analytical methodology (e.g. Slovak railways) and UIC methodology. On the basis of these new approaches, dependencies between occupation time and buffer time is researched. The aim is to compare the needed buffer time and its impact to the line capacity.

Keywords: CAPACITY, METHODOLOGY, TIME TRAFFIC DIAGRAM, BUFFER TIME, OCCUPATION TIME

1. Introduction

In the allocation of the capacity of train paths to railway undertakings, it is necessary for the infrastructure manager to know the capacity of the infrastructure. Defining the capacity of the railway infrastructure (transport route) is relatively difficult and there are many different approaches to its definition.

In view of the different concepts and procedures relating to railway infrastructure capacity and the subsequent calculations applied by railway infrastructure managers, the International Railway Union (UIC) has developed new one methodology. At the nowadays the various of methodologies across the Europe are used. The unification was done so that the results of the assessments on the corridors are reciprocally comparable. The UIC 406 Code, called "Capacity" [5], contains the adopted principles for detecting rail infrastructure capacity using of a compression method with IT support for these practices. Unlike theoretical concepts, the compression method is used in real-time schedules with practical measures and is designed to create a common basis for infrastructure capacity determination. In the second edition of the UIC Code 406 (2013), for the first time there is also a methodology for determining the capacity of stations and nodes based on the same principles. The UIC 406 Code is a recommendation, allowing to the infrastructure managers to use a national methodology for their own needs. [1]

Therefore the aim of the paper is to analyse the equivalence of the results determining the line capacity according to the UIC 406 Code recommendation and according to the applicable national methodology of ŽSR.

2. Methodology of capacity calculation according to national methodology ŽSR D24

In the Slovak infrastructure manager ŽSR, the methodology of the D 24 Regulation is applied, which establishes relations for calculating the quantitative and qualitative indicators of the capacity. [4]

Line practical capacity - n_{prakt} defined as practical throughput performance which is expressed by the number of trains for the defined time period.

$$n_{prakt} = \frac{T - (T_{vjzl} + T_{stai})}{t_{obs} + t_{medz}} \quad [vl.T^{-1}] \quad (1)$$

where the variables already referenced on the line (line section) are:

T – calculation time [min]

T_{vjzl} – total time in which the operating device within the computing time is barred from operation for prescribed inspections, repairs and maintenance [min]

T_{stai} – total time of permanent manipulations, i.e. the time in which the operating device is occupied by other actions than those for which throughput capacity is calculated [min]

t_{obs} – technological time of occupation by one train (or act) in which the throughput capacity is calculated [min]

t_{medz} – average buffer time for one average train [min]

As a result of this quantitative indicator, we evaluate the line practical capacity as well as qualitative indicators, which are in particular the infrastructure occupancy time rate - s_o and the usage of the line practical capacity K_{prakt} .

$$s_o = \frac{T_{obs}}{T - (T_{vjzl} + T_{stai})} \quad [-] \quad (2)$$

$$K_{prakt} = \frac{N_{prav}}{n_{prakt}} \cdot 100 \quad [\%] \quad (3)$$

where:

T_{obs} – total occupancy time of the line [min]

N_{prav} – total number of regular trains[vl.T⁻¹]

A sufficiently occupied train traffic diagram is considered that one with the infrastructure occupation rate of 0.5 to 0.67. The normative capacity is characterised with the usage of the line practical capacity K_{prakt} by the regular transport in the range of 80-90%. [4]

These qualitative indicators constitute an optimal limit between acceptable use of the infrastructure capacity and time reserves. These buffers are particularly necessary for compensation of delays in irregularities and failures in rail transport, as well as the reasons given in the literature [2] for the average additional times t_{dod} and the average time of probable interference of runs - $t_{truš}$. The average time of gaps for one average train (t_{medz}) is the parameter for evaluation and assuring the balance and also the quality of the train traffic diagram.

Recommendation of the ŽSR D 24 Regulation observes to a great extent to the line section character and the occupancy time. The average time of gaps for one average train t_{medz} deposit is recommended for operating conditions difficult (A), normal (B) and simple (C) depending on the occupancy time of the railway section by train. The list of recommended time of gaps is shown in Table 1.

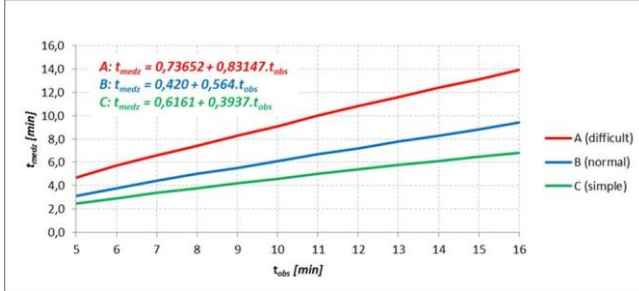
Table 1. Required buffer times t_{obs} [min] according to the Regulations of ŽSR D 24

t_{obs}	5	6	7	8	9	10	11	12	13	14	15	16
A	4,7	5,7	6,6	7,4	8,3	9,1	10,0	10,8	11,6	12,4	13,1	13,9
B	3,1	3,8	4,4	5,0	5,5	6,1	6,7	7,2	7,8	8,3	8,8	9,4
C	2,5	2,9	3,4	3,8	4,2	4,6	5,0	5,4	5,8	6,1	6,5	6,8

Source: [4], authors

Thus, it is evident from Table 1 that with the increasing t_{obs} , the value of the t_{medz} is increasing too, but the slower rate. This property can also be expressed graphically.

Graph 1. Correlation between buffer time t_{medz} and occupancy time t_{obs}



If the calculated value of the buffer time t_{medz} for one average train from the formula (1) is lower than the recommended value according to the ŽSR D 24 (Table 1), then there is a high risk of causing danger of the train traffic diagram quality disruption and its planned feasibility.

Capacity calculation methodology according to UIC 406 Code

Line capacity utilisation, referred to as "capacity consumption", is assessed on the line section and at defined calculation time according to this methodology.

$$\text{Capacity consumption} = \frac{\text{Occupancy time} + \text{Additional times}}{\text{Defined time period}} \cdot 100 \text{ [\%]}$$

In this case of UIC 406 Code formula, the optimal boundary between the use of infrastructure capacity and buffer time, it means the same as t_{medz} in the ŽSR D 24 methodology, is an additional time.

The criteria necessary for determining and assessing the "optimal" additional time are based on the operating characteristics of the existing train traffic diagram and actual delays, as well as in the case of time of gaps in the ŽSR methodology. However, extrapolation of time series may be time-consuming or impossible. For this reason, the standard value of the occupancy time rate was determined as an expression of the required level of services quality provided and is given in percentage expression:

$$\text{Occupancy time rate} = \frac{\text{Occupancy Time}}{\text{Defined Time Period}} \cdot 100 \text{ [\%]}$$

In the graphical process of the train paths compression, UIC 406 Code recommends the standard values of the occupancy time rate according to the type of train traffic on the line as follows:

Table 2. Recommended values of the occupancy time rate

Type of line	Peak hour	Daily period
Dedicated suburban passenger traffic	85 %	70 %
Dedicated high-speed line	75 %	60 %
Mixed-traffic lines	75 %	60 %

Source: [5]

Depending on the occupancy time rate, the recommended values of the additional time rate are given in the following table 3. It is derived from the occupancy time rate.

$$\text{Additional Time Rate} = \left[\frac{100}{\text{Occupancy Time Rate}} - 1 \right] \cdot 100 \text{ [\%]}$$

Table 3. Recommended values of the additional time rate for the types of line

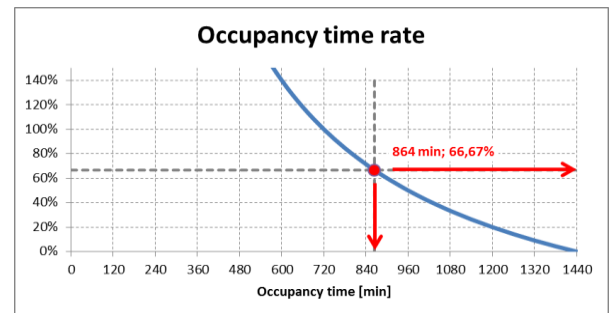
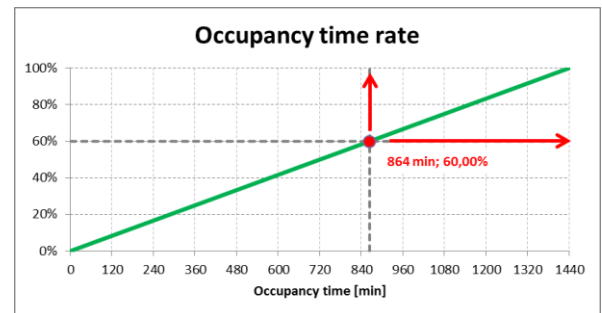
Type of line	Peak hour	Daily period
Dedicated suburban passenger traffic	18 %	43 %
Dedicated high-speed line	33 %	67 %
Mixed-traffic lines	33 %	67 %

Source: [5]

Capacity consumption values reflect the basic concepts of capacity expressed through the train traffic diagram features of individual train paths. Therefore they are used for bottlenecks identification. Therefore, the assessment of the capacity consumption (as well as the recommended weight between the occupancy time and the additional time) will be made according to the relationship:

$$\text{Capacity Consumption} = \frac{\text{Occupancy time} \cdot (1 + \text{Additional Time Rate})}{\text{Defined Time Period}} \cdot 100 \text{ [\%]}$$

Graph 2. Occupancy time rate



Source: authors

The occupancy time rate logically increases by the increasing of occupancy time. It is obvious from the formula (5). But there is evident from the formula (6) that with the increasing occupancy time the value of the additional time rate decreases. Thus, the dependence of the occupancy time rate and the additional time rate from the occupancy time at the constant defined time period can also be expressed graphically (see the graph 2)..

For the defined time period (1440 minutes), the recommended limits for mixed traffic lines(the majority) are indicated in the graphs 2 and 3 according to tables 2 and 3. The limit values and their direction, where the value is exceeded, are indicated red in the graph.

Overall, it can be assessed if the capacity consumption value is below the 100% limit, some of the line section capacity is still unutilised. Otherwise, if the recommended limit values are exceeded (for example Tables and graphs 2 and 3), there is a high risk of the causing danger of the train traffic diagram quality and its planned feasibility.

Comparison of methodologies through the calculations achieved

The presented methodologies for calculating and assessing of the line capacity use different calculation methods to achieve their results, although apparently different parameters are ultimately mutually comparable.

Therefore, the above mentioned methodologies will be referred in practical calculations. Their aim is to maximize the line capacity consumption (according to ŽSR practical capacity, according to UIC the capacity utilisation) using the maximum train paths, while the required quality and stability of the train traffic diagram is maintained. For both methodologies, the delimited time for capacity calculation is 24 hours (1440 minutes), and we do not expect to cut it off by T_{vijl} and $T_{stál}$.

Calculation of the practical capacity according to the methodology of ŽSR D24

If the occupancy time is $t_{obs} = 5$ min, and for a line with complicated ratios (A) is determined average time of gaps for one average train $t_{medz} = 4,7$ min, according to Table 1. Then the practical capacity according to formula (1) is:

$$n_{prakt} = \frac{1440}{5 + 4,7} = 148,45 \cong 148 \text{ trains during 24 hours}$$

Because it is done $T_{obs} = n \cdot t_{obs}$, then the infrastructure occupancy time rate s_o according to formula (2) is:

$$s_o = \frac{148 \cdot 5}{1440} = 0,514$$

The usage of the line practical capacity K_{prakt} converges to 100% (it is counted with the integer value of the trains number and not with the exact number). It can be verified with the following formulas (we put formula 3 into relationship 1 and modify it):

$$K_{prakt} = \frac{n \cdot (t_{obs} + t_{medz})}{T - (T_{vijl} - T_{stál})} \cdot 100 \text{ [%]} \quad (9)$$

$$K_{prakt} = \frac{148 \cdot (5 + 4,7)}{1440} \cdot 100 = 99,69\% \quad (10)$$

The all calculated values of these indicators for all occupancy times (t_{obs}) from Table 1 are as follows in the table 4.

Table 4. Calculation of indicators

t_{obs}	$n_{prakt} = N_{prav}$			s_o			K_{prakt}		
	A	B	C	A	B	C	A	B	C
5	148	177	192	0,514	0,615	0,667	99,69%	99,56%	100,00%
6	123	146	161	0,513	0,608	0,671	99,94%	99,36%	99,51%
7	105	126	138	0,510	0,613	0,671	99,17%	99,75%	99,67%
8	93	110	122	0,517	0,611	0,678	99,46%	99,31%	99,97%
9	83	99	109	0,519	0,619	0,681	99,72%	99,69%	99,92%
10	75	89	98	0,521	0,618	0,681	99,48%	99,51%	99,36%
11	68	81	90	0,519	0,619	0,688	99,17%	99,56%	100,00%
12	63	75	82	0,525	0,625	0,683	99,75%	100,00%	99,08%
13	58	69	76	0,524	0,623	0,686	99,08%	99,67%	99,22%
14	54	64	71	0,525	0,622	0,690	99,00%	99,11%	99,10%
15	51	60	66	0,531	0,625	0,688	99,52%	99,17%	98,54%
16	48	56	63	0,533	0,622	0,700	99,67%	98,78%	98,75%
average:				0,521	0,618	0,682	99,47%	99,45%	99,51%

Source: [4], authors

Calculation of practical capacity according to UIC 406 methodology

The UIC calculation methodology will be also applied to the same times of the line section occupancy. If there is the mixed traffic on the line, the recommended value of occupancy time rate is 60% according to Table 2 and the recommended value of the additional time rate is 67% during the day according to Table 3. Then, according to the formula (5), the value of the line occupancy time is [5]:

$$Occupancy\ time = \frac{Defined\ time\ period \cdot Occupancy\ time\ rate}{100} [min] \quad (10)$$

$$Occupancy\ time = \frac{1440 \cdot 60}{100} = 864\ min$$

Subsequently the additional time value is 576 minutes. It is possible to calculate the practical capacity from these values (similarly as in the previous methodology):

$$n_{prakt} = \frac{Occupancy\ time}{t_{obs}} [vl.T^{-1}] \quad (11)$$

$$n_{prakt} = \frac{864}{5} = 172,8 \cong 172 \text{ trains during 24 hours}$$

The average additional time t_{dod} for one train according to this methodology is:

$$t_{dod} = \frac{Additional\ times}{n_{prakt}} = 3,35\ min$$

$$t_{dod} = \frac{576}{172} = 3,35\ min$$

All calculated values of these measures for all occupancy times t_{obs} from the Table 1 are shown in Table 5. Comparison of the practical capacity calculated according to the UIC methodology and the ŽSR methodology is shown in this table in the differences between the routes, not only in quantitative expressions in number of routes, but also in qualitative expressions - percentage expression.

Table 5. Calculation of indicators

Mixed traffic line					Dedicated suburban passenger traffic				
t_{obs}	n_{prakt}	t_{medz}	paths differences		t_{obs}	n_{prakt}	t_{medz}	paths differences	
(min)	(path)	(min)	(path)	(%)	(min)	(path)	(min)	(path)	(%)
5	172	3,35	-5	97,18%	5	201	2,15	9	104,69%
6	144	4,00	-2	98,63%	6	168	2,57	7	104,35%
7	123	4,68	-3	97,62%	7	144	3,00	6	104,35%
8	108	5,33	-2	98,18%	8	126	3,43	4	103,28%
9	96	6,00	-3	96,97%	9	112	3,86	3	102,75%
10	86	6,70	-3	96,63%	10	100	4,32	2	102,04%
11	78	7,38	-3	96,30%	11	91	4,75	1	101,11%
12	72	8,00	-3	96,00%	12	84	5,14	2	102,44%
13	66	8,73	-3	95,65%	13	77	5,61	1	101,32%
14	61	9,44	-3	95,31%	14	72	6,00	1	101,41%
15	57	10,11	-3	95,00%	15	67	6,45	1	101,52%
16	64	10,67	-2	96,43%	16	63	6,86	0	100,00%
96,66%					102,44%				

Conclusion

There were practiced two capacity methodologies. Despite the different computation methods, their results are relatively similar. Current minor differences between the results of these methodologies are caused only by the limit of the acceptable line occupation time, limit of the required time of gaps. Practically, we can accept the UIC 406 and implement its methodology into national practices to estimate the practical capacity at ŽSR lines.

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APPLICATION OF THE THEORY OF INVARIANCE FOR NOISE-RESISTANCE ESTIMATION OF TRANSPORTATION INFORMATION SYSTEMS

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Abstract: *In the present paper is defined the functional stability of the communication systems for radio connection in the railway transport. It is associated with the possibilities for the realization of the principles of invariance within signal – noise environment altering itself.*

Keywords: INFORMATION SYSTEMS, TRANSPORT, FUNCTIONAL STABILITY, INVARIANCE, NOISE-RESISTANCE .

1. Introduction in the problem

Information systems in some important production sectors, such as transport, production and distribution of electricity, etc., are crucial for their correct and reliable functioning. They required providing for the relevant security level and functional safety.

The traditional methods, based on multiple reservations, bringing into use systems for “built-in” control, and elements with enhanced security level, are insufficient.

For instance, the mobile systems for radio contact in the railway transport are distinguished on the one hand by functioning under extremely arduous and complex conditions with complex influence exerted by strong fluctuative, concentrated, impulse disturbances [4] in the grid – circuit as well as the operation of multiple devices while on the other hand by utilizing high level of reliability of the information being transferred which is related to the traffic safety. In relation to that, the development of approaches and methods capable of providing for reliability assigned in advance and guaranteed level of jamming resistance respectively is of exceptionally high interest and special actuality.

In the present paper, the mobile communication systems’ capability of preserving characteristics’ qualities of the jamming resistance property within certain bounds, while altering static characteristics of the random parameters, as well as varying both shape and parameters of the signal and the disturbances, is defined as functional stability [1,2,3].

It means that the given quantity of the system functioning is achieved thanks to the independency (partial or complete) of the performance of the noise-resistance from reasons causing the non-stationary state of the channel of connection. This ability of the system to oppose resist against the disturbing actions is known as invariance [2,3].

In this paper the functional stability of the mobile systems for radio connection in the railway transport is associated with the possibilities for the realization of the principles of invariance within signal – noise environment altering itself.

2. Connection between functional stability of the communication system and theory of invariance

The problem of functional stability of the radio – communication systems for mobile radio connection establishment has been defined and given proof on in the [1,2]. Besides, as it has been mentioned in [1], the distinction between the problems of functional stability of the automatic control systems and suggested radio – communication systems must be emphasized in particular.

In the automatic control systems, both disturbances and control signals are spatially divided in main. This allows one to measure as well as estimate the disturbances regardless its random nature. Also, this allows one to utilize different compensational methods to realize their invariance regarding the disturbances distinguished by conditions and methods being employed in achieving the invariance [2].

In addition, it is also necessary to mention that the notion “invariance,” being the main component and the goal the functionally stable control is to achieve, requires refinement in

relation to which one of the control system’s numerical characteristics is an invariant as well as which transformations or influences the system is invariant towards.

In case of radio – communication systems, the disturbances themselves in a broad sense play a certain part as disturbances: the different kind of noise, superposing the received signal, as well as random alterations of characteristics and parameters of both the communication channel and the signal influencing the jamming resistance. In that case, the system’s characteristic that should be invariant to the disturbances is its jamming resistance being equalized quantitatively to the error probability during digital communications.

At the same time, it should be emphasized that in the communication systems, in contrast to the automatic control systems, the useful signal and the disturbance react upon the same point, i.e. the receiver input oftentimes, and could not be divided thoroughly. In the opposite case, it could be mentioned that the problem of struggling against the disturbances would not exist.

In the radio – communication systems, it is all about a composite between a signal and noise since the white noise is always available as additive. The parameters of the additive disturbance determine at first hand the jamming resistance of the communication system. If it were a non-stationary random process, the level of thrust-worthiness of the information transmitting process would be altered. For instance, if the disturbance power increased in time, the error probability of information transmitting would get increased as well. The non – additive disturbances lead to relevant alteration of the particular parameters of both signal and channel. Since the channel parameters alteration could be expressed through the relevant alteration of signal parameters, the non – additive disturbances exert influence on the jamming resistance while the receiving conditions are getting either deteriorated or improved, yet this alter the error probability.

This is why building functionally stable radio – communication systems with invariant, in relation to the disturbances complex influence, parameters and characteristics, requires for a variety of reasons another formulation and approach to be met as compared to the problem of functional stability of the automatic control systems.

Such a fundamental characteristic of the system for official radio contact with mobile objects, such as the jamming resistance, could not represent thoroughly the system’s qualitative functioning. For this purpose, it is necessary to introduce indicators that would allow the system’s ability to preserve characteristics’ qualities of the jamming resistance within certain bounds, while altering the parameters of the signals and disturbances.

On the present level of growth of the mobile radio – communication systems, operating under conditions of complex influence exerted by disturbances, development of methods for increasing the jamming resistance is related to usage of signals with complex structure, channels with adjustable feedback, and synthesis of special algorithms [1,3], minimizing the influence exerted by disturbances on the jamming resistance. On these lines, looking into algorithms of information being transmitted through noise – like signals with optimized structure, permitting warranty related to the working capability of the system in a variety of situations rendering into account the static characteristics of the signal, the channel, and

the noise environment, is topical in particular. This approach is related to two – dimensional (frequency – temporal) coding of each signal parameter: by means of either forming pseudo – stable switching between the operative frequencies or usage of pseudo – random sequences manipulating the signal's phase [5,6]. Using either of the mentioned complex signals allow one to increase significantly both the jamming resistance of the radio systems, at the expense of introducing multiple frequency – temporal surplus within the signal, and the relevant complication arising during the signal's processing by the receiver.

Under conditions of work of businesses radio communication systems for transmitting information with security reliability in the railway transport, the decisive factor is the influence of the impulse disturbances during signals receiving [2,3]. This influence reveals itself during spontaneous alteration of the dispersion as well as failures of the adaptive devices of spatial – frequency – temporal signals' processing which signals are generated assuming that the received mixture is quasi – stationary and Gauss one (in common sense) [7].

As a result of that, the efficiency of the radio system is getting vastly deteriorated under the influence of these signals. It must be borne in mind that the indicators of the jamming resistance (the weighted error of the signal's reproduction and the probability of wrong decision to be taken by the demodulator regarding the discrete message being transmitted) are not completely adequate to the real conditions the connection is established under. In the non – stationary channels of the systems for mobile radio connection establishment, the relation "signal/noise" is altered during the system's functioning process. Therefore, the determined in this way reliability is also getting altered. If these alterations could be neglected within the time interval of message transmitting, the channel is considered as locally stationary one. In addition to either the weighted error or the probability of wrong estimation of the jamming resistance, it is necessary one to determine what the trust probability that the values of these variables will not exceed the limit is. During the effect of impulse disturbances, the constancy of the ratio "signal/noise" is violated by powerful momentary peaks within the electromagnetic field of the disturbances. These peaks dramatically change the ratio and evaluation of the acquired specific resistance (jamming resistance) traits.

In radio channels, intended to establish connection to mobile objects, the probability of error is variable quantity (heterogeneous channel with variable characteristics). In this case, even if securing the average probability of error less than assigned limit were successful, the probability of error could be set greater than permissible value. Furthermore, regarding all mobile channels, reducing the average probability of error does not show clearly improving the quality of the system's functioning. For example, if the percentage of cases of error probability were getting greater than admissible value, along with reducing the average probability of error allowance, the jamming resistance of the system would get decreased. It follows that, in particular, optimization of the radio system, in accordance with the widely used criterion for the minimum average probability of error, does not provide the best quality of operation of the real system in the radio channel with variable parameters. To ensure an acceptable quality of functioning of the real system in the radio channel with variable characteristics, it is necessary to maintain the probability of error at a level not exceeding a preset limit. In essence, this means that the specified quality of the system functioning is achieved due to error likelihood independence (partial or complete) of causes for non-stationary nature of the communication channel.

This standard, known as the invariance, is a property of the system to oppose the disturbing effects.

In the most general case, if the initial system coordinate $y(t)$ for any point in time t does not depend on the disturbance $f(t)$, the system will be possessed by absolute invariance regarding $f(t)$, i.e:

$$y(t) = \text{invar}[f(t)]. \quad (1)$$

If this property is fulfilled roughly (in a certain sense) then the invariance will be accurate up to ε and the system will be relatively invariant, i.e:

$$y(t) = \text{invar}[f(\varepsilon)]. \quad (2)$$

The concepts of "invariance" and "functional stability" are interrelated. If one examined invariance of the jamming resistance characteristics, put in the form of functional dependence of the error probability of both the signal's and disturbances' parameters, in which case the system has characteristic of the jamming resistance being absolute invariance in relation to a definite class of disturbances, the study of functional stability would become futility. If the system has an invariant characteristic then the relative invariance and functional stability will be thought as concepts being largely equivalent.

3. Defining of conditions of invariance of the performance of noise-resistance

For a radio channel, the typical situation is the one where the performance of noise-resistance is determined by the presence of disturbances of several classes (fluctuating, spectrum-concentrated, impulse). The functional kind [3] of the expression of the error probability with receiving by elements depends on the sets of signal parameters, the disturbances and the interaction between them :

$$P = \left\{ \bar{h}_i^2 \right\} \left\{ \bar{h}_\zeta^2 \right\} \bar{G}_{ij}^2, \quad (3)$$

where $\bar{h}_i^2$ and $\bar{h}_\zeta^2$ express the mean statistical properties of the ratios between the energies of the i -th signal variant and the j -th disturbance variant and the white noise spectral density.

The part of parameters of interaction between the signal and disturbances is played by set $\{ \bar{G}_{ij}^2 \}$, $i=1 \div n$, $j=1 \div n_\zeta$, average statistical values of the coefficients of the reciprocal differences in the frequency-and-time area of their structures.

As the degree of the interaction between the useful signal and the disturbance on the frequency-and-time plane is analogous to their mutual correlation function, it is suitable to assume the average statistical value of the mutual difference coefficient in the position of interaction between them. This value is expressed in the kind of [3]:

$$\bar{G}_{ij}^2 = \left[\frac{K_0 K_\zeta}{2P_i T} \int_0^T \dot{S}_i(t) \Sigma_{\zeta_j}^*(t) dt \right]^2, \quad (4)$$

where K_0 , K_ζ , are the amplitude coefficients of the signal and disturbance, $T = \tau_0 N$ is the signal length, $\dot{S}_i(t)$ and $\Sigma_{\zeta_j}^*(t)$ are the complex functions of the i -th signal and j -th disturbance,

$$P_i = \frac{K_0^2}{T} \int_0^T s_i^2(t) dt \quad (5)$$

is the average power of the i -th signal variant.

The conditions of the invariance of the connection system are expressed in relation to a certain class of disturbances and in dependence with the metrics selected on the signal space.

If $n(t)$ and $\zeta(t)$ are random realizations of fluctuation noise $\{N\}$ and quasi-determined interferences $\{\Xi\}$ respectively, then the performance of noise-resistance is a function of both interferences:

$$P = P(N, \Xi). \quad (6)$$

The system of connection is absolutely invariant to $\zeta(t)$, if :

$$P(n, \zeta) = P(n, 0) = P(n) \quad (7)$$

is fulfilled.

When the noise-resistance characterization depends on interferences Ξ to a certain extent, e.g.:

$$|P(n, 0) - P(n, \zeta)| \leq \varepsilon, \quad (8)$$

then the system is relatively invariant (invariant to ε), where ε presents the given distance between $P(n, \zeta)$ and $P(n, 0)$:

$$\varepsilon = \max_{\zeta} |P(n, \zeta) - P(n, 0)|. \quad (9)$$

4. Conclusion

The functional stability is a broader concept which is associated with the investigation of possibilities opened up by the development of modern element base for the realization of the principles of invariance within signal – noise environment altering itself

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ИЗСЛЕДВАНЕ И ОЦЕНКА НА РИСКА НА ЕЛЕКТРОННО БАЗИРАНАТА СИСТЕМА ЗА ДИСТАНЦИОННО ОБУЧЕНИЕ НА НВУ „ВАСИЛ ЛЕВСКИ“

RESEARCH AND ASSESSMENT OF THE RISK OF VASIL LEVSKI NATIONAL MILITARY UNIVERSITY'S DISTANCE LEARNING SYSTEM

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Резюме: В настоящия доклад се изследва и оценява риска на електронно базираната система за дистанционно обучение на НВУ „Васил Левски“ при максимално натоварване като се използва SWOT – анализ. Целта му е да се оценят външните условия (благоприятни възможности - заплахи) и вътрешните условия (силни страни - слаби страни) на организацията. Представеният SWOT - анализ е разработен въз основа на експертни оценки, получени в резултат на проведено проучване.

Ключови думи: ДИСТАНЦИОННО ОБУЧЕНИЕ, РИСК ПРИ МАКСИМАЛНО НАТОВАРВАНЕ, SWOT - АНАЛИЗ

1. Увод

Изследването на електронно базираната система за дистанционно обучение на НВУ „Васил Левски“ и оценката на риска изисква тестване на системата в реални условия при максимално натоварване при провеждане на първи семестър за дистанционно обучение в пет магистърски програми.

За целта се извърши преглед на технологичните и функционални характеристики на модернизирания център за дистанционно обучение и неговите възможности за предоставяне на електронни форми на обучение в пет нови магистърски програми. Ключов елемент в рамките на тази дейност беше подготовката на 10 администратори на залите за дистанционно обучение, които трябва да обезпечават приспособяването и поддръжката на информационните системи при предоставяне на дистанционно обучение. Като част от дейността се извърши апробиране на отделни дисциплини в реални условия, като едновременно с това се направи адекватна оценка на рисковете при натоварване и максимално използване на информационната система. Приеха се 153 студенти, които успешно завършиха първи семестър в дистанционно обучение в пет магистърски програми. Провеждането на дистанционно обучение е обезпечено с преподавателски състав – 30 преподавателя за първи семестър, 10 администратора, учебни материали за присъствено и дистанционно обучение по 29 учебни дисциплини, както и с материали за самоподготовка на студентите и провеждане на изпити.

Целта на настоящата разработка е да се изследва електронно базираната система за дистанционно обучение на НВУ „Васил Левски“ и да се оцени риска при максимално натоварване на системата при провеждане на първи семестър в пет магистърски програми.

Първият семестър на обучение в петте магистърски програми приключи като средния успех по всяка магистърска програма е, както следва:

- Стопанска логистика – 5,38
- Национална и регионална сигурност – 5,13
- Индустриален мениджмънт – 5,49
- Административна и информационна сигурност – 5,06
- Авиационна техника и технологии – 4,06

От средният успех по всяка от петте магистърски програми е видно, че обучението в дистанционна форма на обучение по

проекта е преминало на много добро ниво с реални резултати много добра успеваемост на студентите.

Изследването на системата за предлагане на електронни форми на дистанционно обучение в реални условия и оценката на риска при оптимално натоварване при провеждане на първи семестър за дистанционно обучение в петте магистърски програми се налага от гледна точка на установяване на ефективността на функциониране на системата, отчитане на „слабите“ места в нея, които трябва да бъдат коригирани, избор на верни стратегически и оперативни решения и актуализиране на стратегията за развитие.

2. Методология за изследване на функционирането на електронно базираната система за дистанционно обучение на НВУ „Васил Левски“ и оценка на риска.

Изборът на стратегическо решение и изборът на стратегия за развитие изобщо е изключително важен компонент в управленческата дейност за дистанционното обучение, особено в съвременните условия на динамично развитие на обществените процеси, технологиите и потребностите, в условията на силно конкурентна среда, глобализация и трансфер на производствените, финансовите, материалните и информационните ресурси. Целесъобразният стратегически избор, основан на надеждна прогноза, е единственото вярно условие и гаранция за успешно развитие в отговор на новите предизвикателства. Всеки университет, предлагащ дистанционно обучение днес се нуждае от ясно формулирани мисия, цели, приоритети и стратегически направления за своето бъдещо съществуване и просперитет.

За да се очертае правдива и точна стратегическа насока за развитието на организацията (университетите се явяват вид организация) са разработени и съществуват голямо разнообразие от подходи и модели. Съществуват десет основни школи, поддържащи и развиващи концепции и методи за формулирането на стратегии – от такива, които указват, учат, предписват, претендират да са ръководства за....., как да се формира стратегията, до такива, които се стремят да обяснят как стратегията се формира фактически на практика или до разглеждането на стратегията като процес, като нещо непостоянно, което се формира в зависимост от времето и обстоятелствата и може да обхваща анализ, размишление, политика, планиране, визия или интуиция и всякаква друга възможност за стратегически избор, зависеща от времето и контекста.

Първата група школи включват: „стратегия на големия модел“ – най-разпространения възглед за процеса на

формирането на стратегия, който се асоциира най-вече с Harvard Business School; „стратегията като план” – с най-влиятелния си представител Игор Ансоф и „стратегията като позиция” – от Сун Цзъ до Бостънската матрица и моделите на Майкъл Портьър, който си поставя за задача да опише „какви стратегии най-добре съответстват на конкретни и на всякакви обстоятелства”.

Стратегията е резултат на съзнателен и щателен мисловен процес. Текущите цели и задачи се проверяват в най-добра степен, чрез SWOT - анализа (силни, слаби страни, възможности и заплахи), след което се определят стратегическите алтернативи. Впоследствие тези алтернативи се оценяват в различни аспекти и се извършва стратегическия избор (фигура 1).



Фиг. 1 Основни елементи на процеса на стратегическото решение

Ключов момент в процеса на стратегическото решение е SWOT - анализа. Целта му е да се оценят външните условия (благоприятни възможности - заплахи) и вътрешните условия (силни страни - слаби страни) на организацията. Резултатите от ситуационния анализ позволяват да се уточнят и по-ясно да се открият приоритетите и целите от една страна и да се подпомогне избора на стратегия – от друга.

При разработване на SWOT - анализ на системата за дистанционно обучение трябва да се даде отговор и на следните въпроси:

1. Кои са рисковете и ограниченията, които правят системата за дистанционно обучение уязвима, пречат ѝ да бъде максимално ефективна и намаляват нейните резултати?
2. Кои са дисбалансите на системата за дистанционно обучение?
3. Кои са заплахите за системата за дистанционно обучение и как могат да се използват като възможности?
4. Защо системата за дистанционно обучение е уязвима от външни и конюнктурни обстоятелства?

Доколкото очакваните резултати от SWOT - анализа са достатъчно конкретни, необходимо е провеждането му да се осъществи максимално точно и прецизно и да завърши с ясни и недвусмислени изводи и препоръки.

SWOT-анализът е подходящ да се използва на промеждутъчния етап на изследването – за задълбочаване на анализа за състоянието на системата за дистанционно обучение.

Стратегическото управление като категория и като фактическо приложение, все по-осезателно и все по-настойчиво се нуждае от развитие на методите и техниките за методично изследване и изброяване на всички възможни изменения в главните променливи, както на средата, така и на самата система за дистанционно обучение, а също да се направи пълен списък на възможните алтернативи за разрешаване на стратегическия проблем.

Очевидна е необходимостта за развитието на моделите, подпомагащи вземането на стратегически решения и най-вече в посока на усъвършенстване на техниките за практическото им приложение.

Обичайно следваната практика на SWOT - анализа е след разкриване на силните и слабите страни (вътрешни рискове) на организацията и външните фактори – благоприятни възможности и заплахи (външни рискове), да се позиционират елементите на вътрешния фокус спрямо тези от външния фокус в табличен или графичен вид като се образува т.н. swot-матрица или матрица на състоянието. Очертават се четири зони (квадранти) на възможни състояния: силни страни – възможности, силни страни – заплахи (външни рискове), слаби страни (вътрешни рискове) – възможности и слаби страни (вътрешни рискове) – заплахи (външни рискове). Тези четири зони образуват пространството на стратегическите опции. Възможните стратегически решения се анализират във всяка от зоните поотделно и се определят (интуитивно, евристично) печелившите стратегии – стратегическия портфейл.

Аналитичната интерпретация на SWOT - анализа създава много добри предпоставки за симулационно и компютърно моделиране на процеса и дава възможност за подробно и задълбочено изследване на вътрешните характеристики на дистанционното обучение и съпоставянето им с външните условия с цел формулиране на адекватни и надеждни прогнози и стратегически алтернативи, както и за определяне на главната стратегическа насока за развитие.

Възможности още по-успешно могат да се реализират и в светлината на динамичния SWOT - анализ. Разработването на координатните модели на ситуационния анализ в различни точки на времето ще доведе до резултати, които ще отразяват коректно бързо изменящите се условия на средата и ще очертаят стратегическия планов хоризонт, за който са поставени приоритетите и главните цели на дистанционното обучение.

Предлаганият метод за SWOT - анализ има за цел да улесни стратегическия избор при разработване на дългосрочна стратегия за развитие на дистанционното обучение в НВУ „Васил Левски”.

Методът SWOT - анализ може да преобразува комплексната, трудна процедура за оценка на често качествени, сложни и взаимовлияещи си фактори, за какъвто се счита ситуационния анализ, в точна и надеждна, компютърно базирана програма за всеобхватно изследване на състоянието на организацията и за прогнозиране на нейното развитие.

Главната функция на SWOT - анализа е да поддържа процеса на разработване на стратегията, а не да заменя процеса на разработване на стратегията.

3. SWOT - анализ на системата за дистанционно обучение в НВУ „Васил Левски”.

Представеният SWOT - анализ е разработен въз основа на експертни оценки, получени в резултат на проведеното проучване (Таблица 1.)¹. За всеки от показателите, включени в SWOT - анализа е поставена оценка от 1 до 5, в зависимост от неговата значимост.

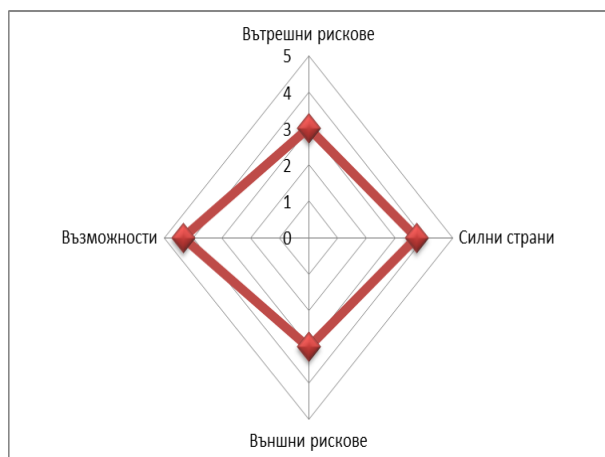
Таблица 1. SWOT – анализ на системата за дистанционно обучение в НВУ „Васил Левски”.

Силни страни, оценка	Вътрешни рискове, оценка
1.Осъзнаване на важната роля на дистанционното обучение като източник на конкурентни	1.Риск от липса на достатъчно опит на част от преподавателите в дистанционна форма на

¹ Проучени са експертните мнения на ръководителя и специалистите от Центъра за дистанционно обучение в НВУ „Васил Левски”, преподаватели, провели първи семестър на дистанционно обучение по петте магистърски програми и студенти, обучаващи се през първи семестър на дистанционно обучение.

предимства за университета - 5 2.Стремеж към преценка на приоритетите, нови конкурентни стратегии и нови начини на обучение на студентите в условията на икономическа криза - 3 3.Стремеж към максимално използване на възможностите на системата за дистанционно обучение с цел повишаване на удовлетвореността на студентите и привличане на нови студенти - 4 4.Осъзнаване, че по-високите разходи и усилия за разработване и предлагане на различни форми за обучение, самооценка и оценка са оправдани - 3 5.Предлагане на разнообразни и удобни за клиента начини за контакт с преподавателя - 2 6.Стремеж към обновяване на учебния материал и формите за обучение, самооценка и оценка - 4 7.Инвестиране в материалната и морална мотивация на преподавателите и административния персонал на системата - 5 8.Отчитане на важността на отделните елементи на дистанционното обучение – преди, по време на, и след приключване на семестъра - 2 9. Точно отчитане на факторите, влияещи върху разработването учебните материали за дистанционно обучение - 4 10. Анализиране на ефективността на дистанционното обучение от гледна точка на рентабилността за университета и удовлетвореността на обучаемите - 4 11.Използване на различни начини за рекламиране и представяне на програмите, предлагани в дистанционна форма на обучение в университета - 5 12.Осъзнаване на важността на добрата подготовка на учебните материали, провеждането на консултации с преподавателите и организацията на учебния процес, чрез системата като фактори за привличане и задържане на студентите - 5 13.Осигуряване на оптимален брой преподаватели и административен персонал от гледна точка на удовлетвореността на студентите и финансовите средства - 3 14.Предлагане на комбинация от методи и средства за обучение, самооценка и оценка, които са задължителни за всеки студент и такива по избор на студента - 2 15.Наличие на модернизирания център за дистанционно обучение и пет оборудвани зали за дистанционно обучение по отделните магистърски програми -	обучение - 2 2.Риск от недостатъчно добро качество на някои учебни материали от гледна точка на пълното съответствие между теми, тестове, задачи и казуси - 4 3.Риск от избора на най-подходящата форма за провеждане на текущ контрол и семестриален изпит - 5 4. Риск от недостатъчно ниво на интеграция, координация и синхрон между преподавателския и административния състав - 4 5.Риск от недостатъчен опит на преподавателския състав в провеждането на ефективни консултации с обучаемите - 2 6.Риск от трудности при поддържането на оптимален брой на персонала, извършващ административното обслужване на дистанционното обучение основно поради финансови проблеми - 3 7.Риск от проблеми с персонала – преподавателски и административен - 2 8.Риск от слабо разнообразие и стремеж към обновяване на предлаганите методи и средства за обучение в дистанционна форма - 4 9.Риск от липса на опит при използване на научни методи за анализ и оптимизиране на обучението в дистанционна форма - 3 10.Риск от технически проблеми при функционирането на системата - 3 11.Риск от недостатъчно надеждни доставчици на техника и техническо обслужване на системата за дистанционно обучение - 4 12.Риск от недостиг на финансови средства - 2 13. Риск от текучество на преподавателския състав - 1 14.Риск от предприемане на икономии, които застрашават пазарните позиции на университета и съответно предлаганата от него дистанционната форма на обучение - 3	4 16.Осъзнаване на необходимостта разработването на политиката за дистанционно обучение да се прави съвместно от специалистите от центъра за дистанционно обучение, преподавателите и ръководството на университета - 5 17.Системно проучване на студентите в различни направления – удовлетвореност от обучението, мотиви, предложения и други - 3 18.Осъзнаване на необходимостта от разработване на маркетингова програма за управление на взаимоотношенията с настоящите и бъдещи студенти - 3 19.Подобряване на конкурентоспособността на университета - 5	
		Възможности, оценка	Външни рискове, оценка
		1.Мотиви на студентите за обучение в дистанционна форма в университета, свързани основно атрактивността на предлаганите магистърски програми - 4 2.Повишаване на ефективността на обучението в дистанционна форма и удовлетвореността на студентите, чрез повишаване на квалификацията на преподавателския и административния персонал - 5 3.Подобряване на позициите на университета, на основата на обучението в дистанционна форма, чрез постепенно увеличаване на предлаганите магистърски програми - 4 4.Подобряване на позициите на университета, на основата на обучението в дистанционна форма, чрез предлагане на обучение за получаване на ОКС „бакалавър” - 5 5.Подобряване на позициите на университета, на основата на обучението в дистанционна форма, чрез предлагане на съобразени с изискванията и възможностите на студентите, включително финансови, условия при възможно най-ефективен за университета разходен модел - 4 6.Трайно очертаваща се тенденция, както в света, така и в страната към предпочитание от страна на студентите към дистанционна форма на обучение - 4	1. Риск от силна конкуренция, както от български, така и от чуждестранни университети, които предлагат дистанционна форма на обучение - 5 2.Риск от финансовата и икономическата криза, която рефлектира върху финансовите възможности на студентите - 3 3.Риск от демографската криза в страната, която намалява броя на студентите в национален мащаб - 3 4.Риск от вдигане на цените на суровините и горивата, което се отразява върху разходите на университета и съответно влияе върху таксите за обучение - 1

Разгледаният SWOT - анализ е представен графично на Фигура 2.



Фиг. 2. SWOT - анализ на системата за дистанционно обучение в НВУ „Васил Левски“ и рисковете при нейното функциониране.

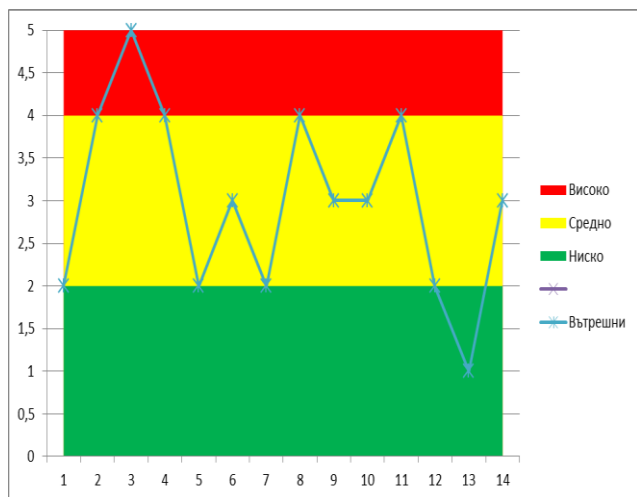
От Таблица 1. е видно, че развитието на системата за дистанционно обучение в НВУ „Васил Левски“ изисква целенасочена работа в следните насоки:

- Поддържане и усъвършенстване на положителните условия и тенденции в дистанционната форма на обучение;
- Набелязване на мерки за постепенно преодоляване на рисковете и слабостите в самото дистанционно обучение и в условията за неговото осъществяване;
- Проучване и анализ на положително влияещите фактори от макросредата и възползване от тях в максимално възможна степен;
- Проучване и анализ на негативно влияещите фактори от макросредата и набелязване на мерки за намаляване на отрицателните последици.

От Фигура 2. е видно, че направеният SWOT - анализ показва много добри възможности за развитие. Необходимо е, обаче още целенасочена работа за доразвиване на силните страни и за минимизиране на вътрешните и външните рискове.

4. Оценка на рисковете при функционирането на електронно базираната система за дистанционно обучение на НВУ „Васил Левски“.

На Фигура 3. са представени вътрешните за системата рискове.



Фиг. 3. Вътрешни за системата рискове, разделени по зони на тежест

От Фигура 3. е видно, че с най-голямо значение са следните, вътрешни за системата рискове – оценка 4 и 5:

- Риск от избора на най-подходящата форма за провеждане на текущ контрол и семестриален изпит – оценка 5.
- Риск от недостатъчно добро качество на някои учебни материали от гледна точка на пълното съответствие между теми, тестове, задачи и казуси – оценка 4.
- Риск от недостатъчно ниво на интеграция, координация и синхрон между преподавателския и административния състав – оценка 4.
- Риск от слабо разнообразие и стремеж към обновяване на предлаганите методи и средства за обучение в дистанционна форма – оценка 4.
- Риск от недостатъчно надеждни доставчици на техника и техническо обслужване на системата за дистанционно обучение – оценка 4.

Представените рискове са управляеми и преодолими. Те, обаче изискват целенасочена работа, свързана с ефективното управление на системата на дистанционно обучение в НВУ „Васил Левски“ по отношение на мотивацията и квалификацията на преподавателския състав, стимулиране на честите контакти между преподавателския и административния състав, изискване на периодична обратна връзка със студентите и строг контрол при избор на доставчици на техника и техническо обслужване.

Със средна тежест са рисковете с оценки 2 и 3:

- Риск от трудности при поддържането на оптимален брой на персонала, извършващ административното обслужване на дистанционното обучение основно поради финансови проблеми – оценка 3.
- Риск от липса на опит при използване на научни методи за анализ и оптимизиране на обучението в дистанционна форма – оценка 3.
- Риск от технически проблеми при функционирането на системата – оценка 3.
- Риск от предприемане на икономии, които застрашават пазарните позиции на университета и съответно предлаганата от него дистанционната форма на обучение – оценка 3.
- Риск от липса на достатъчно опит на част от преподавателите в дистанционна форма на обучение – оценка 2.
- Риск от недостатъчен опит на преподавателския състав в провеждането на ефективни консултации с обучаемите – оценка 2.
- Риск от проблеми с персонала – преподавателски и административен – оценка 2.
- Риск от недостиг на финансови средства – оценка 2.

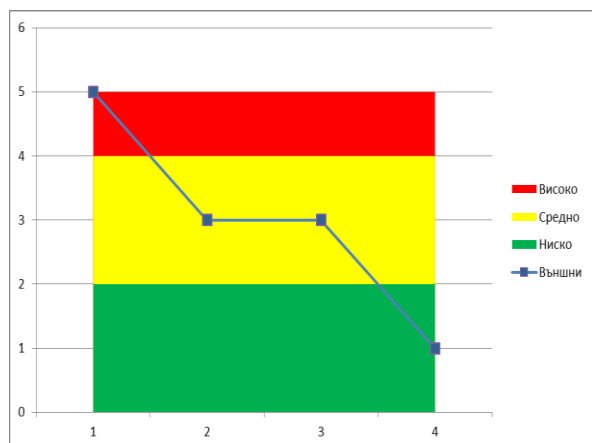
Рисковете със средна тежест са преодолими, но не трябва да се подценяват. Основното при тях е да се осъзнае ролята на дистанционното обучение в НВУ „Васил Левски“ като източник на конкурентни предимства на пазара на висшето образование в страната и на тази основа - необходимостта от инвестиции в него.

Най-малък е риска от текучество на преподавателския състав – оценка 1. Принципно такъв риск съществува, ако той е с по-голяма оценка. Големото текучество на преподавателския състав като краен резултат води до влошаване на качеството на обучение.

Но за НВУ „Васил Левски“ този риск е минимален, тъй като текучеството на преподавателския състав е изключително

малко. Хабилитираните преподаватели и тези с ОКС „Доктор” работят в продължение на години, продължават традициите в обучението и предават своя опит на по-младите си колеги.

Не трябва да се подценяват и външните за системата рискове – тези, които произтичат от макросредата. – Фигура 4.



Фиг. 4. Външни за системата рискове, разделени по зони на тежест.

От Фигура 4. е видно, че логично, с най-голяма тежест е риска от силна конкуренция, както от български, така и от чуждестранни университети, които предлагат дистанционна форма на обучение – оценка 5. Този риск е изключително сериозен като се има в предвид все увеличаващото се предлагане на дистанционна форма на обучение в страната и по света. В същото време, търсенето от страна на студентите на обучение в дистанционна форма също нараства, поради предимствата, които то предлага. В резултат, решението е в предлагане на качествено обучение в дистанционна форма в НВУ „Васил Левски” по атрактивни за студентите специалности и съобразени с възможностите на студентите такси за обучение.

Рисковете от макросредата със средна тежест са:

□ Риск от финансовата и икономическата криза, която рефлектира върху финансовите възможности на студентите – оценка 3.

□ Риск от демографската криза в страната, която намалява броя на студентите в национален мащаб – оценка 3.

Тези рискове са сериозни, но те трябва да се приемат от университета като фактори, които трябва да проучва и да се съобразява с тях. Тези рискове са неуправляеми сами по себе си за университета, но с целенасочена и адекватна конкурентноспособна политика може да се намали тяхното негативно влияние.

Можем да обобщим, че е целесъобразно да се обърне особено внимание на вътрешните и външните рискове, които влизат в зоната на високите рискове и да се предприемат мерки за тяхното намаляване. Същата, но по-умерена политика трябва да се предприеме и към вътрешните и външни рискове, които попадат в средната зона.

На основата на направения анализ на състоянието на системата за дистанционно обучение в НВУ „Васил Левски” и оценка на риска можем да направим извода, че е целесъобразно да се разработи и реализира ефективна конкурентна стратегия и политика за дистанционно обучение в университета в следните стратегически направления:

□ Изучаване и определяне на практиката на конкурентните университети при дистанционното обучение за всеки пазарен сегмент, образователно-квалификационна степен – бакалавър и магистър, професионално направление и специалност;

□ Определяне и оценка на ключовите елементи на дистанционното обучение, които ще превърнат университета в предпочитан образователен център;

□ Оценка на дистанционното обучение за всяка образователно-квалификационна степен – бакалавър и магистър, професионално направление и специалност по отношение на пазарен дял и рентабилност;

□ Проверка и оценка на всеки от елементите и аспектите на дистанционната форма на обучение;

□ Избор и формулиране на най-подходящата за университета конкурентна стратегия за дистанционна форма на обучение – лидерство в разходите, диференциация или фокусиране;

□ Приемане на програма за дистанционна форма на обучение, която да осигурява оптимални приходи при задържане и постоянно увеличаване на студентите с възможно най-ниски разходи и отчитане на бюджетните ограничения и ограниченията по отношение на таксите за обучение;

□ Извършване на системен, цялостен контрол и оценка на резултатите от дистанционното обучение, установяване на отклоненията от приетите стандарти и правила, както и от стратегията и политиката на университета, разкриване на причините за тези отклонения и приемане на решения за коригиране на действията, съобразно конкретната ситуация.

5. Заключение

В заключение считаме, че резултатите от анализа на системата за дистанционно обучение в НВУ „Васил Левски” и оценката на риска при максимално натоварване при провеждане на първи семестър за дистанционно обучение в пет магистърски програми, са положителни. Рисковете с най-голяма тежест са управляеми и преодолими, но изискват амбиции и желание от страна на ръководството на университета, преподавателския и административния състав за систематичното им оценяване и елиминиране.

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COMPARATIVE ANALYSIS SECURITY OF MOBILE DEVICES

СРАВНИТЕЛЕН АНАЛИЗ НА СИГУРНОСТТА В МОБИЛНИ УСТРОЙСТВА

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Abstract: The popularization of smartphones and tablet, and their increasing usage turns them into an attractive target for cyber attackers. This, together with the fact that many organizations employ a Bring Your Own Device (BYOD) policy, make assessing and comparing the security of mobile devices a key issue, in particular in what regards user-defined configurations as these have a huge impact on the potential attack surface. Preliminary results show that Android users neglect important security recommendations while configuring their devices and that benchmarking is indeed a good way to identify the most secure user-defined configuration.

Keywords: MOBILE DIVICES, SECURITY CONFIGURATION,

1. Въведение.

Мобилните устройства (таблети и смартфони) са все по-привлекателна цел за кибератаки [1], причината за това е популярността и текущото им непрекъснато използване. Наред с други дейности: онлайн банкиране, социални мрежи, развлечения, снимки, обмен на текстови и мултимедийни съобщения, купуване на приложения, филми или книги, те са ключово устройство за съхранение на поверителна информация, което от своя страна създава нови проблеми със сигурността и поверителността [2]. На практика мобилните устройства притежават много от традиционните характеристики на персоналните компютри, но също така включват разнообразни технологии за свързване като GSM (Global System for Mobile Communications), GPRS (General Packet Radio Service), NFC (Near Field Communication), Bluetooth и WiFi, както и други сензори и хардуер, като жирокопи, GPS (Global Positioning System), вградени камери и микрофони, като всичко това е в едно по-малко и по-леко устройство. Тъй като такива характеристики улесняват и увеличават шансовете за атака, кражба или изгубване на устройството, потребителите на мобилни устройства трябва да са запознати с разкриването на данни или проблемите с изтичането на информация, което налага необходимостта от нови механизми и инструменти за сигурност, включително техники за оценка на дадена системна конфигурация.

За сравнителния анализ на дефинирана от потребителя конфигурация за сигурност на мобилните устройства, трябва да могат да се сравняват и да се класират мобилните устройства според техните характеристики. Сравнителен анализ на конфигурацията за сигурност може да се дефинира като процес, който е предназначен да оцени идентифицируеми аспекти на сигурността (като напр. дефинирани от потребителя настройки) на системите в областта на приложението на мобилните устройства. Оценяваните системи се разделят на приемливи и неприемливи, предвид специфичните изисквания за сигурност в тази област.

Настоящият доклад представя състоянието на проучваните мобилни устройства по отношение на дефинирани критерии за анализ на сигурността в мобилните устройства. Основната идея е да се сравни нивото на защита на устройството според конфигурациите, които потребителите правят. Това може да се използва например от компании, които искат да позволят на подчинените си да имат достъп до корпоративните системи чрез личните си мобилни устройства. С референтния критерий фирмата може да определи дали устройството е защитено и да му се даде достъп до системата, без да има сериозен риск да се разкрие поверителната информация. Стандартната процедура, която позволява да се оценят и сравнят различните системи или

компоненти използва специфични характеристики като ефективност, надеждност и сигурност [3] (виж фиг.1).



Фиг. 1 Критерии за оценка на системите за сигурност

Теоретично, стандартът за сигурност предоставя показател (или малък набор от показатели), който може да характеризира степента, в която са изпълнени целите за сигурност. В [4] е представена тестваща система, която позволява на разработчиците и администраторите да сравняват алтернативи и да вземат информирани решения. Оценката на сигурността обикновено е много зависима от това, което не е известно за приложенията (например неизвестни бъгове, скрити уязвимости), отколкото от това, което е известно (например известни функции, съществуващи механизми за сигурност). Показателите за сигурност дефинирани от Центъра за защита на интернет (CIS-Center for Internet Security), предоставят най-добри практики, които да помогнат на организациите да оценят и подобрят киберсигурността си [5]. В CIS са създали набор от еталони за конфигуриране на системите за сигурност, предложените насоки е препоръчително да се използват от администраторите, специалистите по сигурността, одиторите и крайните потребители за подобряване на сигурността на техните системи.

В [6] се предлага подход за оценка на ефективността на системите за управление на бази данни (СУБД), които са свързани със сигурността. Подходът се състои в използването на набор от най-добри практики в областта на сигурността, получени чрез подробен анализ на серията от документи за конфигуриране на сигурността в CIS. Най-добрите практики за сигурност се използват за тестове на дадена конфигурация, които могат да бъдат изпълнени по полуавтоматизиран начин. Основното ограничение на работата е сложността на планираните системи и необходимостта от ръчен анализ. Използването на ръчен анализ, предразполага към потребителска грешка и е повлиян от опита на потребителя, което може да изкриви крайния резултат (потребителят може да не разбира всички настройки за сигурност или дори да не знае как да ги оцени). Проучването използва автоматизирано средство (приложение за Android) за събиране и анализ на настройките за конфигурация, предоставящо ключова информация за оценка на сигурността и подобряване на мобилните устройства. Също така се подчертават най-често

срещаните уязвимости, предизвикани от неправилната конфигурация на защитата на потребителите.

2. Изложение.

Конфигуриране на сигурността

Подходът се поддържа от инструмент, който позволява да се оцени сигурността на устройствата с Android въз основа на дефинираните от потребителя настройки, за които се знае, че са ключов източник на уязвимост в сигурността. Инструментът автоматично извлича 41 настройки от подлежащите на тестване мобилни устройства, от които 14 са дефинирани и предложени в [6], а останалите са адаптирани от добре познатите критерии за CIS. Наборът от конфигурации за сигурност може да бъде намерен в [7], [8] и инструментът в Google Play [9].

В [5] се анализират два показателя за сигурност на CIS за устройства с Android (4.0 и 6.0). За да се разберат и извлекат всички съответни потребителски дефинирани защитни конфигурации, трябва да се има предвид оценката на сигурността на устройствата с Android. Предизвикателства за сигурността са много на брой, но 14 от тях могат да се отбележат като особено важни и те са обозначени с ID номер:

- ID ЗАЩИТА НА СИГУРНОСТТА
- A2 Не инсталира root приложения;
- A3 Инсталира анти-злонамерен софтуер;
- A4 Не инсталира анти-злонамерен софтуер;
- C5 Ограничаване броя на снимките;
- C6 Ограничаване на броя на аудио файловете;
- C7 Ограничаване на броя на видеоклиповете;
- C8 Ограничаване броя на документите;
- N10 Деактивиране на ICMP (Internet Control Message Protocol);
- N11 Изключване откриваемостта на bluetooth;
- P12 Активиране на парола на шаблона;
- P13 Изключване на видимия модел на заключване;
- PE3 Деактивиране разрешението за писане в системата;
- PE4 Забраняване разрешението за писане на / данните;
- PE5 root ("JailBreak"), достъпност за приложенията.

Предложените настройки за сигурност са следните: **A2**: някои приложения могат да се вградят в устройството (jailbreak), което води до загуба на гаранцията и нарушава сигурността, тъй като има достъп до съхраняваната информация, **A3**: Антивирусните приложения могат да откриват и премахват злонамерен софтуер, намалявайки атакуваните области на устройството, **A4**: зловредният софтуер може да разкрие лична информация, причинявайки загуби, **C5**, **C6**, **C7** и **C8** са снимки, аудио, видеоклипове и документи с важна информация, които могат да се съхраняват на устройството, **N10**: отговарянето на заявките за ICMP и може да дадат на атакуващия възможността да узнае IP на устройството, като по този начин се увеличава атакуваната област, **N11**: ако достъпът до Bluetooth е невидим, устройството става по-трудно да се намери, намалява се областта на атака, **P12**: въпреки че използването на шаблон за парола е по-малко сигурно от използването на буквено-цифрова парола, по-добре е да не се използва такъв механизъм за парола, **P13**: Видимата парола проследява движението на потребителя, като по този начин може да се разкрие паролата, **PE3** и **PE4**: поради своята чувствителност на системата и данните трябва да имаме разрешение само за четене, като разрешенията за писане улесняват разкриването на

информация от устройството, **PE5**: ако устройството е достъпно (jailbreak), няма гаранция за сигурност, тъй като всяко приложение с разрешение има достъп до всяка информация на устройството.

Оценка на риска. Конфигуриране на Android устройства.

Анализираният подход, може да се използва за оценка на риска за сигурността, създаден от потребителски конфигурации на устройства с Android. Основава се на анализа за риска (въздействието и вероятността) от неправилна конфигурация на потребителски устройства. Стойностите на въздействието и вероятността се определят въз основа на анализ за вземане на решения с множество критерии MCDA (Multiple-Criteria Decision Analysis), който се извършват на входовете, предоставени от набор от експерти по сигурността.

Методът GRIP (Generalized Regression with Intensities of Preference) [10] може да се използва за подреждане на краен набор от действия (т.е. потребителски конфигурации), оценени по няколко критерия. На практика GRIP предоставя информация за интензитета на предпочитанията за двойки действия в комплект. Съществуващият инструмент, Deck за вземане на решения [11], който може да бъде използван в подкрепа на сложния процес на MCDA, като използва метода GRIP. Може да се подредят действията (т.е. конфигурациите за сигурност), като се съобразяват с множеството критерии (въздействието и вероятността, възложени от външните експерти) и DM сравненията. Този метод е успешно приложен и в други разработки в областта на надеждността [12], което показва, че може да се използва за консолидиране на различни мнения на експерти.

Процесът на включване на въздействието и вероятността от всяка препоръка за сигурност включва определянето на вероятността, съставена от решението на осем експерта. Използването на по-голям брой експерти увеличава представителността на резултатите по отношение на общите възприятия. Независимо от това, дали процесът гарантира разнообразие от опити, който трябва да се обмислят. Възможните отговори на въпросите варират от много ниски до много високи стойности или от 1 до 5, като мащаб, който се използва широк анализ на риска [13], [14]. Скалата от петте стойности определени в семантика осигуряваща много добър баланс са представени в таблица 1.

Табл. 1. Семантика на стойностите на скалата на риска

Интензивност на мащаба	Общо описание	Вероятностно описание	Описание на въздействието	Пример
Много ниска	Конфигуриране то не е от значение	Много е малко вероятно да се използва чрез грешна конфигурация	Влиянието в случай на атака е минимално	Разкриване на музикален файл
Ниско	Конфигуриране то е от значение	Малко вероятно е да има експлоатиране в случай на грешна конфигурация	Въздействието в случай на атака е ограничено	Разкриване на неконфиденциална документация
Средна	Препоръчително е да се въведе конфигурация	Малко вероятно е неправилната конфигурация да бъде използвана	Въздействието може да донесе някаква опасност за потребителя	Разкриване на местоположението на устройството
Високо	Конфигурирането е важно	Вероятно ще бъде използвана неправилна конфигурация	Това може да доведе до загуба на важна информация и разкриване на информация	Изпращане на текстови съобщения до номера с добавена стойност
Много високо	Конфигурацията е критична	Много вероятно, да бъде използвана неправилна конфигурация	Това може да доведе до значителни загуби и разкриване на информацията.	Разкриване на цялата съхранявана информация върху устройството

Ключови аспекти на GRIP за вземане на решения са представени в [10] и включват:

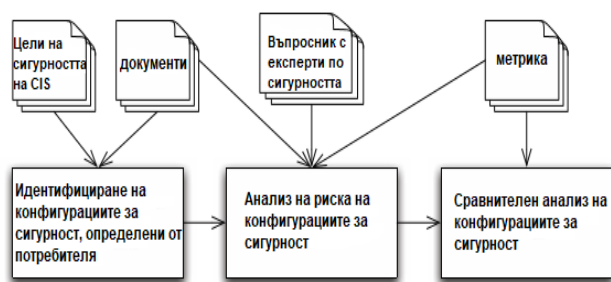
- Предоставяне на входни данни, т.е. препоръките за сигурност и защита, определени от експертите;
- информацията за предпочитанията предоставена от вземащия решение, която се състои от двойки сравнения на действията, т.е. сравняване на две препоръки за сигурност;
- изчислителната фаза на процеса на вземане на решение, която проверява предоставената информация за предпочитанията, ако се открие някакъв проблем, тогава се предоставя подкрепа за преразглеждане на информацията;
- методът извежда интензивността на предпочитанията на всяко действие, т.е. конфигурацията за сигурност, която след това може да се използва за определяне на важността на целия набор от действия.

Причината за използването на метода GRIP е необходимостта да се управляват различията в мненията на експертите и по този начин да може да се изчисли интензивността на предпочитанията по отношение на риска от всички конфигурации на сигурността.

Конфигуриране на безопасността на мобилните устройства.

Сравнителният анализ на дефинираната от потребителя конфигурация за сигурност на мобилни устройства показва, че показателят трябва да може да се управлява от мобилните устройства според конфигурациите им. Процесът на предлагане на бенчмаркинг за сигурност на мобилни устройства има следните макро стъпки:

- Идентификация на дефинираните от потребителя конфигурации за сигурност;
- Анализ на риска на конфигурациите на сигурността;
- Сравнителен анализ на конфигурациите за сигурност въз основа на резултатите, генерирани от фазата на анализа на риска.



Фиг. 2 Стъпки за предлагане на анализ за конфигуриране на сигурността

За по-добро разбиране на стъпките показани на фигура 2 се предлага еквивалент за сигурност на конфигурацията, определени за всяка потребителска дефинирана конфигурация, за да се определи сигурността на устройството. Основният показател, който е предложен за разглеждане на риска е да се присвои определена от потребителя конфигурация за сигурност. Анализът на действителните устройства с Android е ключов принос за откриването на основните и най-често срещаните проблеми, с които се сблъскват потребителите, докато конфигурират своите устройства.

3. Заключение.

Организациите, които искат да позволят използването на лични мобилни устройства за достъп до корпоративните системи, данни и информация, могат да се разглеждат като потенциални потребители на този подход. По този начин те могат да изпълняват квалификация за защита, осигуряваща минимално ниво на защита на мобилните устройства. Освен това, те могат също да извършат количествено определяне на риска, като откриват основните проблеми на системата за погрешно конфигуриране на базата на анализ и да организират сигурността на устройствата, което да доведе до подобряване на дефинираните от потребителя конфигурации за сигурност на мобилните устройства, използвани за достъп от техните киберсистеми.

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CONTINUED PHENOMENON REPRESENTATION BY REGULATORY MODELS IN GEOINFORMATION TECHNOLOGIES

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Abstract: In this paper a survey of existing approaches for modeling and designing GIS applications is presented. The nature of design activities in GIS applications is first discussed; some notations and methods related with GIS design are then analyzed; finally an object-oriented approach, based on design patterns and integrating discrete and continuous data into an uniform design model is shown.

KEY WORDS: GEOINFORMATION TECHNOLOGY, GEOGRAPHIC INFORMATION SYSTEM, DIGITAL ELEVATION MODEL, LIDAR TECHNOLOGY.

1. Въведение

Географските информационни технологии (геоинформационните технологии) - (ГИТ) са съвкупност от методи, производствени процеси и програмно-технически средства, обединени в технологична верига, обезпечаваша сбор, регистрация, обработка, натрупване, съхранение, представяне, търсене, анализ, защита и разпространение на геоинформация. Това определя основните изисквания към геоинформационната технология:

- да осигури разделяне на процеса по обработка на геоинформация на стандартизирани и унифицирани етапи (фази), операции и действия;
- да осъществява целенасочено управление на информационни процеси;
- да включва целия набор от средства за постигане на поставена цел;
- да има регулярен характер.

Обобщеният модел на ГИТ дава най-обща представа за същността, структурата и предназначението на системата [7]. Той пояснява входовете, изходите и процеса на трансформация, извършван в системата.

Непрекъснатите явления (полета) се изобразяват чрез повърхности. Повърхността може да се определи като част от плоскост, подложена на непрекъснати деформации (разтягане, свиване, огъване), всяка точка на която се представя от значенията на координатите X , Y , Z . Значението Z на повърхността се променя при прехода от едно място в друго, образувайки непрекъснатост на пространствения градиент.

Ако параметърът Z се асоциира с височината, то определената повърхност ще представлява релефа на местността. В ГИС чрез параметъра Z могат да се представят различни измерени величини, например: цена, атмосферно налягане, плътност на населението, температура и т.н. В тези случаи, значението Z може да се тълкува като статистическо представяне на величините на разглежданите явления и обекти, а образуваната повърхност - статистическа повърхност.

В ГИС за моделиране на повърхности се използват регулярни модели (растерни и мрежови) и нерегулярни модели (триангулационни модели) [3].

Таблица 1 Резюме на представяне на географски обекти чрез растерни модели.

фокус на модела	триангулационните данни са ориентирани към моделиране на непрекъснати явления и изображения на земната повърхност.
източници на данни	материали от аерофотоснимки, космически снимки, GPS измервания, конвертиране на триангулационни данни, растеризация на векторни данни, сканиране на фотографии и чертежи.
съхранение на пространствени данни	от координатите на долния ляв ъгъл на растера и размера на растера се локализира всяка клетка.

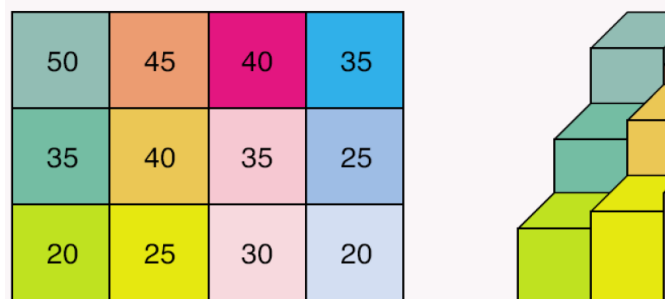
представяне на пространствени обекти	точковите пространствени обекти се представят с една клетка; линейните обекти – чрез поредица съседни клетки с еднакво значение; площните обекти се представят чрез региони клетки с еднакво значение.
топологични отношения	съседните клетки могат бързо да се локализира с нарастване или намаляване на редове и колони.
геопропространствени анализ	пространствено съвпадение, анализ на близост, анализ на повърхности, дисперсия, оптимален път.
картографска продукция	растерните данни са най-добри за презентация на изображения и непрекъснати явления с постепенно изменение на атрибути; те не са съвсем подходящи за изчертаване на точкови, линейни и пространствени обекти.

2. Растерно представяне на повърхност.

Растерите представят повърхността във вид на регулярна матрица от двумерни клетки със значение Z . Всяка клетка съхранява свое значение за Z . Тримерният растерен модел на повърхност представлява съвкупност от съседни блокове. Значението на Z се представя с различен цвят (фиг. 1).

Могат да се изведат следните преимущества и недостатъци на растерното представяне на повърхност. Преимущества:

- това е прост модел;
- прилага се в приложения, където точността на местоположение няма преимуществено значение и не се изисква точно представяне на пространствените обекти на повърхността.



Фигура 1. 2D и 3D растерно представяне на повърхност.

Недостатъци на растерното представяне на повърхност [7]:

- регулярната структура не е приспособена към изменения на сложен релеф;
- разрывите на непрекъснатост не се предават добре;
- точното местоположение на точки като връх, дъно се губи.

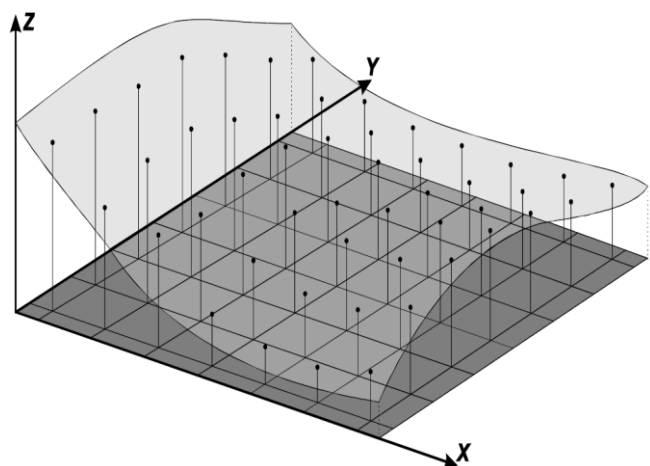
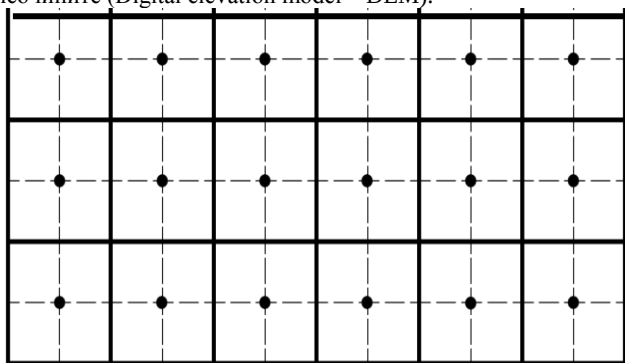
3. Мрежово представяне на повърхност.

Растрното представяне на повърхност е свързано с мрежовото представяне. За всяка клетка от растера се идентифицира местоположение и значение на Z . За определени типове данни значението на клетката представлява измереното значение в централната точка на клетката.

За мрежовото представяне на повърхност базова структура се явява мрежа, образувана от успоредни и взаимно перпендикулярни линии, преминаващи през централните точки на клетката на растера. В ГИС за изобразяване на повърхности на основата на такава мрежа, се използват два основни модела – грид и латис [3], [7], [8].

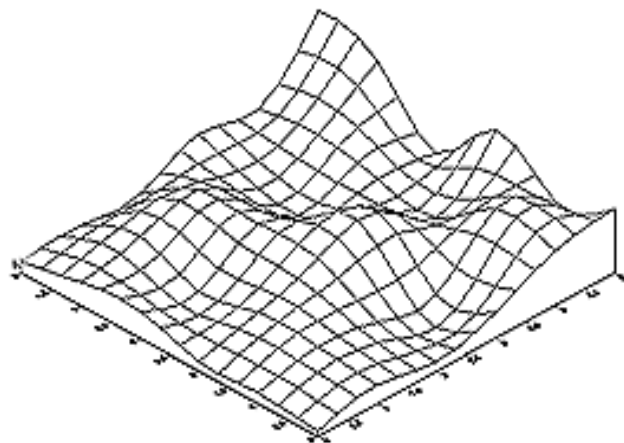
Мрежовите модели се образуват на базата на математическата теория на решетките, опериращи с частично нормални данни [4]. Те са полезни в случаите, когато отсъства йерархия на обектите.

Мрежовият модел Грид (Grid) представлява модел във вид на колекция от централни точки на клетката със значения Z , разположени регулярно през хоризонтални интервали (в отличие от формата Grid на ESRI). Грид предава особеностите на повърхността чрез значението в точки от тримерното пространство. Ако значенията Z са височини на местността, грид представлява цифров модел на височините (Digital elevation model – DEM).



Фигура 2. Грид в 2D и 3D представяне.

Латис (Lattice) представлява структура от точки и линии на пространствена решетка. Латис предава форма на повърхността, използвайки линиите на пространствената решетка. Ако значенията Z са височини на местността, латис представлява геометрически модел на местността (Geometric terrain model – GTM).



Фигура 3. Латис в 3D представяне.

В тримерното представяне на възела четирите линии предават значението на Z . При това четирите линии, свързани с този възел се разтягат пропорционално. Функцията изглаждане позволява представяне на повърхността с плавно изменяща се форма (фигура 3). Използване на латис обезпечава правилна представа за повърхността.

За растрните модели са характерни следните операции: идентификация на зони, изчисляване на площи на зони, разчет на периметър, трансформиране на растрен слой и др.

Заклучение

Атрибутното описание допълва координатните данни, а съвместно създават пълно описание на предметната област на ГИС. Атрибутите могат да бъдат символи, числа, графически признаци на обектите (цвет, рисунок, тип на запълване и др.).

Връзката между атрибутните и координатните данни се извършва различно. Често се използва четиримерното пространство за представяне на характеристиките на обекта: първите две размерности са предназначени за равнинните координати, третата – за описателните атрибути, а четвъртата – за временните набори данни. Третата и четвъртата съставляващи могат да бъдат многомерни таблици.

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NEW WAYS TO PRESENT INFORMATION AND DATA ON THE WEB

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Abstract: The way of presenting information on the Web has always been a serious challenge. In some areas, such as politics, journalism, education, this can be crucial for its proper understanding and interpretation. This article presents a list of some empirically selected by the author contemporary tools for presenting information on the Web.

Keywords: WORDPRESS, WORDPRESS PLUGINS, KNOWLEDGE REPRESENTATION

Characteristics of the term "knowledge"

The term "knowledge" has no exact definition. In the different scientific fields and public spheres it is given a generally coincidental meaning, with the presence of some semantic accents. For the purpose of this publication, we assume that the term "knowledge" refers to a certain amount of information from a subject area describing a generally accepted scientific opinion with regard to an object or phenomenon that is being studied.

The definition, which is given, has no relation to the authenticity of the defined knowledge and is not committed to measuring its final quantity. Knowledge means facts, processes, phenomena, objects. It can also include concepts, assertions, deductions, and others. Such amounts of information (knowledge) are components of instruction manuals, textbooks, lectures, self-study books, as well as the whole practical experience of a professional. Knowledge is identified with a key concept as a name and has its own characteristics. Here are some more important ones:

- Knowledge is endless. Mankind knows and uses only part of it. The boundaries of knowledge are blurred and constantly changing. There is knowledge forgotten by the human kind. However, it is significant and is still used. There is also knowledge which is already known, but is subject to future disclosure and application in practice.

- Knowledge has its own features located in realistically reachable or virtual spatial dimensions. Knowledge is eternal. Back in time and far into the future, all knowledge is inaccessible to mankind, but it exists. The same statement is true of the other two dimensions, respectively the macro (socially growing) and the micro (the individual) level. Knowledge "actually exists" in the "current window of human knowledge", some kinds of it (most commonly the latest discoveries and human practices) are particularly relevant and important for the present time and for the future of mankind. The spatial and temporal characteristics and the relationship between all of the above are constantly changing. Knowledge is constitutive; there is no single or simple knowledge. Even the accepted axiomatic knowledge now is a matter of time to be perceived as constitutive.

- By definition, all knowledge is "true" until the emergence of knowledge that develops, changes or completely compromises it as such. Changed old knowledge further defines the new "true" knowledge.

- Knowledge is connected in different ways with other knowledge. The interrelationship between knowledge is the subject of study in every field of science, and the same applies to links with knowledge from other scientific fields.

The presentation of knowledge is a particularly important topic in some areas of human practice. Training is such a field. One of the main goals of each training is to teach learners a particular amount of knowledge in a certain area and to explain the links between them. The motivation for professional realization (in terms of training) should be considered only in the part motivation for acquiring new knowledge only for the period of study. The same applies to professional development. We believe that the last two in terms of modern training are a matter of historical moment, personal qualities and a competitive environment of development. The transfor-

mation of each learner during the learning period mainly consists of forming a tag cloud of knowledge and knowledge of the relationships between them. The motivation for professional realization (in terms of training) should be considered only in the part motivation for acquiring new knowledge only for the period of study. The same applies to professional development. We believe that the last two in terms of modern training are a matter of historical moment, personal qualities and a competitive environment of development. The transformation of each learner during the learning period mainly consists of forming a tag cloud of knowledge and knowledge of the relationships between them.

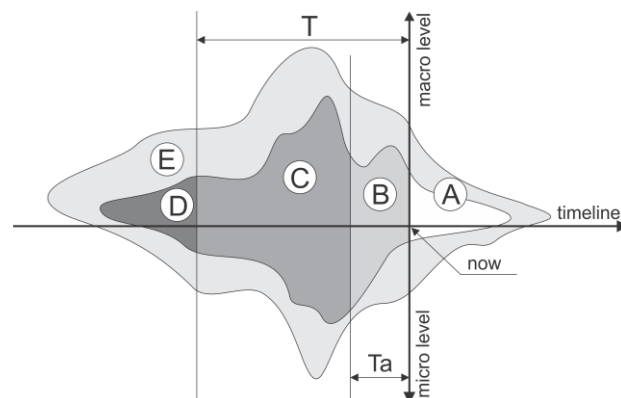


Fig. 1. Human knowledge

Fig.1. illustrates some spatial and temporal characteristics of human knowledge. The following zones and time limits are distinguishable (periods): **T**– a current window of human knowledge; **Ta**– a period of particularly current and very significant now and in the future knowledge; **Zone C** and **B**– human knowledge which is known and used in practice; **Zone B**– recently discovered, up-to-date and highly significant knowledge; **Zone D**– knowledge forgotten by the humankind; **Zone A**– already discovered but not publicly disclosed and usable knowledge; **Zone E**– hypothetical (possible) change in the limits of human knowledge.

Forms of knowledge presentation

In ancient times the way of presentation and preservation of knowledge were at the level of mental human activity. The form of the presentation of knowledge was "associative pictures" stored as memories of individuals in a community. They have passed on the knowledge of their heirs from generation to generation.

Because of the growing need for mass use and dissemination of knowledge, the ways and forms of their presentation and preservation are evolving. The processes of logging and communication go through cave paintings, stone inscriptions, architectural solutions, as knowledge carriers, paper carriers and ... till present day with the use of various types of technical devices, memories and various information carriers. The processes described above are manifested on a macro level (communities inhabiting the planet, entire continents and countries) as well as on a micro level - the separate individual, a professional in a given area, even as a unique biological carrier of human knowledge.

Just until several decades ago, before the modern era of technical progress, the latest modern descriptive and knowledge storage capabilities were paper bodies in which the latter were described, sketched or tabulated. The first sound recording devices were invented. Information carriers were also invented. The technical progress adds to the level and capabilities of recording and playing video information. Multimedia is created as a combination of various formats, such as text, audio, graphic images, animated applications, video and interactive content. Regardless of the new opportunities offered, for a long time people inertially presented knowledge in old classical ways in the new technical environment, but new ideas and ways of work have been formed gradually. User interfaces are developed to communicate with people and the technical environment; a new idea of communication and knowledge exchange between people and between technical devices is also created. A new type of digital culture and communication is created, consumers' expectations about how to acquire new knowledge, both for their acquisition and for their perception, distribution and use, are changing. At present, the Internet covers ever-wider areas of people-to-people communication and thus in the presentation and storage of information.

From the source of knowledge to the user.

Presenting information on the Web is a serious challenge. In order to achieve predetermined goals, this is of paramount importance for its proper understanding and interpretation. The semantic message that is to be transmitted to the audience is crucial. For a long time there have been actively used environments to create blogs, forums, social communities and others, which give creative freedom to the authors. The topical issue in this line of thought now is the emerging new extensions and extras for the above mentioned software environments. They are the ones which support the change and development of users' ideas for a new vision, design and presentation of Web content. This article contains a list of Wordpress extensions that have been selected, based on certain criteria published below. The main idea is to analyze and select new opportunities that extend the functionality of a blog towards presenting objects and phenomena of educational nature. Here is a list of some of these important criteria that have been used for selection:

- ability to position the object in space and time;
- ability to present objects and phenomena such as vision, device, behavior, and interaction with the environment;
- date of creation, latest update, and rate of updating;
- versions and removed bugs in the extension code;
- compatibility with the hosted server environment;
- compatibility with the latest Wordpress version;
- language support;
- support of browsers and their versions;
- support and help offered on the web site of the extension;
- number of active installations and rate of change;
- user rating and evaluation;
- price.

Taking into account the above criteria and (not) taking into account some subjective evaluations of aesthetics and functionality, of all 320 selected and analyzed extensions for Wordpress, the following were selected:

Table 1: Selected extensions

Name of plugin and URL
Time
Timetable for Wordpress, http://rikdevos.com
WP SIMILE Timeline, http://www.simile-widgets.org/timeline
TimelineJS WordPress Plugin, http://timeline.knightlab.com
Space
Maps Marker Pro, https://www.mapsmarker.com

Name of plugin and URL
WP Google Maps, https://www.wpgmaps.com
Pictures, albums, sliders
Albums Switcher, https://codeasily.com
Photo Cluster, https://codeasily.com
Phantom Pro, https://codeasily.com
Album Stripes, https://codeasily.com
MetaSlider, https://www.metaslider.com
Master Slider, http://www.masterslider.com
Audio
Wave Surfer, https://codeasily.com
Music Player, https://codeasily.com
Compact WP Audio Player, https://www.tipsandtricks-hq.com
Video
FV Flowplayer Video Player, https://foliovision.com/player
YouTube, https://www.embedplus.com
Text, tables and datas, diagrams
TablePress, https://tablepress.org
WP Statistics, https://wp-statistics.com
WP Charts and Graphs Lite, https://themeisle.com
Pages, posts and there design
Elementor Page Builder, https://elementor.com
WP Page Builder–Beaver Builder, https://www.wpbeaverbuilder.com
Live Composer, https://livecomposerplugin.com

What is the future like?

All processes, applications and practices cited here will continue to develop. For public bodies, commercial companies of different rank and even for the general public, the possibilities of abstract, accessible and effective knowledge presentation will vastly expand. At the same time, the virtual presence of people in time and space will change their real sense and dull their exact judgment of the authenticity of the new knowledge they gain.

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9. <https://tablepress.org>
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ONE WAY FOR CREATING VISUAL EFFECTS

ЕДИН НАЧИН ЗА СЪЗДАВАНЕ НА ВИЗУАЛНИ ЕФЕКТИ

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Abstract: In this article is exposed one way for creating digital illustrations for commercial purpose. The method combines traditional drawing and calligraphy, 3Ds Max, VRay and Photoshop. The idea of the article is to demonstrate how to build an entire project from the scratch. The purpose of the article is to show how different software for graphic designing with different purpose can be combined together with a traditional art in order to achieve maximum as a result

Keywords: IMAGE, PHOTOSHOP, 3D STUDIO MAX

1. Introduction

The images and illustrations take big part in the modern world. But in order them to be successful and to attract the attention of the crowd it is needed to be created to different and creative way. All of the commercial worlds need illustrations for their purpose. In the article I chose to talk about how to make an illustration for a book cover. The cover shows different kind of arts – calligraphy, tinted glass, gems and wooden box. The purpose of it is to be a contrast of the created missing art in the world of the book.

2. Main part – Creation of an illustration for books, magazines and other commercial activities.

I decided to start the book cover with a hand drawing and later to continue with two different soft wares – Photoshop and 3Ds Max. And finally I mixed the work together in the final result. The idea of the cover is to do a calligram with a circular calligraphy with several rings. Then placing a wooden box in the middle of the canvas and disperse gems around the letters. The viewport of everything will be from above.

The first part of the project is doing a calligraphy. The needed materials for it are 100x75mm paper sheet, pilot parallel pens – 2.4mm and 6mm (can be found everywhere) and calligraphy ink. The idea is to make a circular calligraphy. To do this we first need to do a calligraphy web. To draw it we need to measure the length of each of the circles by using the formula $p=d\pi$ (where p is the length, d is the diameter). After calculating the lengths of each circle we draw a calligraphy line with the same length as the circle. To build the calligraphy line we draw lines for the capital letters, the small letters, the ascending and the descending letters. After calculating the lengths, the connections between the different circles and the space between them we draw the circles (including circles for the capital letters, small letters, ascending and descending) on the paper sheet (100x75mm) and then draw lines that divide the circles into sectors.

After the calligraphy web is done we need to work on the preferable design and to choose a calligraphy font (for example Fraktur, Textura, Copperplate, etc). Modern varieties of the fond Fraktur are used in the project. The final step in this part is to do a scan of the calligraphy.

For the second part we will use 3Ds Max and VRay. Autodesk 3Ds Max, formerly 3D Studio and 3D Studio Max, is a professional 3D computer graphics program for making 3D animations, models, games and images. It is developed and produced by Autodesk Media and Entertainment [1].¹ It has modeling capabilities and a flexible plugin architecture and can be used on the Microsoft Windows platform. It is frequently used by video game developers,

many TV commercial studios and architectural visualization studios. It is also used for movie effects and movie pre-visualization. For its modeling and animation tools, the latest version of 3ds Max also features shaders (such as ambient occlusion and subsurface scattering), dynamic simulation, particle systems, radiosity, normal map creation and rendering, global illumination, a customizable user interface, new icons, and its own scripting language [2].²

Vray is a render plugin. It's a plugin, which means that it adds functionality to an existing program. Vray's features mainly aim at creating photorealistic images, together with improving rendering speed. Currently, VRay exist for 3D Studio Max, Maya, Rhinoceros 3D, Sketchup, Softimage, Blender and there's even a standalone version available [3].³ It is developed by the Bulgarian company Chaos Group and you can find the plugin in their official site.

In 3Ds Max we will create the wooden box and the gems but we will work on two different projects for them. That's why I will divide this part in two smaller parts.

The chosen design for the wooden box is a hexagon. The lid is built with different colored small pieces of glass. To do it we start with building a cylinder and we set the sides to 6 so we can get a hexagon, cap segments – 1 and chose the radius and the height (in the project $r=50$, $h=45$). Afterwards we convert it in editable poly and start modifying the hexagon. We mark the face and use the inset tool (amount 5) to make 1 polygon inside then we use extrude to make the shape concave. This is our box (Fig. 1).

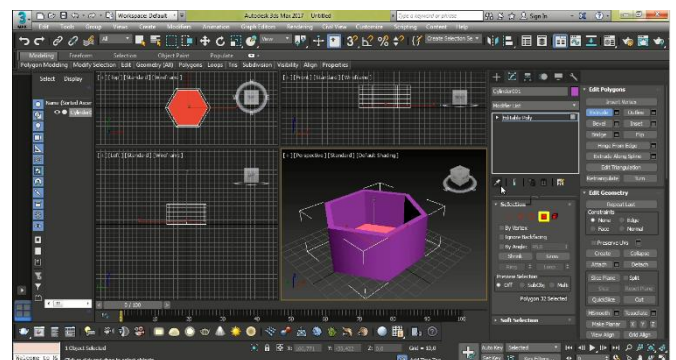


Fig. 1. The wooden box is a hexagon

Then we create another hexagon with the same radius and smaller height (in the project $h=10$). This will be our lid. Again we need to convert it to editable poly. This time we work on the two faces beginning with inset two times in a roll (used amount 1 for the first time and 32 for the second). The idea is with one of them to create the edge and with the other one the center, that's why one of them should be with small amount and the other with proper larger

¹ <http://slideplayer.com/slide/10560987/>

² <https://www.autodesk.com/products/3ds-max/overview>

³ <http://www.aversis.be/tutorials/vray/vray-20-what-is-vray.htm>

amount. Then we use it again on each segment of the hexagon as well as the center segment. We need to use again small amount (amount – 2). Then we mark the inner polygons on the two faces and delete them. We have a concave figure with empty trapezoids and an empty hexagon in the center. Afterwards we delete the edges that are not needed by marking them and using the Remove tool. We select the edges that are not connected and with Bridge tool we connect them (Fig. 2).

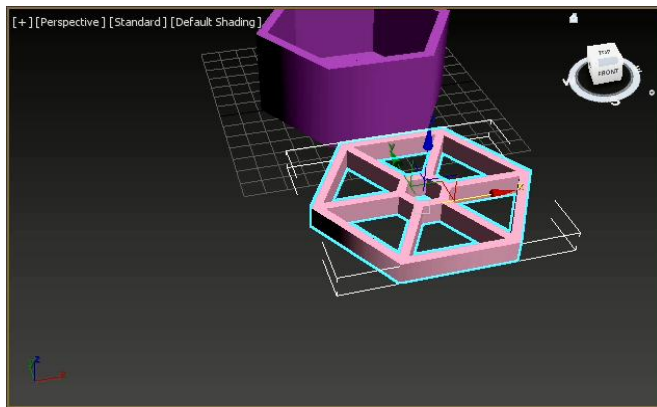


Fig. 2. Bridge tool

To design the glass pieces for the lid we need to create a simple box shape with less height than the lid (used Parameters: Length – 40, width – 40 height – 7; L, W, H Segs – 1). We place the box shape in one of the trapezoids of the figure and convert it to editable poly and by selecting the vertexes we modify it to a trapezoid. Then we make copies and rotate each copy in 60° on the Z axis from the previous and place them in the next trapezoid of the lid. Then we create a small hexagon with the same height as the box shape and place it on the proper place in the lid (Fig. 3).

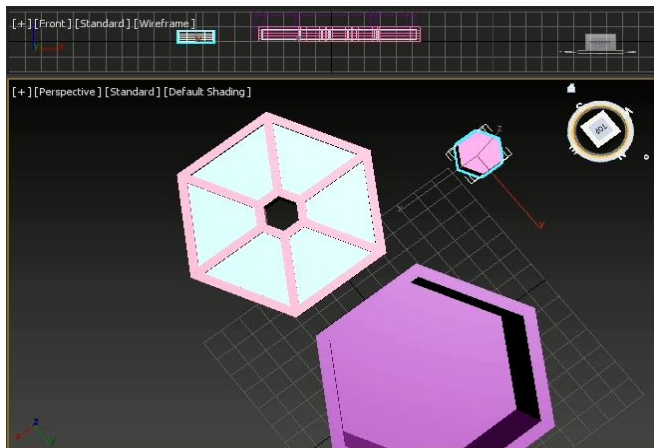


Fig. 3. The designing of glass pieces for the lid

To create the wooden material we need a prepared wooden texture in advance. Then we turn the render and light options to V-Ray mode so we can use V-Ray materials. We open the Material editor and from the Material/Map Browser we choose V-RayMtl to create a V-Ray material. From the options we change the Reflect color to middle grey (R: 35; G: 35; B: 35; H: 0; S: 0; V: 35); HGlossiness – 0,9; RGlossiness – 0,9; turn on Fresnel reflections; IQR Fresnel – 1,6; Max depth – 5; Refract color – black; Glossiness – 1,0; IQR – 1,6; turn on affect shadows. Afterwards we need to go to the button of the menu on Maps section. Then we set the Diffuse to our prepared wooden texture, picking it from the hard drive location. We drag the diffuse map with the mouse and drop it on Bump and we use as a method – copy. The bump amount should be 50 (Fig. 4). To finish this step we need to drag the material from the Material panel and drop it on the hexagon box and on the lid for it.

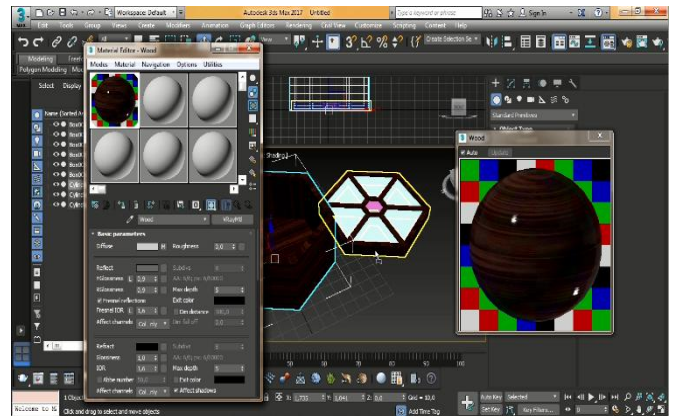


Fig. 4. Advance preparation of wooden texture

To create the tinted glass material we need to use again V-RayMtl. From the options we need to change the Reflect color – white; HGlossiness – 0,9; RGlossiness – 0,9; turn on Fresnel reflections; Refract color – white; turn on Exit color (on the Refract section) and change it to blue (R: 17; G: 5; B: 255; H: 172; S: 250; V: 255); Fog color – blue (R: 17; G: 5; B: 255; H: 172; S: 250; V: 255); Fog multiplier – 0,9 (Fig. 5).

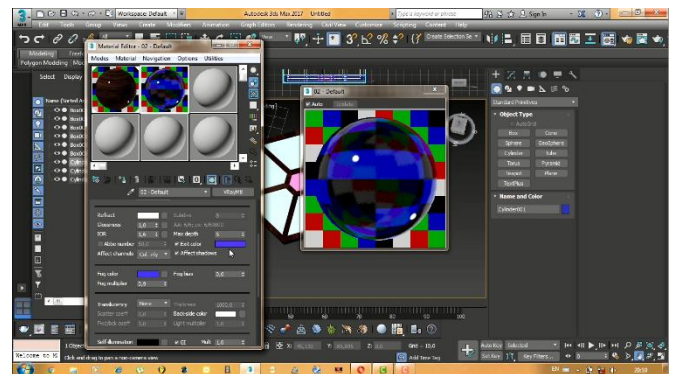


Fig. 5. Creation the tinted glass material

Since we want our glass pieces to be tinted in different colors we copy our material 6 times and change the Exit color and Fog color in each of the copies. (Used colors: Red – R: 255; G: 8; B: 8; H: 255; S: 247; V: 255; Purple: R: 83; G: 5; B: 170; H: 190; S: 248; V: 170; Orange: R: 255; G: 123; B: 5; H: 20; S: 250; V: 255; Green: R: 3; G: 181; B: 32; H: 92; S: 251; V: 181; Turquoise: R: 3; G: 227; B: 247; H: 131; S: 252; V: 247; Yellow: R: 252; G: 255; B: 9; H: 43; S: 246; V: 255;)

We move the lid on top of the box and design hinges by creating 2 little cylinders and placing them properly.

One of the most useful tools in producing computer animation is the ability to link objects together to form a chain. By linking one object to another, you create a parent-child relationship. Transformations applied to the parent are also transmitted to child objects. A chain is also referred to as a hierarchy[4].⁴ Common Uses for Hierarchies - Link a large collection of objects to a single parent so they can be easily animated and transformed by moving, rotating, or scaling the parent; link the target of a camera or light to another object so it tracks the object through the scene; link objects to dummy objects to create complex motions by combining multiple simple motions; link objects to simulate jointed structures to animate characters or mechanical assemblies [5].⁵

⁴ <https://knowledge.autodesk.com/support/3ds-max/learn-explore/caas/CloudHelp/cloudhelp/2017/ENU/3DSMax/files/GUID-0AE92021-9E16-4616-840B-B19773AD9A6E-htm.html>

⁵ <https://knowledge.autodesk.com/support/3ds-max/learn-explore/caas/CloudHelp/cloudhelp/2017/ENU/3DSMax/files>

We want to link the lid with the glasses and the box in a hierarchy so the lid can open freely. To do that we need to click on the Select And Link icon on the toolbar, select the glass pieces as children and then drag the link cursor to the wooden lid as a parent object. We do another link between the lid and the box. We select the lid and the hinges and drop the link cursor on the wooden box. (Fig. 6) Now we can open and close the lid. In the design the box is open so the light rays can go through the glass pieces of the lid.

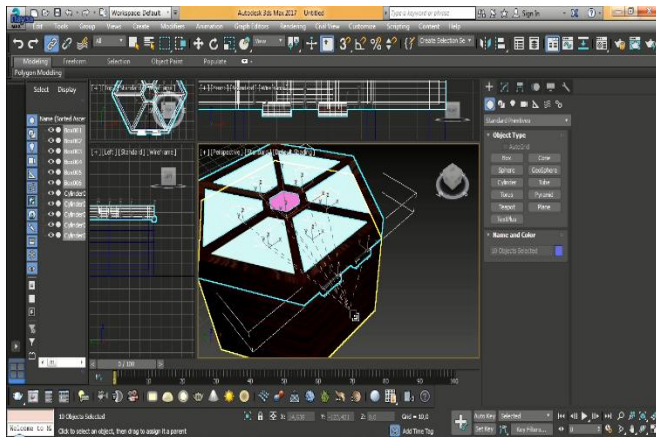


Fig. 6. Select And Link Tool in creation of the hierarchy links

We adjust the light by creating 2 VRayIES light and place them sideways. To design a studio scene we create a plane on the Z axis and change its color to white and leave the viewport on TopView (Fig. 7).

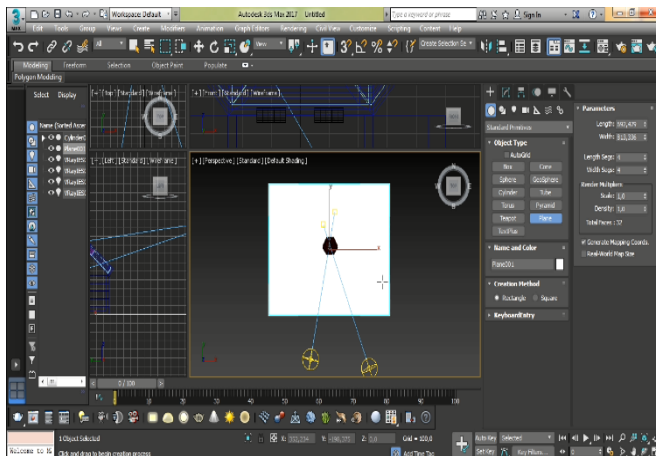


Fig.7. Scene adjustments in preparation for rendering

The final step is to open the Render setup and choose a resolution (used 1400x1050) and render the image and use to render the viewport.

The second 3Ds Max project is designing the gems. In order to do this we start a new project and create 7 box shapes (used Parameters: Length – 30, width – 30 height – 10; Length Segs: 1, Width Segs: 10, Height Segs – 1). We need to work on them one by one by converting them into editable poly and modifying their vertexes so we can get a shape similar to gems. (Fig. 8) We apply the same VRay glass materials. We adjust the light by creating 2 VRayIES light and place them sideways. To design a studio scene we create a plane on the Z axis and change its color to white and leave the viewport on TopView.

Then we open the Render setup and choose a resolution (used 1400x1050) and render the image and use to render the viewport.

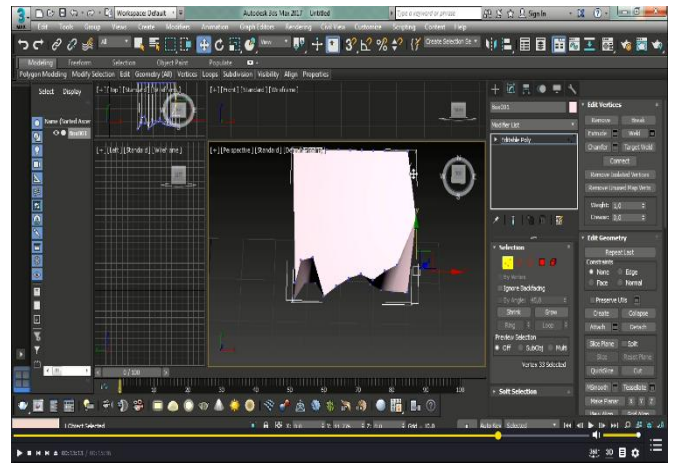


Fig.8. Modifying vertexes from box shape into different form

The final part of the project is in Photoshop where we will connect everything in one and finalize the project. Photoshop is Adobe's photo editing, image creation and graphic design software. The software provides many image editing features for raster (pixel-based) images as well as vector graphics. It uses a layer-based editing system that enables image creation and altering with multiple overlays that support transparency. Layers can also act as masks or filters, altering underlying colors. Shadows and other effects can be added to the layers. Photoshop actions include automation features to reduce the need for repetitive tasks. An option known as Photoshop CC (Creative Cloud) allows users to work on content from any computer. Photoshop is used by photographers, graphic designers, video game artists, advertising and meme designers. The software is available for a monthly fee. Photoshop CC is compatible with Intel-based Mac computers and Windows PCs[6].⁶ It can be found on their official web site.

First we open the image with the calligraphy and we need to erase the white background. In order to do it we click on the eraser tool from the Tool panel with the right button and a window with eraser tools will show. From there we need to select the Magic Eraser Tool. With it we erase the background with a simple click. We repeat the process in every closed space until the background is erased. After that we make color corrections from Layer – New Adjustment Layer – Curves and then Layer – New Adjustment Layer – Hue/Saturation. By that we add 2 adjustment levels for the colors and the contrast.

Then we open the image with the box and make color corrections from Curves. We drag it and drop it on the picture with the calligraphy which is our main picture and rename the layer to Box. We change the Blend Mode to Multiple and if needed erase and blur the background of the layer (Fig. 9).

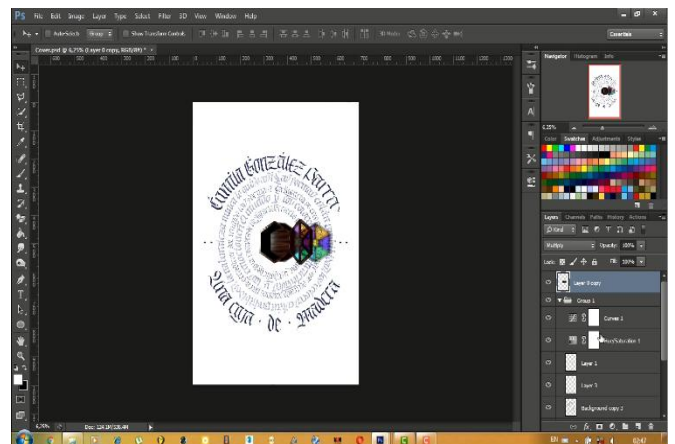


Fig.9. Converted Blend Mode into Multiple on the Box layer

⁶ <https://whatis.techtarget.com/definition/Photoshop>

We open the image with the gems and make color corrections from Curves and again drag and drop it in our main picture, renaming the layer to Gems. We clear the background of the layer and switch to the normal eraser tool to clear any imperfections around the gems. To change the positions of the gems we need to use the Lasso selection tool and mark the gem we want to reposition. By just using the commands ctrl+x (cut) and ctrl+v (paste) we cut the gem and place it in new layer (Note: we can find cut and paste in the Edit menu). We repeat this procedure with all the gems that we want to reposition. Than we merge the gem layers into one by marking them in the layer panel and right click – Merge Layers. Afterwards we need to change the Blend Mode to Darker Color (Fig. 10).

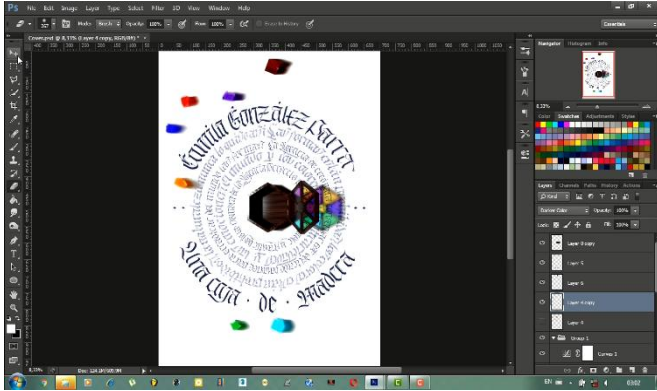


Fig. 10. Converted Blend Mode into Darker Color on the Gems layer

Final step is to add a layer below the calligraphy layer and to create a gradient between light and dark grey (d2d2d2 - 8a8989). We will use this layer as a background (Figure 11).

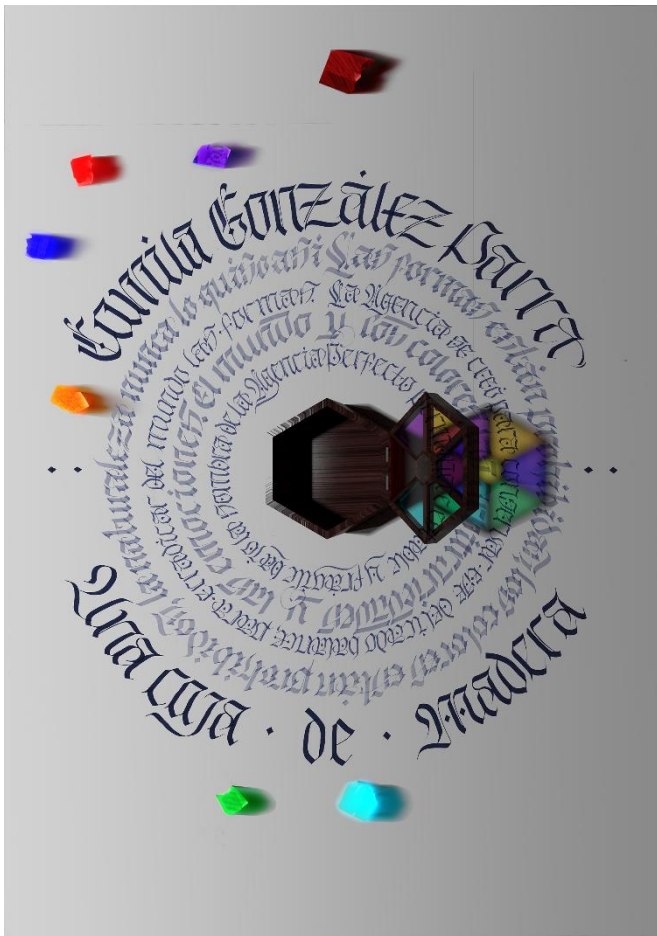


Fig. 11. End result

3. Conclusion

In the modern world there are many ways of creating an illustrations. The approach is in the hands of the creator, the one that builds the entire project. He is the one that organizes the idea and how to build every part of the project to the moment that he realize that idea into reality. In the end he is the first person he is satisfied by his creation and then the auditory that the product is targeted as well as the commercial purpose that is sought.

In a result of the following steps in the article we achieved a final illustration that is approved by the author of the book as well as the creator of the image. We used several different methods combining them to realize the final project.

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ANALYSIS OF USING STEGANOGRAPHY AND CRYPTOGRAPHY IN IMAGES

АНАЛИЗ НА ИЗПОЛЗВАНЕТО НА СТЕГАНОГРАФИЯ И КРИПТОГРАФИЯ В ИЗОБРАЖЕНИЯ

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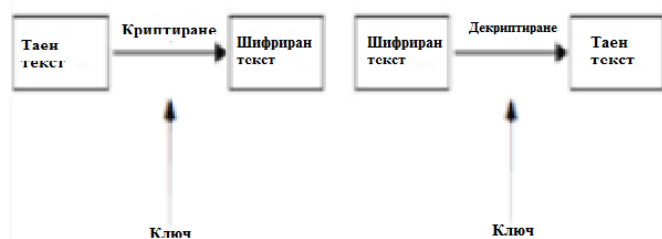
Abstract: The process of jumbling up the contents of a secret message so as to secure it, is known as cryptography, whereas the process of hiding the very existence of a secret message is known as steganography. The contents thus obtained are concealed inside another image so as to hide its very existence. Both these techniques have been tested and it has been observed that they prevent the possibilities of steganalysis also.

Keywords: STEGANOGRAPHY, CRYPTOGRAPHY, LEAST SIGNIFICANT BIT (LSB), DES, STEGO IMAGE

1. Въведение.

В епохата на комуникацията и работата в мрежата, сигурността се превръща в критичен проблем за процъфтяващите мрежи. Едно от най-важните изисквания е да се вземат мерки за предотвратяване на кражбата на данни. Има различни техники за подsigуряване на информацията, но добре известни и широко използвани са криптографията и стеганографията.

Тези две техники се използват много често и имат множество приложения като защита на лични файлове, корпоративни данни, изпращане на поверителни и критични е-мейли и т.н. Криптографията, може да се дефинира като процес на превръщането на текстово съобщение или информация от явен вид в нечетлив (неявен) такъв, без да се използват тайни знания [1]. Тя криптира истинското съобщение, което е изпратено. Това съобщение може да бъде шифровано или кодирано, използвайки различни механизми, включително математически техники и алгоритми за разбъркване на данните в нечетлив формат, който го прави неподходящ без всякакво тайно знание. Шифрираното съобщение, създадено от криптографията може да бъде декодирано или декриптирано само от човек, който притежава тайният ключ [1]. Обобщената криптографска техника е показана на фигура 1.



Фиг. 1 Обобщена криптографска техника.

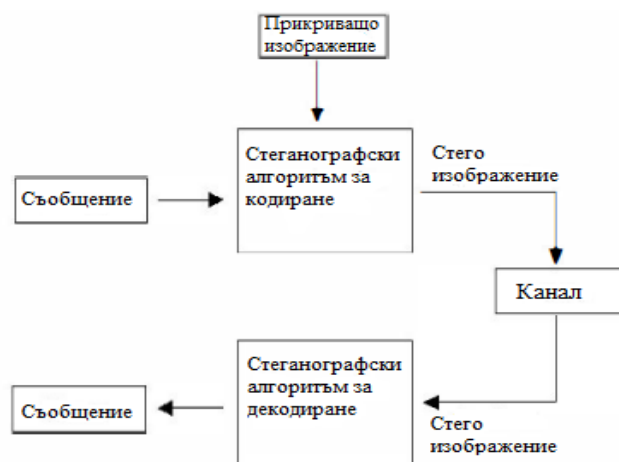
Стеганографията се определя като изкуството и науката за писането на скрити съобщения по такъв начин, че никой друг, с изключение на предназначеният получател да не знае за съществуването на съобщението. Думата "стеганография" е основно от гръцки произход, което означава "скрито писане", „тайнопис“ [2], [3], [4]. Също като при криптографията се крие информация, но принципът на стеганографията е да крие текст или тайно съобщение в друг медиен файл като изображение, текст, звук или видео.

В [2], [3] и [4] се казва, че целта на "криптографията" и "стеганографията" е една и съща, но начинът, по който се постига тази цел е различен.

Криптографията кодира или криптира данните или информацията, така че да я защити от противника, а стеганография от друга страна се опитва да скрие съществуването на информация или данни от противника. Комбинирането на тези две техники позволява по-добра лична

комуникация. Докладът се основава на концепцията за комбиниране на тези две технологии.

Обобщената стеганографска техника е показана на фигура 2.



Фиг.2. Обобщена стеганографска техника.

Много нови идеи и техники са предложени за подsigуряване на данните, главно за да се скрият текстовите данни в изображения. Така се предлагат два нови подхода към стеганографията в изображения.

2. РАЗГЛЕДАНИ АЛГОРИТМИ:

Файлът с цифрови изображения може да се разглежда като файл с множество цветове и различни интензитети на светлината в различните области от изображението. Така може да бъде представено изображението като комбинация от пиксели, съхранявани в табличен вид, като обикновено матрицата помага за по-лесно обработване на изображението.

Ако се разгледа изображение, което има пиксели "i" в хоризонтална посока и "j" пиксели във вертикална посока, а след това общо броят на пикселите в матрицата ще бъде $[i * j]$ и тази стойност е известна също като размер на изображението.

Допълнително всяка стойност на пиксел в едно изображение, също може да бъде представено като комбинация от битове. Що се отнася до изображенията със сива скала, броят на битовете в изображенията, необходими за представяне на пиксел са 8.

Причината е, че в сивата скала изображенията имат интензивност на цвета на определен пиксел и тя варира от 0 до 255, където стойността "0" съответства на черно и стойността "255" съответства на бяло. Това означава, че максималната стойност, която един пиксел може да заема е 255 и следователно са нужни 8 бита, за да се образува пикселът. Пикселът в сивата скала може да бъде представен както е показан на фигура 3.

Пиксел в черно							
0	0	0	0	0	0	0	0
128	64	32	16	8	4	2	1

Пиксел в бяло							
1	1	1	1	1	1	1	1
128	64	32	16	8	4	2	1

Фиг. 3. Пиксел на изображението в сивата скала.

Цветното изображение от друга страна е съставено от пиксели, състоящи се от три цветови компоненти, които са червен, зелен и син компонент. Интензивността на цвета на пиксела ще бъде в зависимост от зависимостите на тези три компонента. За да се представи всеки цветен компонент се изискват 8 бита, което означава, че за да се съхранява всеки пиксел в цветно изображение са необходими 24 бита. Това изображение е представено, както е показано на фигура 4:

RGB изображение																							
червена компонента								зелена компонента								синя компонента							
0	1	0	0	0	0	0	1	0	1	0	0	1	1	0	0	0	1	0	0	1	1	0	1
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1

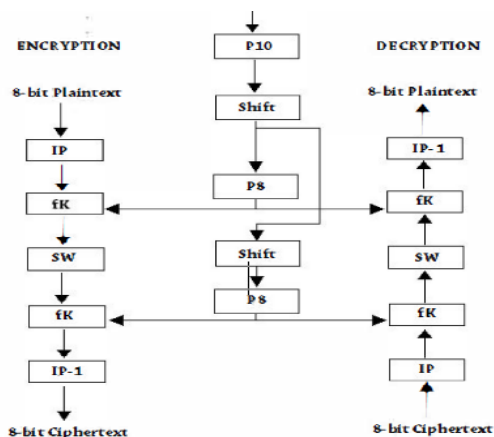
Фиг.4. Пиксел на цветно изображение.

Следователно може да се каже, че изпращането на изображение е нищо друго освен изпращане на пикселните му стойности. Ако по някакъв начин е възможно тези пикселни стойности да се шифроват, цялото изображение ще бъде криптирано.

Такова криптирано изображение може да бъде изпратено до желаня получател, пряко или непряко, като се скрие шифрованото изображение в друга среда. Техниката за криптиране, която е показана е S-DES алгоритъм.

Този алгоритъм приема като вход - 8-битов блок от некриптиран текст (plaintext) и ключ за кодиране, който е дълъг 10 бита и създава 8-битов блок от криптиран текст (ciphertext) като изход. S-DES алгоритъмът се състои от пет различни функции, които приемат 8-битов некриптиран текст като вход и произвежда 8-битов криптиран текст като изход.

Тези функции са: първоначална пермутационна функция представено от (IP); по-сложна функция, представена от (fK) включващи, както пермутации, така и замествания. Тези пермутации и замествания зависят единствено от входния ключ, справедлива и проста пермутационна функция, която завърта двете части от входните данни; (fK) се използва отново и накрая обратното (IP-1), която връща първоначалната стойност [6]. Принциплът на алгоритъмът S-DES е показан във фигури 5 и 6.

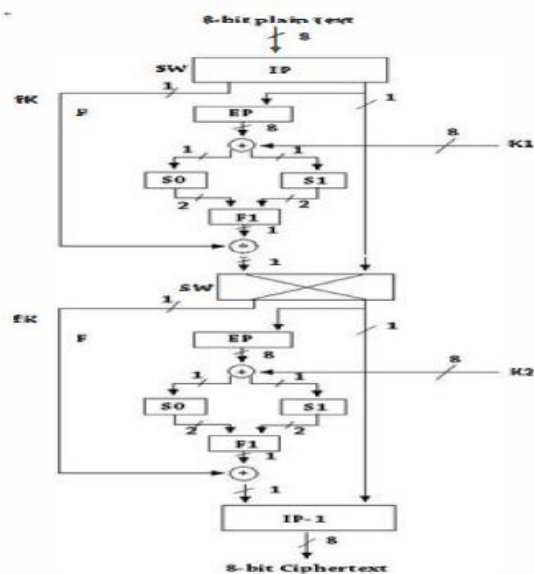


Фиг.5 S-DES алгоритъм.

Алгоритъмът S-DES може да бъде изразен като:
 $Ciphertext = IP^{-1}(fK_2(SW(fK_1(IP(plaintext))))))$
 $K1 = P_8(Shift(P_{10}(key)))$

$$K2 = P_8(Shift(Shift(P_{10}(key))))$$

$$Plaintext = IP^{-1}(fK_1(SW(fK_2(IP(ciphertext)))))) [7]$$



Фиг. 6 Подробен S-DES алгоритъм.

Ако се разгледа цветно 24 BMP изображение, то ще бъде разделено на три матрици или правоъгълни рамки, където всяка рамка или матрица съдържа пиксели, всеки от тези пиксели с определена интензивност на червен, зелен и син компонент.

Ако се предположи, че с j се означава размерът на изображението, тогава можем да кажем, че ще има $(i*j)$ на брой пиксели в това изображение. Освен това означава, че матриците или правоъгълните рамки съответстващи на пропорциите на червено, зелено и синьо цветове ще имат също $(i*j)$ на брой пиксели.

А. Подход 1: - Криптиране на изображение, за да се вгради текстов файл (виж фиг.7.).

Алгоритъмът използва:

Вход: 24 BMP цветно изображение и таен ключ.

Изход: Кодирано изображение, съдържащо текст.

Начало

- Избира се цветно изображение с 24 bmp и таен ключ;
- Шифрира се всеки байт от всичките три матрици [червен, зелен и син], използвайки алгоритъма S-DES за създаване на масив от криптирани пиксели;
- Разделя се всеки елемент на масива на две части. Първата част да съдържа първите четири най-старши бита (MSB) и втората част останалите четири най-младши (LSB);
- Задава се стойност на "A"="0000" и "P"="1111" и задаване за всяка друга стойност на пиксела, съответната буква от азбуката от А до Р;
- Продължава се по този начин, докато целият масив не бъде превърнат в текст, съдържащ букви от А до Р.

Край

Размерът на кодирания масив е $[1, i*j]$ за всяка от трите матрици и съдържа $(i*j*8)$ за всеки от един от битовите. Общият брой на знаците или буквите, които се съдържат в този кодиран масив, ще бъде $(i*j*8/4)$. Общият брой на знаците (TC) представен в крайният шифър ще бъде:

$TC = [Брой\ знаци\ в\ червената\ матрица + Брой\ знаци\ в\ зелената\ матрица + Брой\ знаци\ в\ синята\ матрица]$

$$TC = [(i*j*8/4) + (i*j*8/4) + (i*j*8/4)]$$

$$TC = (i*j)[8/4 + 8/4 + 8/4]$$

$$TC = (i*j)[24/4]$$

$$TC = (i*j)[6]$$

$$TC = (i*j*6).$$

Оригиналните данни в този случай (самото изображение) е възможно да бъдат декриптирани като се използва същият ключ, който се използва за алгоритъмът S-DES за криптиране.

Б. Подход 2: - Криптиране на изображение чрез използването на ключово изображение (виж фиг.8.).

Алгоритъмът използва:

Вход: 24 BMP цветно изображение.

Изход: Изображение с криптирани пиксели.

Начало

- Избира се 24-BMP цветно изображение;
- Шифрира се всеки байт от всичките три матрици [червен, зелен и син], използвайки алгоритъма S-DES за създаване на криптирани пиксели;
- По този начин всички останали пиксели на изображението се криптират.

Край

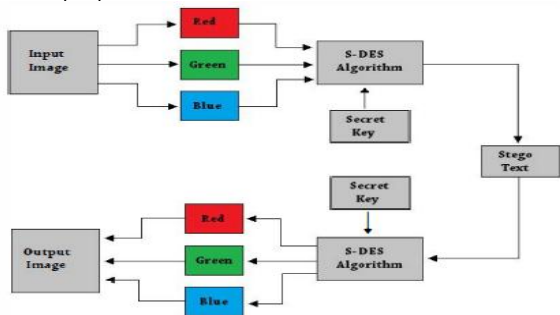
Ключът, който се използва за криптиране на всеки пиксел от изображението е с дължина 10 байта и се получава от самото ключово изображение. Това се прави по следния начин:

- Комбинират се стойностите на червените, зелените и сините цветове на всеки пиксел на ключовото изображение, за да се получи 24 BMP цветно изображение.
- Разделя се стойностите на тези 24 бита в групи от по три и те имат по 10 бита за кодиране на червен, зелен и син компонент на всеки пиксел на основното изображение. Така получените кодирани данни се представят като изображение и могат да бъдат скрити в друго изображение, като се използва стеганографията [8], [9], [10].

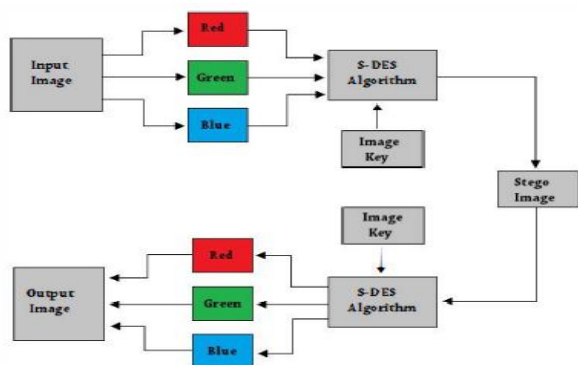
Скриването на криптираното изображение става по следния начин:

- Избира се кодирания байт, както е получен при използване на първата техника или пикселните стойности на криптирано изображение, получени при втората техника;
- Избира се изображението, което ще се изпрати и се скриват пикселните стойности на криптирано изображение в пикселните стойности на носителя чрез вграждане;
- Продължава се по този начин, докато се получи криптирано изображение, скрито в изображението, което ще се изпрати.

Размерът на изпращаното изображение трябва да бъде поне осем пъти по-голямо от размера на криптираното изображение. Ако не е така трябва да се променят размерите на файловете [13].



фиг.7. Детайлен преглед на първия метод.



Фиг.8. Детайлен преглед на втория метод.

3. Резултати.

Двата нови метода се реализират с помощта на MATLAB.

А. Резултати от метод 1.

Изображението, което трябва да бъде криптирано, е показано на фигура 9а. Пикселите на това изображение са шифровани с помощта на S-DES алгоритъма. Текстът, получен след криптиране на изображението е показан на фигура 10. Този получен текст е известен още като крипто текст (ciphertext). По този начин този шифриран текст може да бъде изпратен по каналът на приемащата страна.



а) б)
фиг. 9. а)Оригинално и б) декриптирано изображение

Цифровият текст получен от приемащата страна се подлага на декриптиране, като се използва същият таен ключ за получаване на изображението.

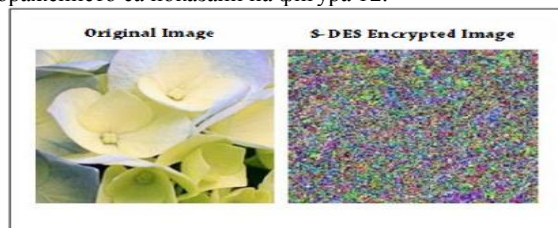
KKKKPDCDEHDDDDIKDJKGDDDFKH
GHDFIIKLHGBNABBAABACDFHH
GJKHJL.....
.....HJAADGFH
KIPPEEBCMNNADDHFGMLNKL

Фиг.10. тайно съобщение

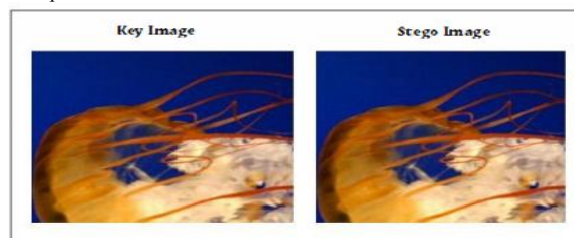
На фигура 9б е показано декриптираното изображение, получено в приемащия край. Това изображение в сравнение с изображението, в което не е вградена информация, резултатът не показва никакви разлики в качеството на изображението и пикселите.

Полученият криптиран текст може да бъде скрит и в други изображения, вместо да се изпраща директно. Този принцип, също се изпълнява с помощта на MATLAB 2014a.

Фигура 11 показва оригиналното изображение (без вградена информация) и кодираното изображение, което се получава чрез прилагане на алгоритъмът S-DES. И накрая полученото криптирано изображение е скрито в ключовото изображение. Полученото ключово изображение и стего изображението са показани на фигура 12.



Фиг. 11. Оригиналното изображение и кодираното изображение чрез S-DES алгоритъмът



фиг. 12 Ключовото и стего изображенията

Забелязва се, че има малка разлика между ключовото изображение и стего изображението, но тя е незначителна и е също така невидима за човешкото око. Полученото стего изображение е изпратено по канал към получателя.

Изображението получено след декриптиране в приемащата страна, съвпада с първоначалното изображение, което е без

вградена информация и е без никаква грешка. Изображението, получено след декриптиране е показано на фигура 13.

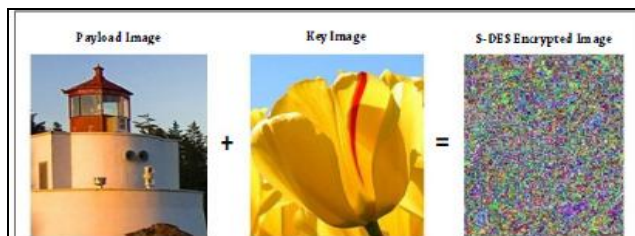


фиг. 13. Изображението, получено от получателя и след декриптирането

Б. Резултати от метод 2.

При използването на този метод са нужни две изображения, от които едното е оригинално изображение, което трябва да бъде криптирано, а другото е ключово изображение, което се използва чрез алгоритъмът S-DES за целите на криптирането. Всяка пикселна стойност на оригиналното изображение се кодира с помощта на съответната пикселна стойност на ключовото изображение, което служи като таен ключ.

Ако ключовото изображение не е съвместимо по размер (както е описано в алгоритъма) с оригиналното изображение, трябва ключовото изображение да бъде преоразмерено. Оригинално изображение, ключовото изображение и полученото криптирано изображение са показани на фигура 14.



фиг. 14 Ключовото изображение, оригиналът и криптираното изображение

Полученото S-DES криптирано изображение е скрито в оригиналното изображение, за да се получи стего изображение. Фигура 15 показва оригиналното изображение и стего изображението, като може да се забележи, че двете изображения нямат никаква разлика.



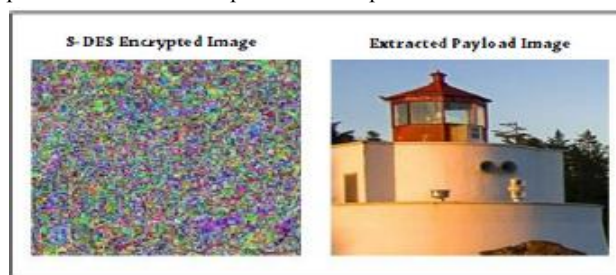
фиг. 15 Изображението, което се изпраща и стего изображението.

След като приключи криптирането, изображението се изпраща по канал към приемащата страна. При достигане до приемащата страна от S-DES криптираното изображение се извлича стего изображението и след като се извлече, то се декриптира, като се използва едно и също изображение, което е използвано за криптирането. Оригинално изображение, извлечено от S-DES криптираното изображение е показано на фигура 16.

От полученото изображение става ясно, че оригиналното е без разлика в стойността на пикселите. Следователно обобщенията, които могат да се направят при използването на двата подхода са:

- При първия подход изображението, което трябва да се криптира, се преобразува в текстов файл и след това този текстов файл може да бъде изпратен директно към приемащата страна или може да бъде скрито в друго изображение преди да бъде изпратено;
- Докато във втория подход изображението е криптирано директно чрез S-DES алгоритъма. Тогава

кодираните данни се скриват в друго изображение преди да се изпратят по канала към приемащата страна.



фиг. 16 Изображението, което е наслагнато и изображението за вграждане.

4. Заключение.

В този доклад се анализират два нови подхода за стеганография на изображения. И двата подхода използват концепцията за комбинация от криптография и стеганография. Подходите са реализирани с помощта на MATLAB.

Резултатите, които са получени предоставят възможни варианти, чрез които може да бъде изпращана и получавана тайна информация. Следващ етап на изследването е да се разгледа, как тези два подхода преодоляват проблемите със стеганализа.

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АНАЛИЗ НА УЯЗВИМОСТТА НА БЕЗЖИЧНА КОМПЮТЪРНА МРЕЖА, ЗАЩИТЕНА С КРИПТОГРАФСКИ ПРОТОКОЛ WPA2

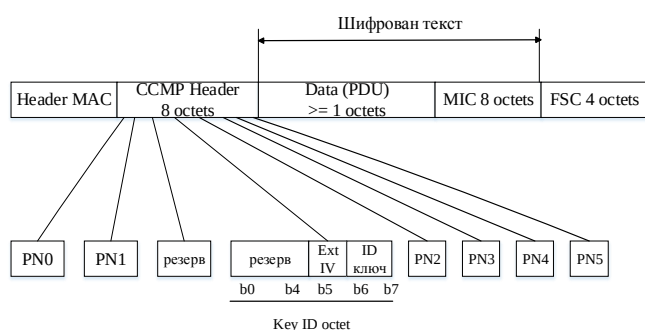
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Abstract: Wireless networks are extremely wide deployed all over the world. The future of Internet communications passes through Internet-of-Things (IoT) and furthermore: Internet-of-Everything (IoE). But nevertheless, most important in the development of networking technologies is the security issue. Computer and networking security will be the great wall built over systems and networks. In this scientific research paper the weakness of Wi-Fi passwords over protocol WPA2 in a controlled network environment is tested. The open source operating system KALI LINUX is used by the means of instrument “aircrack-ng”.

Keywords: Wi-Fi, WPA2, WIRELESS HACKING, ETHICAL HACKING, CYBERSECURITY, KALI LINUX

1. Въведение

Улесеното инсталиране на интернет достъп определи главоломното разпространение на технологията за изграждане на безжични мрежи: Wi-Fi. Основен момент при функционирането на безжичната мрежа обаче си остава защитата на достъпа до нея. Погледнато в хронологичен аспект, първият протокол, осигуряващ защитата на достъпа до безжичната компютърна мрежа, е протокол „Wired Equivalency Privacy“ (WEP), който е имал за цел постигането на защита, еквивалентна с тази на кабелните интернет мрежи. Няколко години след внедряването му обаче се оказва, че този протокол е изключително уязвим на кибер атаки от типа „груба сила“ (brute force attacks). Поради тази причина, от гледна точка на киберсигурността, протокола WEP е препоръчано да не се използва. Протоколът от следващо поколение се явява „Wi-Fi Protected Access“ (WPA), и по-точно – първата версия на този протокол. Не след дълго обаче и той се оказва уязвим на атаки, поради използването на слаби от гледна точка на криптографията хеш-алгоритми. Инженерите и експертите по компютърна и мрежова сигурност разработват ново поколение на този протокол, като е посочено, че той ще използва хеш-алгоритъм от вида „Secure Hash Algorithm“ (SHA). И по този начин, протокола за обмен на паролата за достъп придобива наименованието WPA-2. На фиг. 1 е показана структурата на данните в информационните полета от този протокол. Обекта на атака се явява CCMP хедъра, чрез който впоследствие се изчислява т. нар. „MIC“ код (Message Integrity Code).



Фиг. 1 Информационни полета, изграждащи протокола WPA-2 [1].

При инсталиране на безжичното мрежово оборудване, специалистите посочват необходимостта от дефиниране на парола за достъп до мрежата, с цел осигуряване защита предаването на компютърни и интернет данни. Важен момент в защитата се оказва сложността в изписването на паролата за достъп. Въпреки криптографски защитените методи за обмен на паролата между крайното устройство (STA) и точката за безжичен достъп (AP), използвайки методи на грубата сила, или речникова кибер атака, паролата може да се компрометира и да се реализира нерегламентиран достъп до мрежата.

В този изследователски доклад ще бъдат представени времената за разбиване на няколко модела на пароли чрез инструменти за атака от тип груба сила и речникова атака.

2. Модел на контролирана мрежова среда

За провеждане на изследванията ще бъде използвано мултифункционално устройство за осигуряване на безжичен достъп и маршрутизиране на пакетите с данни: „Huawei HG530“ на фирмата производител „Huawei Technologies“. Като крайно устройство е използван мобилен телефон с операционна система Андроид версия 4.2.2, а като атакуваща система е използван преносим компютър с 2GB RAM памет и операционна система KALI, която е дистрибуция на LINUX. Операционната система KALI се използва широко от експертите по мрежова и компютърна сигурност, благодарение на факта, че в тази система са интегрирани голямо количество инструменти, които се обновяват съвременно. Безплатното й разпространение способства за провеждането на изследвания от аудитория в широка възрастова граница и с различни по специфика познания в областта на компютърните мрежи и системи. Обобщената топология за изследване на уязвимостта на безжичната мрежа е всеизвестната атака тип „Man-in-the-Middle, MITM“. В интерес на правните аспекти и етичното хакерство трябва да се отбележи, че създаването на мрежа е контролирана и не са компрометирани лични данни. Условието за провеждане на изследването са лабораторни, като ресурсите са ограничени. Ограничените ресурси в изследователската машина с ОС KALI LINUX като процесорно време, 2GB RAM памет и др. определят вариации във възможните получавани резултати.

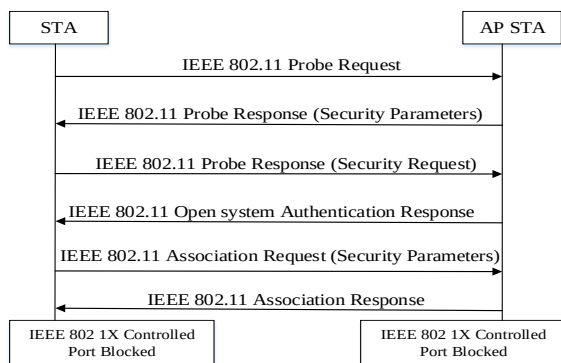
Процеса на разбиване на парола изисква използването или на сравняване на хеш-стойности, произведени от пароли, подредени в речник, или чрез корелация на псевдослучайно генерирани стрингове с хеш-стойността на текущата парола за мрежата. От свободното пространство в Интернет е изтеглен речник „BIG WPA LIST“, който е в текстов формат и има размер около 16 GB.

В протокол WPA-2 са разграничени две разновидности на обмена на ключова информация:

- лична обмяна между двете асоцииращи се устройства (WPA-2 Personal) и
- обмяна, контролирана от специален сървър (WPA-2 Enterprise).

В текущото изследване ще бъде използван първия вариант, а именно - при липса на централизирано устройство-сървър на ключове. Обмяната на пароли ще се извършва единствено между устройството-заявител (Supplicant; Station; STA) и точката за достъп (Authenticator; Access Point Station; AP STA). В режим „WPA-2 Personal“ предварително споделяният ключ се комбинира с идентификатора на мрежата (SSID), за да се създаде двойният главен ключ (Pairwise Main Key, PMK). Клиентът и точката за достъп обменят съобщенията, като

използват PMK, за да създадат двойния преходен ключ (Pairwise Transient Key, PTK).

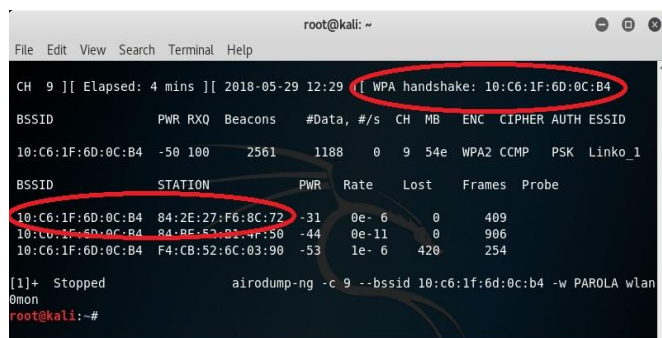


Фиг. 2 Процес на асоцииране на крайно устройство (STA) с точка за достъп (AP STA) чрез парола (Security Parameters) [1].

Атакването на паролите се провежда чрез подслушване и копиране точно на този обмен на служебни съобщения от протокола CCMP, като част от серията WPA-2. Важно е да се повтори, че за целта на изследването, прихващането на пакетите се извършва по контролирана мрежа и не се нарушават никакви правила на секретност или кражба на данни! В никакъв случай този доклад не се представя публично с цел изучаване на методи за атаки на безжични мрежи! Основна цел тук е посочване времената за разбиване на паролите, защитаващи достъпа до мрежата.

3. Ред за провеждане на изследването и изпълними команди

За извършване на речникова атака на пароли, на първо място е необходимо атакуващата система да се позиционира в пространствен обхват, осигуряващ обхват на електромагнитните сигнали, обменяни между точката за достъп и дадено крайно устройство. Както е посочено на фигура 3, прихващаната е комуникационна сесия с ниво на приемане -31 dBm. За техническо уточнение ще се посочи, че тази стойност на нивото на приемания сигнал е изключително висока, което доказва позицията на атакуващата система, а именно на разстояние не повече от 200 см.



Фиг. 3 Прихващане на асоцииране на крайното устройство (STA) с точката за достъп (AP STA) по протокол WPA-2.

След като бъде прихващаната комуникационна сесия, целта е целенасочено атакване и извличане конкретно на пакетите, съдържащи информация за използваните сесийни ключове [3], които от своя страна биват генерирани посредством въвежданата от потребителя парола за достъп до мрежата. Такива пакети се обменят при първоначално асоцииране към точката за достъп от страна на крайното устройство. Но съществуват серия команди „airopay-ng“, чрез които може да се атакува крайното устройство и то да извърши принудителна деавтентикация с точката за достъп. След евентуална деавтентикация, устройството автоматично стартира процес по нова асоциация с AP, при което е възможно прихващането от атакуващата система на т. нар. „handshake“ информация. Имайки записана тази информация в изрично посочен файл,

поместен в атакуващата система, започва процес на „offline“ декриптиране и разбиване на паролата за достъп чрез речникова атака.

Използваните команди в атакуващата система са в следния ред:

- 1: airodump-ng -c 9 --bssid 10:C6:1F:6D:0C:B4 -w PAROLA wlan0mon
- 2: aireplay-ng -0 1 -a 10:C6:1F:6D:0C:B4 -c 84:2E:27:F6:8C:72 wlan0mon
- 3: aircrack-ng -w spisakpass.lst -b 10:C6:1F:6D:0C:B4 PAROLA.cap

Последната команда извършва атака чрез сравняване между записания файл, съдържащ ключова информация, и предоставения речник.

4. Открити слабости

Уязвимостта на мрежата ще се определя от времето, необходимо на атакуващата система за отгатване на паролата за достъп. Таблица 1 изобразява нагледно информацията от извършените изследвания.

Таблица 1: Време за разбиване на паролата за достъп.

парола като низ от символи / време за разбиване	с речникова атака [sec]	с атака от вида „груба сила“ [sec]
1qaz!QAZ	5650	7560
qwertyuiopQWERTYUIOP	9890	∞
1234!@#\$	6180	8820
1qaz2wsx!QAZ@WSX	6940	∞
054886034	7010	9370
telefon054853647	∞	∞
napi6ete3sigurniparoli	∞	∞
IstinskiSigurni3Paroli?	∞	∞

*Забележка: Времената за разбиване са ограничени до три астрономически часа.

От анализа на времената за разбиване на паролите става ясно, че на пръв поглед сложни пароли могат много бързо да се разбият чрез използването на речникова атака и големи по обем бази данни за пароли. Въпреки получените сравнително кратки времена, част от изследваните пароли не бяха въобще разбити (последните три от табл. 1). Причина за това са стрингове с българска семантика, написани на латиница и с достатъчна дължина (над 16 символа). За да бъдат мрежите защитени би било подходящо да се използват пароли със случайни стрингове, генерирани например чрез предварително посочени изисквания, ограничения и развита логика, както е посочено в [2] за вземане на решение.

Използването на WPA-2 Personal е допълнителна предпоставка за улесняване на разбиването. Използването на алгоритми за поверителност чрез централизиран сървър, в сравнение с локалното управление, би затруднило процеса на изчисляване на хеш-стойностите в процеса на обмен на ключовете. Подходящо от гледна точка на киберсигурността е използването на централизиран криптографски сървър за обмен на ключовете (WPA-2 Enterprise). Механизмите за поверителност и целостта на данните са достатъчно стабилни при използването на хедъри CCMP, но само в комплект с уникални по рода си стрингове за пароли. Протокол WPA2 заедно със стандарт AES отговаря на задължителните изисквания в регламентите, но съществен принос в защитата е уникалността и честата смяна на паролите за достъп.

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A MODEL FOR IMAGE BASED INFORMATION SECURITY

МОДЕЛ ЗА СИГУРНОСТ НА ИНФОРМАЦИЯТА НА БАЗАТА НА ИЗОБРАЖЕНИЯ

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Abstract: Images not only represents the information itself but also work as the carrier to keep the information in it. These kind of images work as the cover objects to hold secret communicating information over public network. To perform the compression bit encoding scheme is suggested in this work and finally to hide the information data, LSB scheme is used. The results are applied on real time images and the analysis of work is performed based on MSE and PSNR values.

Keywords: STEGANOGRAPHY, CRYPTOGRAPHY, BIT-ENCODING

1. Въведение.

В ерата на комуникациите, повечето от потребителските данни се разпространяват чрез публична мрежа, но за да се запази тяхната конфиденциалност е нужно да се спазва изискването за сигурен комуникационен подход, такъв който може да осигури сигурност на информацията от вътрешни и външни атаки. Този вид сигурност може да бъде получена чрез използване на различни подходи за сигурна трансформация на информацията. Включват се подходи за скриване на данни и преход на такива. Целта на преход на информация е не само да се постигне надеждност, но и да се постигне ефективност на комуникацията.

За да се постигне сигурност и ефективност при предаване на информацията, съществуват редица подходи, адаптирани за осъществяване на прехода към информация. Три подхода за постигане на сигурност и надеждност при предаване информация, са показани на фигура 1.



Фиг. 1. Предаване на информация

Криптографията се дефинира като кодиращ механизъм, който основно се използва за промяна на съобщенията, така че действителната информация да не бъде разбрана от никой освен двете кореспондиращи си страни. Тя всъщност променя самата информация в кодиран формат, който може да бъде декодиран обратно в оригиналната си форма. Тя осигурява сигурен и надежден начин за кодиране и трансфер на информацията по мрежата. За да се извърши сигурна електронна комуникация на данни има изискване да се използва механизъм за кодиране. Този механизъм за кодиране се дефинира като криптографски подход за извършване на сигурни трансакции като плащания с кредитни карти, електронни трансакции и други. По този начин, също SMS и електронната комуникация се осъществяват по сигурен канал. Криптографските алгоритми се прилагат от двете страни на канала.

Друг вид трансформация на информацията се извършва под формата на алгоритъм за компресия. Компресията намалява размера на съобщаваните данни. Подходите за компресия могат да бъдат с загуби или без загуби. За да се постигне компресията на текстовата информация, се изисква компресия без загуба. Това означава, че когато информацията бъде възстановена от страната на получателя, няма да има загуба на информация. Когато няма загуби от компресия възстановеният

файл е точна реплика на оригинала, загубата от компресия води до влошаване на качеството, като се наблюдава предимно за аудио и графични файлове. Без загуба на компресия, означава, че след компресиране на данните и декомпресирането им, завършвате с точните данни, с които разполагате. Алгоритмите с загуба от компресия се възползват от ограничения на човешкото око и премахват невидимата информация, повечето алгоритми за компресиране позволяват различни нива на качество (компресия), тези нива могат да се увеличават, а размерът на файловете да се намалява. Загубата от компресия означава, че компресираният файл има по-малко данни в него сравнено с оригиналния файл.

Стеганографският подход позволява скриване на някаква информация, така че да се извърши сигурно и безопасно предаване. Стеганографията се използва основно за прехвърляне на малка и критична информационна единица, като се споделя с помощта на пароли. Стеганографията всъщност вгражда информацията в друг информационен обект, като например изображения, аудио, видео и други. Скритостта предлагана от методите на стеганографията е основното и предимство пред криптографията, като двете техники съчетани в една тайна комуникация се явяват мощно оръжие за предаване на конфиденциална информация [7].

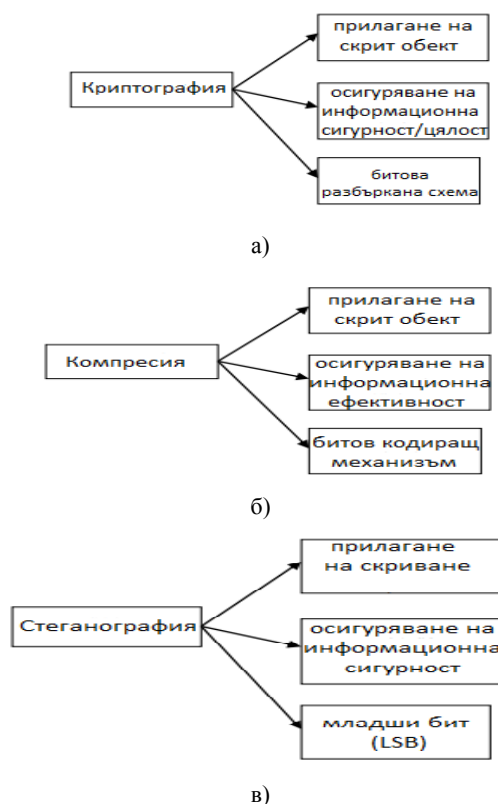
Информационната сигурност е една от най-желаните функции изисквани от потребителя при извършване на комуникация в публична мрежа. В [1] са представени цифровите технологии, включващи воден знак за подобряване на информационната сигурност и цялостността на данните.

От своя страна, [2] определя спектъра на изображението за да се скрие информацията в него. Авторът анализира изображенията в честотните ленти LL и HH, така че по-добрите спектрални области на изображението да бъдат идентифицирани. Определя еднотипната информация върху изображението, така че степента на изкривяване да не се увеличава, докато се вгражда тайната информацията. Тези изследователите са представили нова възможност за представянето на сигурността.

В [3] е представен криптографски подход, като се дефинира възможност за избор на размер, идентифицират се ефективните области на изображението и се кодира самото изображение. Теоретично се определя нов подход за запазване на качеството на изображението. Йерархичен подход за кодиране на изображение е представен в [4]. В [5] се представя визуална криптография чрез извършване на блоков анализ на изображението. Извлича се визуална информация и се изпълнява кодиране на информацията без разширяване на спектъра. В [6] е представен метод за подобряване качеството на изображението при извършване на криптографията.

2. Изложение.

Може да се намери сходство при осигуряването на информационна сигурност чрез методите на криптографията, стеганографията и компресирането. За целта е синтезиран триизмерен модел, използващ различни подходи за трансформация на изображения, с което се постига информационна сигурност и ефективност. Трите аспекта на този модел са представени на фигура 2.

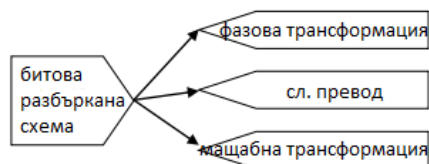


Фиг. 2: Триизмерен модел- а) Криптография, б) Компресия и в) стеганография

Анализирайки модела и проследявайки фигура 2, може да се каже, че сигурността се управлява в три различни напрвления.

Криптография

Криптографията е един от най-традиционните и ефективен подход за трансформиране на действителните входни данни в различна по вид трансформирана форма, за да се извърши кодирането на изображение. Извършва се кодиране чрез изпълнение на схемата за разбъркване на битовите. Разбъркването се извършва по начин показан на фигура 3.



Фиг. 3: Схема за разбъркване на битове

Тъй като всичко се основава на схемата за кодиране, изпълнявана върху входните данни и използвана чрез математически оператори, напълно постижимо и лесно ще може да се извлече обратно информацията от кодирано изображение. Параметрите на трансформацията ще работят като ключ към криптографския метод.

Сега след този процес на трансформация на бита, кодираният обект ще бъде получен. За да възстанови действителната информация от обекта, ще се приложи обратната трансформация.

Компресия

Вторият етап на информационната сигурност е компресията. Компресирането намалява размера на предавания обект. Кодиращият механизъм, който е дефиниран е кодиране без загуба, така че размерът на информацията да бъде намалена, без да се засяга самата информация. Компресията ще се извършва при преобразуване на размера в блока, който работи за извършване на блокова трансформация.

За да се осъществи този процес на кодиране, ще се приложи процесът на кодиране въз основа на векторно квантуване. Съгласно този подход стойностите на данните ще бъдат конвертирани под формата на масивни данни с размера на блок N. Размера на блок N ще бъде преобразуван в M блокови данни. Редукцията на битовите ще бъде изпълнена с размер N-M.

Стеганография

Последователността, която се спазва при прилагане на стеганографията за да се установи ефективността ѝ при осигуряване на информационна сигурност е следната:

- Преобразуване на прикриващия обект и обекта за криене в двоичен код и сравняване побитово на стойностите на най-младшият бит (LSB) на всеки пиксел;
- Замяна на LSB на прикриващия обект с бита на конфиденциалната информация;
- Добавяне на ключ, с който се гарантира и ефективна защита на информацията;
- Комбинирането на стеганографията с криптиращ алгоритъм гарантира по-висока защита на данните и осигуряване на информационна сигурност, което е цел на всяка скрита комуникация;
- Незабележимостта от прилагането на стеганографията е основна задача.

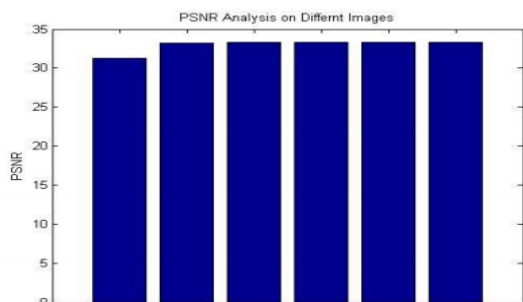
В последния етап на работа компресираният и кодиран обект ще бъде съхранен в прикриващото изображение, за да се генерира стеганографията. При този подход информацията се съхранява в 9 бита на всеки пиксел. Използваният цветови модел е RGB, и

Тези изображения се извличат от уеб източник, използван от други изследователи. Анализът на работата се извършва като се сравняват основни статистически характеристики MSE (Mean Squared Error), PSNR (Peak Signal to Noise Ratio), еднаквост, препоръчително е да се изследва и корелацията при възможност. Анализът и оценката се извършва с помощта на шест различни прикриващи изображения с еднакви размери, 256x256 пиксела, а вгражданото изображение е с размер 50x20.

Табл. 1. Сравнителен анализ статистически характеристики

Прикриващо изображение	Тайно изображение	MSE	PSNR	Еднаквост
1.jpeg	50x20	49.1362	31.2168	0.4721
2.jpeg	50x20	31.2375	33.1840	0.6995
3.jpeg	50x20	30.4333	33.2973	0.6810
4.jpeg	50x20	30.5768	33.2769	0.5874
5.jpeg	50x20	30.2942	33.3172	0.6622
6.jpeg	50x20	30.4298	33.2978	0.5513

В таблица 1 са представени резултатите от сравнителния анализ на статистическите характеристики на всяко от тестовите изображения, а фигура 4 визуализира с помощта на Матлаб съотношението на PSNR за всяко от шестте изображения.



Фиг. 4. Сравнителен анализ на PSNR

3. Заключение.

В този доклад се разглежда модел на сигурността, който позволява ефективно и защитено предаване на изображения. Подходът, който съчетава криптография и стеганография в изображения се характеризира с най-висока ефективност. Статистическите характеристики са получени с помощта на MATLAB. Резултатите показват ефективното кодиране на данните, независимо от прикривания обект статистическите характеристики имат сходни стойности. Разлика при PSNR се наблюдава в десетите, което е пример сходност в очкованите резултати при прилагане на стеганографията. Следващ етап на изследването е да се разгледа, как тези подходи преодоляват проблемите със стеганализата.

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