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TRANSPORT PLANNING ON THE LIBERALIZED MARKET OF PUBLIC SERVICES

Ing. Vít Janoš, Ph.D., Ing. Karel Baudyš, Ph.D.
Czech Technical University in Prague, Faculty of Transportation Sciences, Czech Republic
E-mail: janos@fd.cvut.cz; E-mail: baudys@fd.cvut.cz

Abstract: *The importance of transport planning in public services gradually becomes to be fully appreciated in the context of the Czech Republic. Public transport such as investment and operationally intensive industries require a guaranteed long-term strategy, not only in the field of transport infrastructure, but also in the field of transport services. The first prerequisite for successful transport planning is the most accurate description of passenger flows, including the parameters affecting the choice of transport mode. These inputs are an important basis for additional steps: the creation of a line network, timetable design, creating circulation of vehicles and courses of staff, controlling, and any requests for infrastructure improvements. At the end of this article are referred specific practical examples, where thank to a compliance with the rules of theoretical transport planning it has been achieved the increased operational efficiency of public passenger rail-transport.*

KEYWORDS*: RAILWAY TRANSPORT, PUBLIC TRAFFIC, RAILWAY TECHNOLOGY, TIMETABLE DESIGNING, PERIODIC TIMETABLE, TRANSPORT PLANNING, TRANSPORT DEMAND ESTIMATION, VEHICLE CIRCULATION*

1. Defining the objectives of transport planning

Currently, the transport planning in the Czech Republic stands in their factual beginnings. Institutionally transport planning establishes the "Law on public passenger transport services" (194/2010 Coll.), and individual orderers of public transport are thus required to build transport plans for its scope. Public transport in the concept of quality of transport service is more than just a social service for those who have no other option but to achieve an overall transport accessibility of the region so that public transport represent an attractive alternative to individual transport. The law on public passenger transport services (194/2010 Coll.), Title I, § 2, defines the transport service as follows:

Transportation services means the ensuring of transport every day of the week, especially in schools and educational institutions, the public authorities, to work, to health facilities providing basic health care and to meet the cultural, recreational and social needs, including transportation back, contributing to sustainable territory development.

The interpretation of this provision is quite clear, because it does not specify objectives, waiting time, number of transfers, number of connections, the number of people with the same destination and purpose of the trip, walking distance or other parameters of transport services and thus depends entirely on the specific access of the orderer to public transport services. All these parameters of transport services must identify the orderer and transport services are defined as the transport plan.

It is clear that public transport cannot cover all the passenger flows, nor all the transport needs of individuals. Public transport with regard to the need for compensation (income from fares do not cover the cost of providing) must have elements of the mass. If in a particular place and time together transportation needs of individuals in a transport flow, then it can be addressed by public transport organized on a collective basis. With regard to the rational planning of public transport and the final volume of funds for compensation payments (compensation) cannot be on the one hand these resources inefficiently spent on transportation of individuals and on the other hand not to have the resources to ensure transport in relationships with much higher demand.

Theoretical public transport planning takes place at 7 classic steps:

1) Estimation of passenger flows, part of transport modelling

2) Formulation of the line network plans

3) Implementation line network to the infrastructure, revision modal choice

4) Timetable design

5) Circulation plans of vehicles and stuff courses

6) Evaluation of the operation performance, controlling

7) Defining the requirements for the infrastructure improvements

This article briefly summarizes selected procedures leading to greater operational efficiency. On the example of planned tender for a rail carrier in the regional transport on the selected lines in the Region Jihočeský kraj, it is shown, how the compliance with the theoretical rules can lead to a reduction in the number of operating rolling stock, while increasing the supply of the connections. Because the regions compete in a regular public transport by the so-called "gross principle", where the yield risk is on the side of the public authority, this article focuses primarily on such transport-planning processes that affect the cost side of the transport concept.

1.1. Characteristics of passenger flows

The information of passenger flows is currently available mainly from the CSO data - data on the number of permanent residents in the municipalities and their local areas, information about regular commuting. Further information is available from carriers - information about the load-factor, number of boarding and alighting passengers at each stops, shortly will be provided the origin-destination matrices. For more information on the origins and destinations relate mainly to number of employment opportunities (data from major employers) and regular commuting school children - these data are used in abundance in the case of larger optimization of timetables in the region.

Available CSO data are not broken down by mode of transport attributable to a specific origin-destination, because this is the information about the total passenger flows - across all modes of transport. On the contrary, data from carriers are related only to a particular type of service and thus have explanatory power only for passengers who already use the public transport.

For a description of all passenger flows in the region across all transport modes can only be used the theoretical transport models. Thus established passenger flows can be followed on the basis of the

availability of origins and destinations of share assigned to each mode of transport - theoretically calculated passenger flows thus assign theoretical modal split. It shows how important is the role of public transport in a whole transport system where there is generally a high demand for transport and the passenger flows which makes it suitable to be targeted and at the same time, in which relations there is a most unused potential for public transport.

Contemporary no region today has processed quality transport model, because the benefits of high-quality and comprehensive transport modelling in the Czech area are still not fully appreciated. What is missing, is a quality travel surveys, surveys on the transport behaviour and sensitivity of users to parameters of public transport offer. Finally, it is difficult, often impossible, to group the time incommensurable data needed for the transport model setting.

For the purpose of transport planning are so often used incremental theoretical gravity models of passenger flows in the region. The output of these models is the proportional comparison of significance of passenger flows, often associated with the theoretical calculation of the modal split.

From the gravity model taking into account the modal split can be seen, how the public transport is successful in individual relations. Clearly then follows the disproportion in the region and the relations that represent the greatest potential for growth in public transport. Juxtaposition of relations can also be inferred where is potential for core railway lines, collecting railway lines and core bus services.

All the above information is important for line network planning and timetable improvements. Outputs of gravity model introducing the core and collecting lines with high (not yet used) potential will be applied gradually to the ongoing optimization of individual areas in the region.

1.2. General rules for the ensuring of transport services

Definition of passenger flows form the first input for the formulation of the line network. The second input is the restrictive conditions, which formulates each individual public service orderer. These restrictive conditions usually relate to the minimum limit for operating public transport. From our experience, there is a "critical" size of settlements where the passenger flows are not possible to capture on the collective principle and where the providing of public transport is very inefficient. Operation of such settlements is left to individual transport, or social services, and in these cases there are not provided public transport services. They are defined as:

- Municipalities and local area without an operation of public transport (where it is possible to solve transportation services using e.g. subsidized taxi service, social services, etc.)

- Community and the local area that are served to a minimum - there is usually used the limit according the number of permanent residents, combined with the requirement of minimum average daily exchange of passengers at the bus stop

- Parameters of the hierarchical organization of other lines that make up the network core / superior and subsidiary network

It is clear that in regular commuting is the greatest potential for public transport and should thus concentrate on measures that affect the modal split in favour of public transport in just this type of passenger flows. The key is to make the public transport system so attractive that it will use and the passengers who are free in their choice of means of transport (driving license holders and owners of a car - referred to as *captive drivers* and *choice drivers*) and not only those who do not choice (e.g. school children - *captive riders*).

1.3. General rules for line-planning in public transport

When creating a line network plan is necessary to combine aspects of passengers and technological and operational aspects, which combine the need of such a proposal, on the one hand positively affects Modal-Split in favour of public transport and on the other hand, such a proposal will be operationally viable.

This combination includes consideration the most important factors monitored by passengers:

- can be used between all points "shortest time" path
- the minimum number of changes

and most important operating factors:

- similar need of the vehicle-capacity along the whole length of the line
- minimum number of vehicles on providing the required operation performance

Based on the generated line networks of public transport, it is necessary to proceed to the definition of each segment of transport services. In this step, the plan will specify the stop/service strategy of lines in the network and define the function of individual lines in parts of the network where multiple lines were proposed simultaneously. When positioning time slots of each connection of particular line are assayed assuming the achieving of certain nodes in the network.

The line draft must consider the needs of homogeneous groups of passengers, for which is the line intended in terms of segmentation.

The main modifiable criterion is travel time, which is mainly based on network suspended waiting time. Due to operational capabilities and transport requirements (mainly interconnections for transit passengers) there are produced technology links in the timetable, i.e. the time dependence between two connections, respectively systematically between the lines. Scheduled line network significantly influences the Modal-Split and so should be given to the preparation of appropriate attention.

When creating the structure and hierarchy we can use a variety of terms that are easy to characterize a soft system (for example "regional services"), but if we want to project these concepts into a hard system, we are dealing with certain problems, since in the fully deterministic system is not possible to use intuitive definitions that work with the majority interpretation.

Building the structure of the public transport system must follow the hierarchy downwards, i.e. building the functional core systems. The reasoning used model layers (segments) of public transport, which together form an integrated structure. Segmentation method clarifies the structure of public transport.

Segmentation according to transport functions:

- Rapid transit between agglomerations (A)

- Rapid transport service between regions and within regions (B)

- Core regional transport (C)

- Collecting/distributing regional transport (D)

- additionally it could be considered an alternative segment (E) of additional transport systems

The individual operating segments have with regard to the time competitive with individual transport general recommended length of intervals based on general assumptions that the mean waiting time for a service should not be longer than the actual travel time. In the segmented system by transport function is very difficult to define the concept of regional transport, which is essentially perceived very intuitive. In practice, although institutionally defined by another orderer, but the actual impact of passenger flows this definition does not logically.

Regional transport we can delineate the way that a regional transportation means all that falls within the daily commuting. The structure and size of the confidence ellipse can be so intuitively define the concept of regional transport, while regional transportation is implemented in this concept across all segments A - E.

1.4. General principles of timetable design

Timetable of public transport is a direct result of the application of transport planning in the area and determines the structure and form of the offer.

The distribution of types of timetables for timetables without a fixed interval and with fixed period so there is a choice of type:

- Classic commercial timetable (connections are spread in the projected traffic demand)

- Interval schedule (fixed intervals always unchanging within part of the operational period, without a broader network of interconnections)

- And integrated periodic timetable (systematic coordination of timetables of individual lines, which are used in the selected interconnected periodic nodes to achieve maximum of optimal connections, to create a coherent network-wide interconnected periodic timetable. Unified cycle time on all lines is observed throughout all the civil day. Local requirements are addressed beyond periodic system by additional special connections)

The following figure expresses general applicability of different types of schedules depending on demand and interval combination:

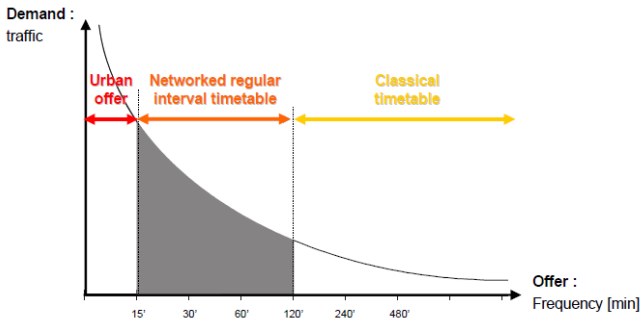

Fig. 1: *Models for the three levels of offer and demand (SMA und Partner)*

In the concrete operational level is not easy to find a specific time / place to change the type of schedule, because if the individual lines are hierarchically interconnected, then the change type between fixed and without a fixed interval almost always at the expense of transfer relations.

In the case of scheduled commercial applications are usually mostly covered with rush hours, which clearly determines the number of necessary sources (vehicles, staff), which are then often during the day unused. Commercial timetable means at our conditions almost always less operation performance than in periodic timetable and its ensuring is so associated with a relatively high proportion of fixed costs. The unit's performance is usually very expensive.

The transition from a commercial timetable to periodic in the initial phase all of the vehicles needed to ensure the transport peak in the intervals seeded throughout the operational period. So decreases the relative loss per unit of output, even though the variable costs are rising. Increasing offer leads to a progressive increase in the number of passengers carried and thus a more favourable development of revenues and reduce pressure on operating compensation payments.

The main benefit of integrated periodic timetable is consistency of public transport offer for passengers. Simplicity, ease of memorability, transfers without undue delay, and above all territorial and network availability. The concept of periodic and integrated periodic timetable is particularly appropriate where there are large passenger flows without clearly grasp time requirements (as in the commercial timetable), while the frequency of operation cannot be so high as to be able to give up on interchange links (as in the interval schedule). The concept of integrated periodic timetable is currently the highest possible level of public services offer.

1.5. Methods of circulation of vehicles and staff courses

There are many methods of production cycles of vehicles and staff courses. In the methods of operations research, this is called the assignment problem to be addressed such as the Hungarian method, which is generally known, and therefore will not be reported in detail.

Number of vehicles on the line does not be in itself determinative of their circulation. In any software solution assignment problem is passed optimization confronted with the need for operational maintenance. Existing software currently cannot take into account the operational maintenance in a particular location in the network after driving certain number of kilometers necessary for operating the maintenance. Number of possible combinations gives rise to NP-hard problems. Most software allows you to manually enter the transition vehicle (connection/connection) - so if there is circulation, which is at the normal operating maintenance option noticeable time vehicle downtime for this maintenance, then the transition will be set manually and optimization of the number of vehicles will take place again with this restrictive condition. But this is a manual intervention, which must always be done by the user. In an extreme case, this intervention leads to an increase in the number of vehicles. Operating maintenance options and associated increases the regular number of vehicles, as well as the extent of empty runs are directly associated with the location of depots/service centers. Choosing the appropriate service center for line servicing is connected to the schedule - his appearance, scheduled downtime of connections etc.

2. Application methods of transportation planning to the operating area of Šumava

On the concrete case of the operating regular public transport in the area Šumava in the region Jihočeský kraj were in the operational planning previous general principles applied. Jihočeský kraj is one of 14 regions in the Czech Republic responsible for ordering of public transport. Operating area Šumava is now generally geographically bounded by the towns of České Budějovice – Strakonice – Volary – Český Krumlov. Operational performance of around 1,38 million train-km per year providing 12 trainsets (vehicles), the average daily run of one vehicle is about 315 km in a day. This value is low and

create opportunities for increase. The costs associated with the vehicle (depreciation, maintenance), personnel costs (salaries, payments) and traction costs (fuel, electricity) are generally usually more than two-thirds of the total costs of transport capacity. When designing the most realistic operational concepts, from the outset attempt to apply maximum operating efficiency.

Operating concept Šumava is characterized by containing performances, that have character of purely regional transportation with daily commute, and performances, that are mostly tourist. Seasonality of several trains is so high, that in the summer, occupancy of individual connections are reaching to quadruple levels than during the off-season.

Based on the review of known facts about the occupation and load of individual train connections and CSO data were applied methods of timetabling leading to shorten of transfer- and travel times, with the following modifications:

- narrowing of transfer connections in the nodes
- introduction of fast regional trains in the peak tourist season (as a substitute for some of today's passenger trains)
- introduction of new embedded connections during the downtime of vehicles
- reducing the travel times during the tourist season contributed to the shortening of the vehicle-circulation-time, which extended the combinatorial possibilities for creation of their circulation and helped to reduce their number
- definition of the two-stage operation concept with identical demand of the number of the vehicles (where the second concept defined the requirements for modification of the infrastructure - with particular benefits to additional travel time reducing)

After designing of the basic structure of the periodic timetable and IPT-junctions were made minor changes in the raster of periodic timetable. In the morning peak hours were separately taken into account the requirements of the local time (starting times by significant employers, beginning of school hours) and the structure of IPT was often partially deflected. At the same time, during the morning peak hours was usually a structure of IPT preserved primarily in the main transport directions and main change linkages, which led to the minimization of the number of vehicles in the morning peak hour of the workday. It is just a morning peak hour of the working day, which determines the number of vehicles. The total volume of operational performace has been increased to 1,57 million train-km per year.

To minimize the number of vehicles in the network was used authors-own heuristic procedure, which can achieve such solution that takes into account the specifics of the operational processes (or as refueling or changing staff in a specific place, etc.). This procedure has 6 basic steps:

1) for every point in the network, where are starting or ending courses of single lines in the operational area, is created table of arrivals / departures
2) create a sets of "network conditional transitions" (such transitions of vehicles between course to course, whose failure leads to necessary occupying the default connection of an additional vehicle)
3) from these sets of network conditional transitions are by a sequence of courses created integrated continuous strings (the string terminates just at such place and time, when the vehicle has equivalent combination, crossing to another string - i.e. there does not arise network conditional transition)
4) individual strings are evaluated by its kilometric (for an operating treatment, or tanking) or time (in case of deployment of personnel and compliance with time breaks) length
5) thereafter follows coupling of strings into the complex circulation (for vehicles), or stays (for staff)
6) if the fact, that a string exceeds the beginning of the specified limit (the mileage or time duration), it is obvious, that it is necessary to use additional vehicle / personnel, which will further extend the possible combinations

This approach is equally usable for the production cycles of vehicles on road and rail, as well as for creating personal session. The procedure itself does not guarantee the creation of an optimal proposal (in terms of steady running vehicles, or optimal use of staff), provides however, that will be deployed only the minimum number of vehicles (or staff) in compliance to the boundary conditions. Limit to the number of vehicles in the application of this procedure lies in manual processing of approximately 30 vehicles, which from experience usually leads to the need for a combination of about 60-150 strings.

Application of these principles fully reflected in the operation costs. In operational area Šumava was the number of operating vehicles reduced by optimizing from 12 to 11, while the average daily running of the vehicle has increased from the current 315 km/day to the proposed 390 km/day. Since the extent of ordered transport was limited, it was not possible to further enhance the performance of vehicles. Such modified operational concept is prepared for the tender of Jihočeský kraj for selecting new rail-carrier.

3. Conclusion

The overall problem of transportation planning is very extensive. The aim of this article is not to describe in detail all the procedures and methods, which hides behind each step of transportation planning. Transportation planning as such is a complex task that is involved in many scientific disciplines. Individual tasks are closely related and cannot be resolved individually, without overlap in the overall context of the transport plan. The aim was to go through the steps that are necessary from the initial entry, the need to create operational concept to final product, including its timetable technical support. It was also the purpose to show, that the theoretical rules compliance can be achieved by increasing operational efficiency.

On the specific case of the operating area Šumava in the region of Jihočeský kraj, these principles fully take effect, when the current number of vehicles has been reduced, performance volume slightly increased, and additionally it was observed shortening travel times. The operating concept was also prepared for two states of operation - without modification of the infrastructure, and with infrastructure modifications. To ensure upward compatibility are both operational concepts optimized for the same number of vehicles, and the differ is in benefits in the region in the travel times. Thus prepared optimized operational concept is ready for the competition on the rail-carrier. In the case of market opening of public services should be preparation of the operational concept performed together with operational optimization. It´s one of the few ways to ensure long-term sustainability of public rail services. In a liberalized bus market in the

Czech Republic, the optimizing procedures of the operation brought the transport price reduction by 10-25 %. These savings were reinvested back into enhancing the quality of public service. It will be interesting to see, whether similar results come even in regional rail transport.

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LOGISTICS LEGAL REGULATION PROBLEMS

ПРОБЛЕМЫ ПРАВОВОГО РЕГУЛИРОВАНИЯ ЛОГИСТИКИ

Dr.N.Pepanashvili [1], Rs. I. Kochadze [2], Prof.Dr. T.Kochadze [3]
Ivane Javakhishvili Tbilisi state University [1], Ilia State University [2] - Tbilisi,Georgia;
Akaki Tsereteli state Unibersity [3] – Qutaisi, Georgia
ninopepanashvili@yahoo.com , Irakli.kochadze@iliauni.edu.ge , temko1954@mail.ru

Abstract *: Relationships that are the subject of logistics in general, in principle have still not been resolved from a juridical standpoint. Even individual types of logistics do not have holistic, integrated legal regulation. However, even the legal regulation of the transport logistics is a fragmented set of norms regulating individual types of transportation, but not a transport logistics in general.*

It is hard to imagine that in principle it is possible to develop a set of international legal standards, which would constitute a coherent legal system ensuring the functioning of macro-logistics systems, i.e. the so-called "the international logistics right" or "the right of international logistics systems". International practice is on the way of the development of legal regulation of individual logistics operations, but not of the logistics in general.

Many of the logistics spheres are not regulated by international law even on that level. Moreover, a large number of logistics operations is not regulated, even at the level of national law. Management of the goods distribution process, from the legal point of view, is one of the most "non-image" fields of economic activities.

There are adopted many international agreements in the field of international goods distribution (especially in the field of transport and customs regulation). However, majority of these agreements have hardly representative character (many of them, which are adopted quite a long time ago, still await either entry into force, because they do not have the required number of ratifications).

International trade interests, the process of international division of labor, and the internationalization of economic life have created a special tool of legal regulation - "Lex mercatoria" (international commercial law).

KEY WORDS : *INTERNATIONAL LAW; LOGISTICS; LEGAL FLOW; TRADE TERMS.*

1. Introduction

The progress of the logistics in all spheres of economic activities significantly exceeds its regulation by the state and state institutions. Functioning of the separate areas and spheres of logistical activities is subject to laws and subordinate legislation, whereas there is need for the methodologies of centrally unified regulation of the logistics chains as the set of subjects, objects and logistical activities for moving the material, information, financial and other flows from the initial point to the receiving point.

Insufficient readiness of the methods of legal regulation of the logistics processes in the supply chains, including the relevant legal framework, has a direct and indirect effect on: the activities of the logistics subjects, creation and application of documentation flows, execution of logistical operations and functions. In this context, there is required a scientific explanation of the processes of distribution and ownership exchange for the economic resources inside the logistical systems, as well as of the delegation of rights, duties and responsibilities of logistics subjects at all levels of logistics.

Guidelines for regulation of the interactions of the supply chain participants inside the logistics flows allow implementing more effectively the logistical management of material and followed flows inside and outside enterprise. It would be advisable to address the main logistics processes with a view to application to them the methods of legal regulation.

At present, such scientific areas began to take off as, on the one hand, legal economics, which combines an economic approach to legal aspects and, on the other hand, considering the economic and logistics theories from a juridical standpoint.

2. Preconditions and means for resolving the problem

The research data are based on the analysis of "boundary" zones of logistics as an area of the economics and other sciences – information technology, commerce, and employment and labor law. A logistical approach to the management of economic processes is based on the operation of information standards, business and other statutory acts in the field of logistics.

In the process of the development of logistics as a science, there have been studied the issues of the existence and functioning of logistics flows. Along with the generally accepted – material, financial and information – flows, they also started to consider the supporting, accompanying flows, including the documentation and legal ones.

Some issues of the application of the statutory acts in logistics are considered in the majority of manuals on logistics. However, they dwell on administrative or legal accompanying of the logistics procedures at meso- and macro-levels, for example, conclusion of the supply agreements, transport operations, considering the basis terms of delivery, legal status of the trade agents within the distribution channels, transfer of ownership during the process of the delivery of goods and so on. Thus and so, it is time to pose the question of the elimination of gap in the theoretical-methodological tooling of investigation of logistics chains with a view to legal regulation. Based on the analysis of statistical data of the contract-based activities of enterprises, as well as on the information on the pre-action and legal controversies on the issues of non-fulfillment of obligations flowed from these agreements, taking the account for the legal constituent in the modeling of meso- and macro-logistical systems contributes to the decrease in the number of violation of administrative and contractual obligations of enterprise to their employees, contractors and state, and consequently, the reduction of the amount of losses incurred in connection with payments of penalties. For the clearer substantiation of the character and role of legal regulation of the activities of enterprises, there is introduced the concept of legal flow as a kind of logistics flows. It is defined as a combination of legal standards and in-house acts of the organizations, and legal actions based on them, which regulate the rights and duties of the subjects of logistics in the management and control of logistical operations and functions for reaching the efficient solution of goals and objectives at micro-, meso- and macro-logistics levels. There is a need for the inclusion of legal flow in synchronizing band of the logistics flows that allows, on the one hand, considering the legal aspects of the activities of enterprises as an element of the logistical system, and on the other hand, taking account for the legal constituent of the logistical management during the enterprise costing, including determination of transaction expenses [1].

The role of the legal flow within the logistical system consists in: legal regulation of participants (subjects) of the logistical systems; setting the norms and rules for execution of logistical operations and functions; accompanying other types of logistics flows; creating the regulatory environment acting within a single logistical system or going beyond its limits.

The structure of the legal flow is represented by the following elements: documents; rights and functional duties of the logistics subjects; logistical operations and functions as a basis for arising the rights and responsibilities of participants of logistical processes. These elements act at three levels of logistics: micro-, meso- and macro-logistics levels. Based on the classification and structure of flow, there are identified the following main functions of it: ensuring the principles of economic efficiency, legal environment and optimizing logistical processes; creating the integrated legal environment, in which the subjects and objects of logistical system are acting; creating the effective basis for authorizing the subjects of logistical systems with rights, duties and responsibilities during the process of logistical activities; ensuring the integrated system of interaction of material, financial, information and other flows; ensuring the coordinated operation of all logistical sections during execution of logistical operations and functions; efficient distribution of rights of logistics subjects during vertical and horizontal integrations; inclusion of legal foundation in vertical hierarchy of the supply chain management.

Legal regulation of logistical processes is based on the application of regulatory and legal framework as one of the instruments of centralized and objective impact on the activities of economic entities. An important thing is the correct definition of legal regulation principles of logistics management of the production-commercial activities of company at micro-, meso- and macro-levels of logistics that allows assessing the necessity of effective application of the regulatory legal acts in organization of logistical processes.

The methodology of legal regulation of the analysis of company's economic activities is based on the elements of general economic analysis with consideration of logistics principles. At each logistics level there are used the same particular principles. For example, the micro-level is represented by company's internal structure and combination of main stages of its activities. Taking into consideration of the matter of logistic analysis of legal flows, as well as their character, structure and link with other logistics flows as an algorithm of analysis, the outline of analysis of management of micrologistical system is applicable.

The meso-level is represented by commercial activities of enterprise, its relationship with the state, municipal organizations, legal and natural persons during the execution of all logistical business-processes.

The macro-level is represented by the external environment of enterprise, which is conditioned by economic, social, political and other factors of regional, federal and international importance. The highest significance is given to the analysis of the activities of enterprise at a meso-level, which consists of the following stages:

1. Defining purpose and performance evaluation criterion of legal ensuring with account for peculiarities of logistical system of a particular enterprise, tiesd with logistics subjects at meso-level, and strategic and tactical plans of the company;
2. Decomposition of purpose, its breakdown into sub-purposes according to strategic, tactical and operational plans, functional area of logistical activities and subject matter of existing commercial relations of the company.
3. Evaluation of objectives and factors with a view to time, resource and financial costs, conditions of environment and interdependence of objectives.
4. The analysis of the structure of mutual relations – studies of subject and object matters, and logistics tooling of commercial activities of enterprise with account for legal constituent.
5. Identification of problems in functional areas of logistical activities – studies of drawbacks in logistics chains of different functional areas of logistics, in commercial and contracting documentation, violations of requirements of legislative and regulatory acts. Identification of problems includes finding and exact defining of problem, analysis of its statistical and dynamic state, defining the ties with other problems.
6. Decomposition and analysis of sources of problem – determining the factors influencing on origin, development and transformation of problem, its breakdown with respect to object and functional signs.
7. Determining the means for problem solving:
   - the availability of possibilities of problem solving;
   - defining and evaluating the options of solving;
   - selection of option (options) for problem solving.
8. Forming of the program and control include elaborating the program, projects and development plans of legal logistical system, their regular succession and stage-by-stage approach, determination of executives, their rights and duties, and control of program performance.

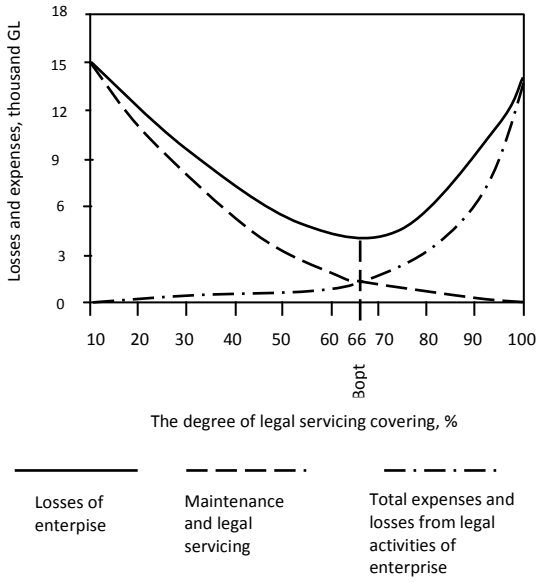

Fig. 1. *Nature of the change of total cost structure of the company for legal support of the production-commercial activities.*

The increase of the effect occurs owing to decreasing, but not excluding expenses, including for legal support of the activities of enterprise. With effective legal servicing, the economic losses of company go down, but there are appeared the service costs. Thus and so, there is a certain optimum relationship of the volume of legal ensuring and total costs incurred by enterprise (Fig. 1).

Performance evaluation of legal support of the production-commercial processes in logistical systems has a complex nature of dependency on the degree of covering the costs for this support. The legal ensuring of the company's activities is carried by legal service, and it can be evaluated by using a number of legal indicators. Thus and so, it is possible to set a question about performance evaluation of the activities of legal service in the enterprise with a view to relation of costs for its maintenance and savings, which is ensured by it for the enterprise.

The formation process of the model of logistical activities of enterprise comprises conducting the following steps:

1) Analysis of exiting legal regulation of logistical processes within supply chains;
2) Planning of statutory-legal support of company's logistical system.
3) Developing the project of public administration of processes company's logistical system, including legal support.
4) Approbation and application of proposed logistical system.
5) The process of using and evaluating of logistical system with account for its state regulation.

6) Approbation and application of proposed logistical system.
7) The process of using and evaluating of logistical system with account for its state regulation.

3. Conclusion

The model of logistical activities of company with account for legal elements fosters identification of economic, legal, production and other factors influencing on passing all stages from the initial point to the point of destination by material and followed flows, with account for logistics subjects, objects and activities at all levels. Taking account for the combination of these factors should allow lowering the negative impact of these factors and increasing efficiency of company's logistical activities due to reducing costs, decreasing the number and volume of penal sanctions and losses caused by legal infringements in the activities of logistical systems at micro, meso and macro levels.

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A MATHEMATICAL MODEL OF OIL SPILL DIFFUSION IN NEAR-SHORE ZONE OF GEORGIA

МАТЕМАТИЧЕСКАЯ МОДЕЛЬ РАСПРОСТРАНЕНИЯ НЕФТЯННОГО ПЯТНА В ПРИБРЕЖНОЙ ЗОНЕ ГРУЗИИ

Dr. eng.Tsetskhladze R., Assoc.Prof. Chogovadze J. Emeritus R. Chabikiani
AkakiTsereteliStateUniversity, Kutaisi, Georgia
jumberi54@gmail.com

Abstract : *The oil products remain the main contaminant of the Black Sea, as well as of the entire world's oceans. A main amount of oil is transported by tankers and reloaded in port terminals. 12 per cent of overall marine pollution is the share of transportation, oil congestion and accidents losses. At the Caspian-Black Sea-Mediterranean area there are actively used the Black Sea ports of Batumi, Poti and Kulevi.*

A huge damage to the nature is doing by oil spills on the surface of the oceans and seas owing to transportation oil by tankers. These spills are associated with loading and unloading operations as well as with tankers accidents. In this case, the oil spreads as a spot on the surface of the sea.

Problems associated with environmental pollution from the oil spill in the sea, made necessity to develop mathematical models that describe the transportation and transformation processes of oil spills. The proposed mathematical model can be used for prediction of the spread of an oil spill during the process of spreading of oil products on the water surface, and it also enables to take into account the reduction of the area of spill due to the action of sea-surface winds and turbulence of the water surface.

KEY WORDS : *BLACK SEA, OIL SPILL, MATEMATIKAL MODEL, TRANSFORMATION PROCESSES.*

1. Introduction

The oil products remain the main contaminant of the Black Sea, as well as of the entire world's oceans. According to International Energy Agency, oil production is 91,3 million barrels per day, from which 3/5 – is transported by tankers, 2/5 – through pipelines, i.e., a main amount of oil is transported by tankers and reloaded in port terminals; 12 per cent of overall marine pollution is the share of transportation, oil congestion and accidents losses. Experts estimate that by 2020, the world consumption of crude oil will be increased by 1,2-1,5. Besides, the demand for oil in developing countries will be increased by 2,5-2,8, and in advanced countries – by 30-35%.

In the near future, the annual volume of oil transportation in the Black Sea may be increased to 220-250 million ton. Besides, it is expected to transport annually: 50 mln through the ports of Ukraine; about 60 mln – through the ports of Russia; about 30 mln – through the ports of Georgia; about 25 mln – through the ports of Bulgaria; about 35 mln – through the ports of Turkey. Without regard to accidents, only with technological loss at 0,01% of the volume of transported oil products, about 20 thousand ton of oil products may be discharged into the marine environment. During accidents, these losses may be increased tenfold.

At the Caspian-Black Sea-Mediterranean area there are actively used the Black Sea ports of Batumi, Poti and Kulevi. Navigation and the maritime transport objects of Georgia have significant impact on the Black Sea ecosystem.

A huge damage to the nature is doing by oil spills on the surface of the oceans and seas owing to transportation oil by tankers. These spills are associated with loading and unloading operations as well as with tankers accidents. In this case, the oil spreads as a spot on the surface of the sea. Just one liter of oil is enough for forming of spill of almost 1 hectare. Besides, depending on the quantity of oil and the velocity of spreading the spill can be appeared either in the form of “peak” emission or as a continuous ingress of oil within a certain period of time.

2. Preconditions and means for resolving the problem

Problems associated with environmental pollution from the oil spill in the sea, made necessity to develop mathematical models that describe the transportation and transformation processes of oil spills. Such models are used for prediction of the spread of an oil spill and for estimate of its characteristics required for planning and carrying out activities for the liquidation of spills in the events of accidents, as well as for assessment of environmental impact.

The process of spreading the oil spills in the sea is a fairly complex process, which depends on a large number of factors defining as the state of the environment so the properties of substance itself. Thus, the solution of this multifunctional problem requires a comprehensive and integrated approach.

When setting the problem on oil pollution transfer into the sea, it is necessary to adequately describe not only physical-chemical properties of oil itself and the character of the source of pollution, but also such characteristic as the diameter of oil spill.

The realized complex takes account for the following processes that occur with oil as the object under study: 1. Oil spread; 2. Displacement caused by the sea water flow and wind.

For the first process of spilling of liquid lighter than oil over the water surface, it is necessary to emphasize several merging one into another stages, from which the most important for spills less than 2000 m^3 is the phase of spreading under the action of forces of the superficial tension of oil so far as the spill remains a single whole. This process is thoroughly investigated through the experiments of John Fay by modified semiempirical formulas.

The oil spill diameter against the wind direction Ry is determined as follows::

$$\sigma = \left[\frac{\rho_W - \rho_0}{\rho_0}\right]^a$$

Here,

where, ρ_W - is the sea water density;

ρ_H - oil density; M – the volume of the initial spill of oil.

t – time of spill;

a, в, c – spreading coefficients of layer (a=42,5; в=1/3; c=1/4)

The oil spill diameter in the direction of wind R_X:

where, W – the wind velocity, m/sec;

β = 1,82; d=4/3; e=3/4.

2. The process of displacement of oil pill under the action of sea current and wind. пятна под действием течении моря и ветра; It is assumed that the oil products move by means of the following factors:

1. Sea water current;
2. The wave action arisen near the margin of coast of water area. .

The process of displacement is described by the expression:

$$V_t = K_W W_t + K_u U_t + K_S(L) F_t$$

where, $\mathbf{V_t}$ - the vector of velocity of the shift of the center of "micro-spill";

$\mathbf{W_t}$ - the vector of wind velocity at a height of 10 m from the surface of coast;

$\mathbf{U_t}$ - the vector of the total wind and flood currents;

$\mathbf{F_t}$ - the influence vector of the coast and its configuration;

K_W - the influence coefficient of wind – in the calculations it is assumed that each spill has its own coefficient of permissible range 2-4%;

K_u - the influence coefficient of the sea water current. In calculations it is taken as equal to 100%.

K_S - the influence coefficient of the coast by the distance from spillage.

3. The wave action arisen near the coast-line.

The coast-line has a significant influence on "micro-spills", since with decreasing water depth the waves turn toward the coast. This factor is especially evident when the angle between the coast normal and vector is under 90^0. When the distance to the coast is reduced this influence is more violent. The influence coefficients of the coast are the empirical values and they are determined during the experiments.

As the input data the following information is used:

1. The sea-coast configuration;
2. Meteorological situation for the entire period of modeling;
3. The real or calculated currents;
4. The place and dynamics of spillage of oil products.

The air temperature on the Georgian coastline during the most cold months – in January and February – is an average minimum of $4,3^0$C, $3,8^0$C, but some days it can be lowered to $-5,3^0$C, $-7,5^0$C. During the most warm

months – in July and August – the mean temperature of air is $22,3 – 23,1^0$C, the absolute maximum is $37,6 – 41,0^0$C.

For most of the year, the north-east winds blow in near-shore zone of Georgia, which are characterized by considerable velocity and duration, but in the winter they bring cooling. In the summer, the south winds are not unusual. The violent winds occur mostly in winter and autumn. The currents mostly depend on winds.

The process of merging of oil into the "micro-spills" occurs as follows:

a) by gravitational viscose forces and by surface tension forces, which move under the action of water and wind current during a certain period of time;

by the division of spill into individual particles under the action of wind and current (there is applied the Lagrangian method by using of the stochastic nature of the formation of spills by particles).

It turned out that right after the spillage, there begins the spreading and displacement of oil over the water area of reservoir; when reaching the specified thickness of lash, the spill is divided into individual N particles, each of which has a certain mass and henceforward is considered as the «micro-spill". Then for each particle there begins the iteration (repetitive_ process of calculating its displacement trajectory. This process proceeds for each particle: a) until it reaches the coast; b) until it goes beyond the boundaries of computational region.

The results of theoretical calculations have shown that the diameters of petrol and diesel fuel spill are not very different from each other. This is explained by their densities, the values of which are almost the same. Similarly, the diameters of the mazut and oil spill are also not different from each other, but their values are by 23% lower than the diameters of petrol and diesel fuel spill.

Fig. 1 shows the change of the oil spill diameter with the dependence on time of spreading. As is seen from the diagrams (Fig. 1), the diameter of spreading of oil spill depends significantly on the wind direction.

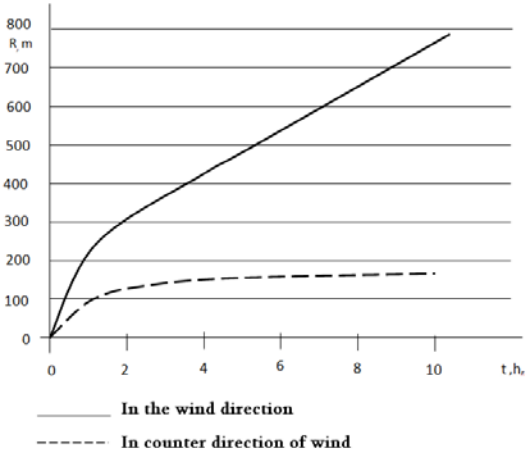

***Fig. 1**. The change of the oil spill diameter over the water surface with the dependence on time*

According to the results of studies (Fig. 2), there are constructed the diagrams of distribution of mazut both in the water area and in near-shore zone of Georgia.

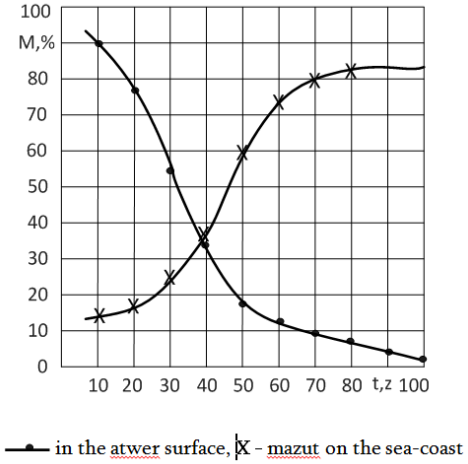

***Fig. 2.** . Distribution of mazut in the water area and near-shore zone of Georgia*

The movement of the layer of mazut spill in near-shore zone of Georgia and in the water area is determined by the field of wind, the state of the sea surface and physical-mechanical properties of the mazut itself. The use of the method of spill division into elementary particles allows assessing the quantity of distributed oil products within particular territories, as well as determining the trajectory of displacement of these particles.

3. Conclusion

It has been established by the calculations that the diameter of spill increases with increasing quantity of the spilt oil. The maximum diameter, which can be reached by oil spill also depends on the quantity of the spilt oil and oil products over the water surface.

The wind direction as well as its rate has more significant influence on the oil spill diameter than the density of oil and oil products.

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BALLAST WATER IN THE BLACK SEA GEORGIAN COASTAL ZONE

БАЛАСТНЫЕ ВОДЫ В ЧЕРНОМОРСКОЙ ПРИБРЕЖНОЙ ЗОНЕ ГРУЗИИ

, Dr. eng. Shotadze A., Prof. Dr. Kochadze T., Assoc. Prof. Dr. Kamkamidze N.
– Akaki Tsereteli state University, Kutaisi, Georgia
ashotadze@hotmail.com , Temko1954@mail.ru,, natia.kam@yandex.com

Abstract: *Today global shipping transports over 90% of the world's commodities in intercontinental traffic. Within the EU,waterborne traffic accounts for more than 90% of foreign and approximately 40% of domestic trade, transfers around 12 billion tons of ballast water across the planet each year. While ballast water is essential for safe and efficient modern shipping operations, it may pose serious ecological, economic and health threats. Trends anticipate an increasing role for global and local shipping in the future Apart from harmful effects such as consequences of shipping disasters, shipping activity exerts other negative influences on the environment; e.g. sea pollution through the discharges of oily water and sewage water from vessels, air pollution from exhaust gases emitted from the vessel's machinery, pollution of water and marine organisms from toxic protective underwater hull coatings(antifouling paints), and one of the most recent water born concerns – the translocation of harmful organisms and pathogens via ballast water and sediments inside ballast water tanks.*

Ballast water is absolutely essential to the safe and efficient operation of modern shipping, providing balance and stability to unla-den ships. However, it may also pose a serious ecological, economic and health threat for sea nature life.The introduction of invasive marine species into new environments by ships ballast water is an issue that does not always receive the public exposure that it merits.

Despite the serious degradation that has already occurred in the Black Sea, studies have indicated that concerted action can both restore and protect the environment. But the problem clearly requires a multi-lateral approach .The introduction of invasive marine species into new environments by ships' ballast water attached to ships' hulls and via other vectors has been identified as one of the four greatest threats to the world's oceans. The other three are land-based sources of marine pollution, over exploitation of living marine resources and physical alteration/destruction of marine habitat. Quantity of ballast water is change depend of ship's type. The release of ballast water may introduce non-native organisms into the port of discharge.

Black Sea geography contributes to the manifestation of additional environmental risks: these sea or do not have access or have a very limited relationship with the oceans. Pollution from land-based sources is one of the main causes of environmental degradation of rivers and, as a consequence, seas and coastal areas. Pollution from ships and other activities in the seas are another factor contributing to the deterioration of the environmental status of marine waters and coasts.Much of Georgia's coastal zone is subject to significant anthropogenic pressures, that could be reason of causing the pollution of marine environment.

KEY WORDS : *COASTAL ZONE, MARITIME TRANSPORT, BALLAST WATER MANAGEMENT, MARINE POLLUTION.*

1. Introduction

Today global shipping transports over 90% of the world's commodities in intercontinental traffic. Within the EU,waterborne traffic accounts for more than 90% of foreign and approximately 40% of domestic trade, transfers around 12 billion tons of ballast water across the planet each year. While ballast water is essential for safe and efficient modern shipping operations, it may pose serious ecological, economic and health threat. Trends anticipate an increasing role for global and local shipping in the future
What is ballast water?

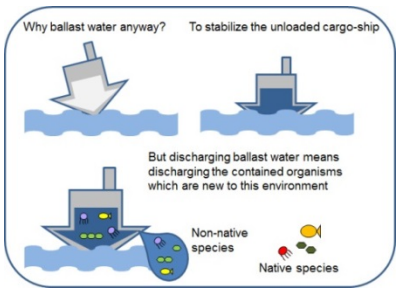

Figure 1.
Ballast water provides stability and manoeuvrability to a ship. Usually ballast water is pumped into ballast tanks when a ship has delivered cargo to a port and is departing with less or no cargo. Large ships can carry millions of gallons of ballast water.

Ballast water discharged by ships can have a negative impact on the marine environment. Ships use a huge amount of ballast water, which is often taken on in the coastal waters in one region after ships discharge wastewater or unload cargo, and discharged at the next port of call, wherever more cargo is loaded. Ballast water discharge typically contains a variety of biological materials, including plants, animals, viruses, and bacteria. These materials often include non-native, nuisance, exotic species that can cause extensive ecological and economic damage to aquatic ecosystems, along with serious human health issues including death.

The ballast water inside a ship can be seen as an onboard aquarium full of microscopic life forms. That's because small organisms living in the sea water are pumped into ballast tanks along with the water. Moreover, coastal sediments and any associated organisms may be pumped into ballast tanks.

The ballast water is taken from coastal port areas and transported inside the ship to the next port of call where the water may be discharged, along with all the surviving organisms. This way, ballast water may introduce organisms into the port of discharge that do not naturally belong there. These introduced species are also called exotic species. Populations of exotic species may grow very quickly in the absence of natural predators. In that case they are called 'invasive'.

Only few species are successful invaders, because most species are not able to survive in new surroundings, because temperature, food, and salinity are less than optimal. However, the species that do survive and establish a population are very hardy species that have the potential to cause major harm (to ecology, economy or human health).

Ballast is defined; "ballast is any material used to weight and balance an object. It is the additional weight necessary to bring the vessel to a suitable draft and trim and reduce stresses and improve stability." In the ship's terminology ballast is divided two types: clean ballast and dirty ballast. Clean ballast, if discharged from vessel that is stationary into clean,calm water on a clear day would

not produce visible traces of oil on the surface of the water or on adjoining shore lines. Dirty ballast, to seawater introduced into cargo tanks upon completion of cargo discharge (Huge, 2001).

Ships have carried solid ballast, in the form of rocks, sand or metal, for thousands of years. In modern times, ships use water as ballast. It is much easier to load on and off a ship, and is therefore more efficient and economical than solid ballast. When a ship is empty of cargo, it fills with ballast water. When it loads cargo, the ballast water is discharged. Shipping moves over 80% of the world's commodities and transfers approximately 3 to 5 billion tones of ballast water internationally each year.

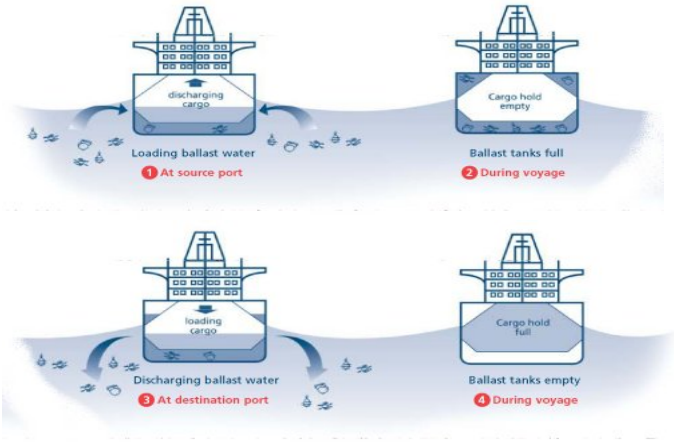

Figure 2. Ballast exchange between ports (IMO GloBallast)

There are thousands of marine species that may be carried in ships' ballast water; basically anything that is small enough to pass through a ship' ballast water intake ports and pumps. These include bacteria and other microbes, small invertebrates and the eggs, cysts and larvae of various species. The problem is compounded by the fact that virtually all marine species have life cycles that include a plank tonic stage or stages.

2. Preconditions and means for resolving the problem

The release of ballast water may introduce non-native organisms into the port of discharge. These introduced species, or bioinvaders, are also referred to as exotic species, alien species and no indigenous species. Typically, very few organisms are able to survive in new surroundings because temperature, food, and salinity are less than optimal; however, the few that do survive and establish a population have the potential to cause ecological and economic harm. Populations of bioinvaders may grow very quickly in the absence of natural predators. In turn bioinvaders may displace native organisms by preying on them or out competing native species for food and habitat space. Economic damage may occur when a bioinvader displaces species that are harvested for food or other goods, or when bioinvaders damage structures.

Apart from harmful effects such as consequences of shipping disasters, shipping activity exerts other negative influences on the environment; e.g. sea pollution through the discharges of oily water and sewage water from vessels, air pollution from exhaust gases emitted from the vessel's machinery, pollution of water and marine organisms from toxic protective underwater hull coatings(antifouling paints), and one of the most recent water born concerns – the translocation of harmful organisms and pathogens via ballast water and sediments inside ballast water tanks.

Ballast water is absolutely essential to the safe and efficient operation of modern shipping, providing balance and stability to un-laden ships. However, it may also pose a serious ecological, economic and health threat for sea nature life.The introduction of invasive marine species into new environments by ships ballast water is an issue that does not always receive the public exposure that it merits.

But the problem clearly requires a multi-lateral approach .The introduction of invasive marine species into new environments by ships' ballast water attached to ships' hulls and via other vectors has been identified as one of the four greatest threats to the world's oceans. The other three are land-based sources of marine pollution, over exploitation of living marine resources and physical alteration/destruction of marine habitat. Quantity of ballast water is change depend of ship's type. The release of ballast water may introduce non-native organisms into the port of discharge.

Black Sea geography contributes to the manifestation of additional environmental risks: these sea or do not have access or have a very limited relationship with the oceans. The Black Sea region presents a most unusual environmental problem. Of all the world ís inland seas, it is the most isolated from the world ís oceans. Its only link with other seas is with the Mediterranean, through the narrow channel so for the Bosphorus strait, the sea of Marmora and the Dardanelles. Relative to its size, this is indeed a tenuous link.Yet almost a third of Europe and huge areas of Asia drain into the Black Sea and more than 160 million people live in the overall Black Sea catchment area. The Black Sea coastal zone is densely populated. In the summer season, the permanent population of around 16 million swells to around 20 million with the influx of tourists.

During the last 30 years, the Black Sea environment has been transformed by the harmful effects of
modern industry, agriculture and fishing. The add aditional damage caused by exotic marine species and pathogens in ships ballast water is another major contributor to the degradation of the environment, Pollution from land-based sources is one of the main causes of environmental degradation of rivers and, as a consequence, seas and coastal areas. Pollution from ships and other activities in the seas are another factor contributing to the deterioration of the environmental status of marine waters and coasts.Much of Georgia's coastal zone is subject to significant anthropogenic pressures, that could be reason of causing the pollution of marine environment, and should be adopted the measures that will represent a significant step forward in the battle to reverse those harmful effects.

The introduction process of alien species is still ongoing in the Black Sea and it needs to be monitored at the national, regional and international level. A special monitoring programme is requested for key areas, in order to understand better the dispersion patterns of alien species. The impact of the alien species is complex and most of the time unpredictable due to lack of monitoring and the lack of scientific knowledge about those species. Experts on alien species, such as taxonomists, should be trained and encouraged. Capacity building for riparian countries is essential for the monitoring of alien species. Initiatives for the database management on Mnemiopsis and other jellyfish should be continued by an international organization like the Black Sea Commission. The International Convention for the Control and Management of Ship's Ballast Water and Sediment (BWM Convention) within the International Maritime Organization (IMO) system was adopted in 2004. This convention has not come into force yet but in some countries like, the Russian Federation,

Turkey and Ukraine the port authorities request the reporting of ballast water and follow ships to their ports. In a port Novorossisk, ballast water is monitored for chemical contamination. Ukrainian authorities sample ballast water to assess possible chemical contamination (Matej and Gollash, 2008). Turkish authorities conduct a project for the impacts of the ship ballast waters on the

Turkish Seas. This kind of implementation should be encouraged to prevent alien species to enter local seas. To control alien species via incoming ships, a defined concerted area for discharging ballast water should be established in the Black Sea. Some of these national or local Ballast Water Management legislations are generally consistent with the IMO Convention but others impose different and often more stringent requirements on ships. Inevitably this leads to confusion amongst owners, operators and seafarers.

There may be conflicting requirements at different parts of a voyage which inevitably increase the risk of regulations being breached. Most introductions of non-indigenous species result from ballast discharge and sediment from vessels after ocean crossings. Georgia is an exporting country. Most vessels arriving in Georgian ports discharge ballast and then load oil. According to the Convention on the Protection of the Black Sea emptying segregated, un-contaminated ballast water is allowed. But different countries of the region enforce the Convention differently. For example, vessels calling for the port of Odessa have to change their ballast water immediately upon entry into the Black Sea area. This has to be recorded in the ship logbook. This policy is not a viable solution, since ballast waters are emptied upon arrival in the Black Sea.A synopsis of known national and local ballast water management regulations for Georgia .

Figure 3.

According to the National ballast water management requirements (January 2014) ,Lloyd's Register Marine
2.8 Georgia .
Authority: Georgian Environmental Protection Ministry;
Ports affected: All Georgian ports;
Ships affected:All;
Implementation:Mandatory;
Start date: No information;
Acceptable methods: Ballast water exchange (BWE): BWE must be conducted in the
Black Sea;
Unwanted organisms and pathogens: No information;
Uptake control:No information;
Sampling:No information;
Ballast Water Management Plan: Required ;
Records and reporting:No information;
Alternatives to en route management procedures: No information;
Procedure for unacceptable ballast water: No information;
Notes: No information.

3. Conclusion

Despite the serious degradation that has already occurred in the Black Sea, studies have indicated that concerted action can both restore and protect the environment, and should be adopted the measures that will represent a significant step forward in the battle to reverse those harmful effects.

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DIESEL ENGINE'S COMBINED CARBURETION PROCESS

ПРОЦЕСС КОМБИНИРОВАННОГО СМЕСЕОБРАЗОВАНИЯ В ДИЗЕЛЬНОМ ДВИГАТЕЛЕ

Assoc.Prof. Dr. Topuria R., Prof. Dr. Kochadze T., Eng. Shotadze Z.,
– Akaki Tsereteli state University, Kutaisi, Georgia
r.topuria@gmail.com ; Temko1954@mail.ru ; ZURAB.SHOTADZE@gmail.com

Abstract *: The carburation process in modern diesel engines practically begins with the moment of fuel injection in into the cylinder, and ends at the same time as the combustion process. The improvement and development of the carburation process depend on the injection parameters, particularly on: the motion of charge in the combustion chamber; fuel properties; combustion chamber sizes; a surface temperature; interdependent motion of charge and fuel. With a view to carburation in diesel engines, we obtain a nonhomogeneous mixture in diesel engines. First of all, the internal carburation process cannot ensure uniform distribution of the injected fuel's steam and air. Besides, the improvement of carburation process is impeded by fact that as a result of the combustion process development there occur the fuel injection and carburation that increases that amount of fuel, which is burnt in the expansion line. All this causes increasing thermal heat losses and growing amount of toxic substances in exhaust emissions. Also, the improvement and efficiency largely depends on the length of self-ignition impeding period that directly defines the engine's dynamic magnification factor. The paper dwells also on the possibilities of partial eradication of negative phenomena and increasing the engine's efficiency, as well as reducing toxicity. In the engine's intake system, the electric injector is inserted, by means of which, at the beginning of the intake process, there is carried out the injection of a certain amount of fuel in front of the inlet valve, and together with the air coming into the cylinder it creates the mixture, which occurs during the filling and compression process, and at the end of the compression process, the main amount of fuel is atomized by means of basic injector.*

By the end of the compression process, until the fuel is atomized from the basic injector, we have the depleted, but almost homogenous mixture, and therefore, this mixture is uniformly distributed in the combustion chamber. At the same time, the primary oxides, to a certain extent, are created for starting combustion. Immediately after the fuel atomizing from the basic injector, we will obtain the mixture required for combustion, and the combustion process begins earlier than during the process of the creation of a standard mixture, and this means that the length of self-ignition impeding period reduces, and consequently the efficiency goes up, and the amount of soot in exhaust emissions is reduced.

KEY WORDS : *DIESEL ENGINE, CARBURATION, FUEL INJECTION, TOXICITY.*

1. Introduction

The work process of ignition mixtures for diesel engine is conventionally divided into the following main phases: [1]

• initial stage of time τ_1 - during which the temperature rise is negligible, or it may be a decrease of temperature, so that the pressure does not increase. Completion by the end of this stage formed aldehydes, oxides of carbon, oxidants and decomposition products;

• Initial stage refrigerating plasma τ_2 - during which allocated 10% of the heat evaporation of burned fuel, whereby there is a slight increase in temperature and pressure. Suggest that at this stage of the process , take place the oxidation of acetaldehyde and achieved critical concentration of new types of oxides and the accumulation of their products.

• secondary cold-flame stage τ_3 - during the passage which chemical reaction has as endothermic and exothermic nature, There are a slight total heat allocation process, and it is accompanied by shades of blue flame.

Thus, each review stage, which is carried out in a specific time period, gives the ignition delay: τ_1 - Cold flame; τ_2 - blue flame, which also refers to a stage cold flame and τ_3 - thermal explosion. Thus, the ignition delay period is equal to $\tau = \tau_1 + \tau_2 + \tau_3$ which is shown in Fig. 1. Of the three stages of the ignition delay period long stage period period τ_2 is long stage period - cold flame , that is 75-80% of the total ignition delay period. Thermal explosion spreads srapidly in the cavity of the combustion chamber and is characterized by the release of the total thermal energy, followed by Instant increase pressure and temperature. (Fig. 1).

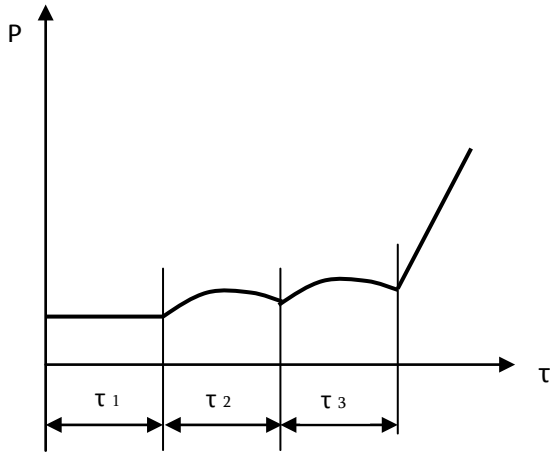

Figure 1. *Schematic representation of the ignition process in the diesel engines.*

Duration of the various phases of the autoignition delay period depends on the specific conditions. Thus, with increasing pressure during the ignition delay period, the first and the third stages are greatly reduced,at the same time, the initial process of the nature of the flame remains generally unchanged. respectively, for ignition of fuel in a diesel engine will not be necessary the existence of all three consecutive steps. So, for the τ3 stage ,with a very small period of time process is a two step process. In this case, the second and the third stage correspond to the initiation high cold ignition flame in the first stage. So at the same time periods second and third stages of $\tau_{2,3} = \tau_2 + \tau_3$ are considered as a hot flame delay. interpretation of this ignition delay period, comfortable enough, because somewhat difficult to distinguish (separate) the time of appearance of the blue flame and thermal explosion. Accordingly, the essence of the final process of auto-ignition in a diesel engine is the implementation of a possible auto-ignition of the working mixture provided when the working mixture with an initial low temperature.

2. Preconditions and means for resolving the problem

The duration of the time of the ignition delay period τi of diesel engines depends upon many factors, including temperature and air pressure in the cylinder at the fuel injection timing. The influence of these parameters for a ignition delay time is important because fuel injection moment into the cylinder, the process of mixing at the end of compression depends on the compressed air and temperature. This means that if the allowable temperature and pressure values are lower, then the ignition delay increases and therefore worsens mixing process which negatively affects on the efficiency of the engine and toxic properties .

Air pressure and temperature during the filling process - Increasing values of these parameters at the end of compression occurs with increasing temperature and pressure, respectively, with fuel spray. As a result decreases time of autoignition delay, therefore heating the incoming air is a good opportunity to ensure the normal development of the combustion process, but it should be noted that heating the inlet air reduces the quality of the degree of filling of the cylinder and, hence, efficiency engine performance ; increase of quality of compression increases the pressure and temperature at the end of compression at the beginning of fuel atomization. Thus, the ignition delay time decreases. Heating the incoming air in the inlet system will cause thermal stress major parts,as increase compression degree, and the increase in of nitrogen oxides due to maximizing temperature in cycle.

Quality - hydrocarbon fuels quantitative increase carbon atoms shortens the delay period autoignition.The higher the cetane number of diesel fuel more likely to self-ignition propensity therefore reduced auto-ignition delay period.

The shape and dimensions of the combustion chamber-studies carried out with diesel engines with fuel injection can not reveal the precise regularity between the size of the engine and a latency period of auto-ignition; Therefore it is logical to consider the impact of the main dimensions of the cylinder on the value indicators of pressure and temperature at the start of the process the fuel injection. Usually taken into account the value of the specific heat area transfer on the impact the geometrical dimensions of the engine and the duration of the autoignition delay period, the more engine power, the less marked area and minimal amount of heat consumed from the mixture, respectively unto the completion of compression the temperature increases and reduces the period the ignition delay.

Pressure and saturation charge of vortex motion injection - Higher fuel injection pressure reduces the average diameter of the fuel spray droplet, Increases the total area of evaporation, evaporation rate Accordingly fuel carburetion, As a result, this leads to a decrease in the ignition delay period. It is difficult to create pressure the equipment fuel pressure with high-pressure spraying. Therefore, more and more widely used diesels with separated chambers where intensive mixture formation occurs mainly due to strong turbulence kinetic energy of the new charge, so do not require the use of sophisticated equipment for fuel . At the same time,remains the problem of unsolved undivided diesel engine with low efficiency. So now, more widespread received the diesel engines with combustion chambers separated by half. Thus at present, more widespread diesels, with a half-separated combustion chambers, used in the result a relatively high pressure for the fuel injection which significantly increases the rate of production of steam and the delay period of autoignition is reduced.

The intensity of the vortex motion charging - when it is possible to select slightly higher intensity motion to improve mixing. Ie The higher the intensity of the vortex motion, the lower the autoignition delay period. At the same time, increasing the intensity of the vortex motion can cause deterioration in performance of the engine.

As a result, one can observe, that analysis of the facts above shows that they affect the duration of the autoignition delay period, but do not provide an exhaustive answer.

Thus the development of fast transient diesel engines, the effective use of the working volume and opportunities undivided cameras , hinder-inferiority of the internal mixing of mixture, Ie Inability achieve a relatively uniform mixture, is a significant limiting factor in the excess air ratio (Rated power $\alpha \geq 1{,}35$).

To implementation partial elimination of side effects and increase efficiency and reducing the toxicity of the engine to the inlet cylinder system of the diesel engine , set fuel injector (Fig. 2) by means of which starts the injection of process a certain amount of diesel fuel in front of the inlet valve and begin the process of carburetion with air, entering the cylinder with air which occurs during the filling process and at the end of compression which occurs during the filling process and at the end of compression and the compression process in the combustion chamber by means of the main injector (in a prearranged lean fuel mixture) injected the amount of fuel

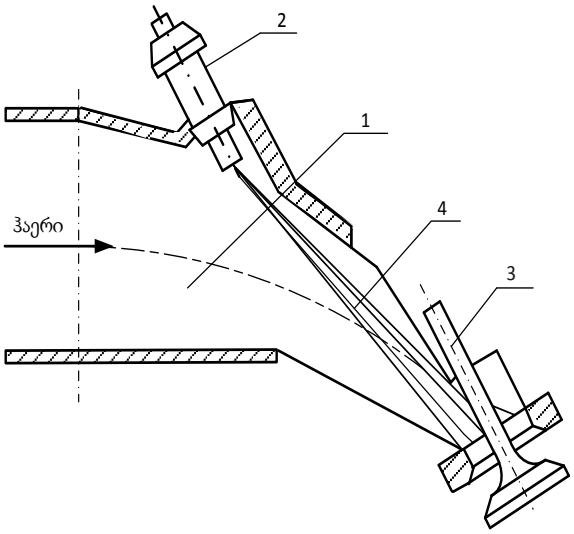

Figure. 2. *atomization of the fuel circuit in the input system of cylinder;*

1 - inlet channel; 2 - fuel injector or dispenser; 3 - inlet valve; 4 - soot from the atomized fuel

that is necessary for the selected mode. In this case, the fuel mixture formed as in the process of filling or compression process. At this time, the fuel vapor with air in contact with the heated surface of the engine and begins the process of mixing intensively before. Before reaching the top of the critical state of piston compression should spray from the main injector the amount of fuel that is required to implement the selected mode.

3. Conclusion

By the end of the compression process until spraying fuel from the main injector, in combustion chamber, we have lean mixture, but almost homogeneous mixture,which is uniformly distributed in the combustion chamber cavity. At the same time, to some extent primary oxides are formed for begin the combustion process,but insufficient for realization of the combustion process. As soon as a the fuel is sprayed from the ground sprayer, we could obtain necessary quantity of fuel mixture required for combustion and the combustion process starts earlier than the formation of the standard mixture, and hence declining value of the autoignition delay period.

4. Literature

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STUDYING OF VIBRATIONS, ACTING OF THE DRIVERS OF THE ROAD-BUILDING MACHINERY AND AUTOMOBILES

ИЗСЛЕДВАНЕ НА ВИБРАЦИИТЕ, ДЕЙСТВАЩИ НА ВОДАЧИТЕ НА ПЪТНО-СТРОИТЕЛНИ МАШИНИ И АВТОМОБИЛИ

Eng. Slivarov O., PhD[1], Eng. Staneva G., PhD[2]

1. Technical College of Smolyan, Plovdiv University " Paisii Hilendarski, Bulgaria, e-mail: oslivarov@dir.bg

2. Faculty of Transport – University of Ruse, Bulgaria, e-mail: glstaneva@uni-ruse.bg

Abstract: *The vibrations caused by road-building machinery affect drivers equally harmful to the three axes of the coordinate system. Assessment of exposure to vibration hand-arm system is based on the calculation of daily exposure value for the 8-hour A (8).*

Keywords: VIBRATIONS, ROAD-BUILDING MACHINERY, AFFECT DRIVERS, HAND-ARM SYSTEM.

1. Introduction

The impact of vibration on humans is associated with the oscillation of certain internal variable force effects on the machine, or on its system. At the beginning of this kind of oscillations may be associated not only with power but with kinematic excitation, typically for vehicles in their movement on rough roads.

The minimum requirements to protect workers from existing or potential risks to health and safety associated with exposure to vibration at work are set out in Ordinance № 3 of 5.05.2005, Acording to this Ordinance, the vibrations are divided into vibration system "hand -arm" and vibrations transmitted to the whole body. [2]

Vibrations of the whole body disturbs the human body. It is normalized by taking into account the source of the impact that a sign is divided into:

- transport - result from movement of machinery in areas and roads;

- transportation technology - are formed during operation of machines performing technological operation in stationary and/or moving of a specially prepared portion of the production area or industrial site;

- technology - arise when working on stationary machines or transmitted jobs, havent got source of vibration.

The purpose of this study is to identify and demonstrate the values of vibration experienced by drivers of different types of road-building machinery (trucks, excavators, tractors and other vehicles).

The transport machineries and vehicles are randomly selected, the only condition for their research is more common types operating in the region of Smolyan.

In accordance with the ordinance, the values of vibrations of hand-arm system should not exceed the daily exposure limit value set for the 8-hour (5 m/s^2) and the daily exposure value action specified period 8 h (2,5 m/s^2).

The values of the vibrations of the whole body must not exceed the daily exposure limit value set for the 8-hour (1,15 m/s^2) and the daily exposure value action set for the 8-hour (0, 5 m/s^2).

2. Theoretical formulation and methodology of the study

Used in the article terms and definitions of Ordinance № 3 of 5.05.2005, and BDS EN ISO 5349-1 Vibrations: exposure, daily value of exposure action, daily value of exposure set for the 8 hours (A (8) or $a_{hv(eq,8h)}$, (m/s^2), the total value of vibration frequency weighted rms acceleration a_{hv}, (m/s^2), RMS acceleration frequency-weighted vibration in hands, one axis (a_{hw}), (m/s^2).[3]

Assessment of exposure to vibration hand-arm system is based on the calculation of daily exposure value for the 8-hour A (8).

The daily vibration effect is obtained from the magnitude of vibration (vibration of a total amount) and the length of day effects.

Daily exposure value for the 8-hour is calculated by the formula:

$$A(8) = a_{hv}\sqrt{\frac{T}{T_0}}, \qquad 1)$$

where:

A (8) is the daily amount of exposure to vibration in m/s^2;

a_{hv} - total vibration values in m/s^2;

T - total daily duration of exposure in h (s);

T_0 - duration 8 h (28 800 s).

The total value of the vibration is determined by the formula:

$$a_{hv} = \sqrt{a_{hwx}^2 + a_{hwy}^2 + a_{hwz}^2}, \qquad 2)$$

where:

a_{hv} is the total value of vibration in m/s^2;

$a_{hwx}^2, a_{hwy,}^2 a_{hwz}^2$ are frequency-weighted RMS acceleration in m/s^2, measured in three axes - x, y and z the vibrating surface in contact with the hand.

From the cited methods, it is clear that the longer the time of impact, the driver will be exposed to a higher exposure and at eight-hour working day, the exposure will be equal to the total value of the vibrations - a_{hv}, and when the length of the impact is less than 8 hours, it is necessary recalculated leftmost value of the daily exposure to vibrations A (8).

Measurement of vibrations in the system "hand-arm" and the whole body were made with a meter conforming to ISO 8041. Device is calibrated by an accredited laboratory valid until 2015. Before each measurement, the device is controlled with vibrokalibrator, which is also calibrated by an accredited laboratory valid till October, 2014

The apparatus allows measurements to be made in three axes simultaneously.

Vibration arm were recorded for the three strands of rectangular coordinate system, as shown in Figure 1. Orientation of the coordinate system in measurements correspond to BDS EN ISO 5349-1.

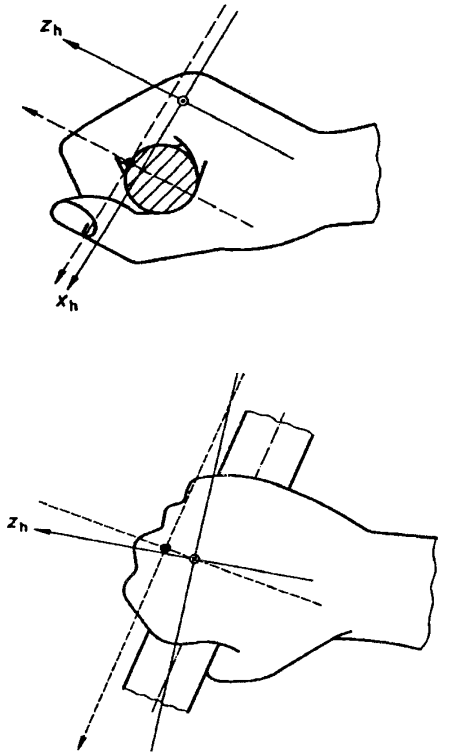

Fig. 1. *Scheme targeting the coordinate system*
Biodynamic coordinate system
Basecentered coordinate system

Methodology in Ordinance № 3 of 5.05.2005, and BDS EN ISO 5349-1 requires the sensor to be placed in areas where there is contact of the body with a vibrating surface. When measuring vibration system "hand-arm", the sensor is located between the arm and the vibrating surface, which in this case the steering wheel.

Drivers of road-building machinery - trucks, excavators, tractors and other vehicles are tested parameters of vibration system "hand-arm." Observed parameters apply to both hands in contact with the steering wheel.

According to standard BDS EN ISO 5349-1, the vibrations in each of the three directions defined by the axes of the rectangular coordinate system shown in Figure 1, are equally harmful and that the same frequency weighting can be used for each axis. Therefore, the risk of damage caused by vibrations, transmitted by hand, are evaluated by the total value of the vibrations, a_{hv} calculated from three frequency components weighted (for the individual axes) of the acceleration of a surface, which is in contact with the arm.

In that standard is assumed that the method for obtaining the total value of the vibrations, which is equivalent to the energy for a period of 8 hours, the appropriately reflects the relationship between the different sizes of the vibration and the duration of the daily action.

3. Analysis of the results of studies of production of vibration

The purpose of the statistical survey is to identify and demonstrate the level of vibration experienced by drivers of different types of road-building machinery (trucks, excavators, tractors and other vehicles), without focusing on the duration of exposure. They focused reported and registered by the device totals vibration a_{hv} and RMS acceleration $a^2_{hwx}, a^2_{hwy,} a^2_{hwz}$ measured of the three axes - x, y and z the vibrating surface.

Conditions under which the measurements were performed are the same for the groups of machines: type of road surface (asphalt, stone, rough road); movement of the car (loaded or unloaded, in no time flat, horizontal gradients); state of the road surface (wet, dry, snow, smooth, rough, flat, downhill, uphill) and instantaneous technical condition of machines.

The researches has been aimed to determining exposure, which requires measurement of the vibration level for the time of impact, i.e. for the entire period of operation of the machines, the data presented in this article apply only to the level of vibration measurement time of 30 min.

Of each machine have been studied a number, and reported by the device parameters are averaged for each species.

Object of study in this article the vibration during the work in the operating conditions of the following types of road construction machines and vehicles:

- excavator: excavator "JCB" - 4 pcs.; wheel excavator "ATLAS 1304" - 2 pcs.; front loader "ATLAS 52 D" - 2 pc.; mini excavator "Bobcat" - 2 pcs.;

- Tractors wheel - "Universal" 651 M - 2 pcs.; UMZ 6l - 2 pcs.; "TK-80" - 2 pcs.;

- Tractors chain - T 170-1 pc.; DT 75 - 1 pc.

- Trucks: KAMAZ 5511-12 pcs.; DAF cf 85-5 pcs.; MAN TGS - 10 pcs.; STEYR 91; IFA L60; IFA W 50; Mercedes 914; Mercedes 409.

In carrying out a statistical measurements are made as one of the two factors of the said standard, which affects the impact of the vibration arm, namely the magnitude of the vibrations. The parameters considered were: the total value of the vibration of hand-arm system, frequency-weighted RMS acceleration in m/s^2, measured along three axes - x, y and z of the hand-arm system.

Table 1. Results of measurements

Types of machines	Source of vibrations	a_{hw} - RMS acceleration of the frequency weighted vibration axis ", (m/s^2)			a_{hv} - Total vibration frequency weighted rms acceleration, (m/s^2)
		x	y	z	
Excavators	Backhoe „JCB”	0,31	0,33	0,15	0,48
	Wheel excavator „ATLAS 1304	3,15	4,01	2,99	5,91
	Front loader „ATLAS 52 D	2,14	3,23	2,45	4,58
	Mini excavator "Bobcat"	1,87	0,93	0,89	2,27
Wheeled tractors	Universal 651 M	3,27	3,71	1,82	5,27
	UMZ 6JI	2,75	3,38	2,22	4,89
	TK-80	4,72	6,83	9,25	10,68
Crawler tractors	T 170	4,88	5,21	4,26	8,31
	DT 75	4,25	4,83	3,67	7,41
Trucks	KAMAZ 5511	2,51	1,48	2,47	3,82

	DAF cf 85	0,77	0,93	0,51	1,31
	MAN TGS	0,63	0,71	0,41	1,03
	STEYR 91	1,32	2,29	0,99	2,82
	IFA L60	2,51	1,48	2,47	3,82
	IFA W 50	1,12	0,74	0,68	1,50
	Mercedes 914	1,87	2,32	1,06	3,16
	Mercedes 409	1,84	2,23	1,08	3,09

Results obtained from the survey were processed using methods of mathematical statistics and probability theory, and are summarized in tabular and graphical dependencies.

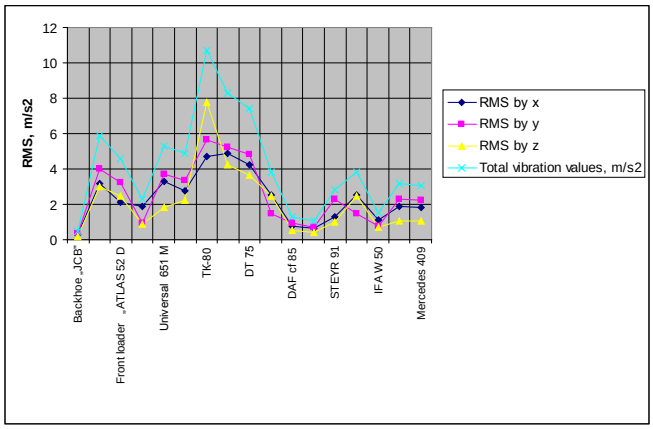

***Fig.2**. Changing of vibration direction for different types of handling equipment*

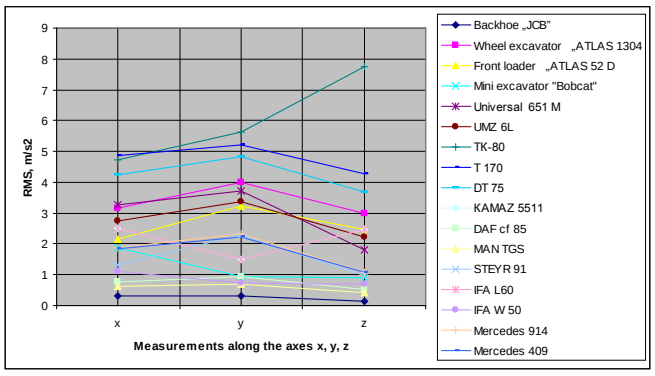

***Fig. 3**. Distribution of level of vibration for different types of transport vehicles in the direction Lenin*

4. Conclusion

1. From the measurements, calculations and built graphical relationships shows that in the tractors levels of vibration of the "hand-arm" are higher than other tested machines.

2. Investigations show that the vibration measured on vehicles and road construction equipment are higher in tractors and trucks from older models.

3. Vibration system "hand- arm" are higher in axis "y" in the majority of the machines.

6. References

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[2] Ordinance № 3 of 5.05.2005 on the minimum requirements for the provision of health-veto and safety of workers on the risks related to exposure to vibration.

[3] BS EN ISO 5349-1 Vibrations. Measurement and evaluation of human exposure to vibration in the hand.

Contacts:

Ognyan Slivarov, Technical College of Smolyan, Plovdiv University “Paisii Hilendarski”, 28 Dicho Petrov Str., 4700 Smolyan, Bulgaria. E-mail: oslivarov@dir.bg

Gergana Staneva, Department Engines & Transport Equipment – University of Rousse, 8 Studentska Str., 7017 Ruse, Bulgaria. E-mail: glstaneva@uni-ruse.bg

STUDYING OF NIOSE, ACTING OF THE DRIVERS OF THE ROAD-BUILDING MACHINERY AND AUTOMOBILES

ИЗСЛЕДВАНЕ НА ШУМА, ДЕЙСТВАЩ НА ВОДАЧИТЕ НА ПЪТНО-СТРОИТЕЛНИ МАШИНИ И АВТОМОБИЛИ

Eng. Slivarov O., PhD[1], Eng. Staneva G., PhD[2]

1. Technical College of Smolyan, Plovdiv University " Paisii Hilendarski, Bulgaria, e-mail: oslivarov@dir.bg

2. Faculty of Transport – University of Ruse, Bulgaria, e-mail: glstaneva@uni-ruse.bg

Abstract: *Drivers of road-building machinery are subjected to noise pollution variable nature of the noise. The purpose of this study is to show the values of noise experienced by drivers of different types of road-building machinery (trucks, excavators, tractors).*

Keywords: NOISE, ROAD-BUILDING MACHINERY, AFFECT DRIVERS.

1. Introduction

The noise on its health matter takes one of the first places among the adversely existing physical work environment factors. The increasing production of noise which is often accompanied by deterioration of the noisy parameters, leads to increase in both occupational groups exposed to excessive noise levels and occupational risk of noise injury and illness.

The purpose of this study is to show the values of noise experienced by drivers of different types of road-building machinery (trucks, excavators, tractors). The machines are randomly selected, and only one condition of this research is more common species in the region of Smolyan.

Therefore the noise standards apply to protect the health of the drivers of the machines, the values obtained for the noise in this article are considered as noise production. About the measured values of noise are measured at Ordinance № 6 of 15.08.2005 on the minimum requirements for ensuring the health and safety of workers at risks related to exposure to noise [2]. Methodology of measurement complies with BS ISO 1999:2004 Acoustics. Determining the impact of noise at work and assessing hearing damage reasons, but noise [3].

2. Theoretical formulation and methodology of the study

In accordance with Ordinance № 6 of 15.08.2005, the limits of the exposure and the exposure action are determined with based daily rates of exposure to noise and peak sound pressure as follows:

1. Exposure limit values: Lex,8h = 87 dB (A) and ppeak = 200 Pa, respectively 140 dB (C);

2. Upper values exposure action: Lex,8h = 85 dB (A) and ppeak = 140 Pa, corresponding to 137 dB (C);

3. Lower values exposure limits for action: Lex, 8h = 80 dB (A) and ppeak = 112 Pa, respectively 135 dB (C).

Peak sound pressure level represents ten times the logarithm of the ratio of the square of the peak sound pressure to the square of the reference sound pressure, where the peak sound pressure is the maximum absolute value of the instantaneous sound pressure for a specified period of time at a standard frequency weighting or standard width of the measuring tape.

Sound pressure is a variable which changes the frequency of sound waves. Sound pressure is the difference between the pressure at the time and static. Sound pressure characterizes the intensity of the sound wave at a given point of space and represents the variable component of the pressure, arising as a result of tremulous movements of the sound source and accumulation on pressure. Sound pressure is denoted by P and its benchmark (atmospheric pressure) - Pc.

In BS ISO 1999:2004 is a methodology for determining the "level of exposure to noise, standardized for nominal working day of eight hours - (Lex,8h)", which according to Ordinance № 6 of 15.08.2005 on a 'daily level noise exposure (Lex,8h) ".

The methods include direct measurement of "daily level of exposure to noise (Lex,8h)", standardized for nominal working day of eight hours or calculation of the "level of daily noise exposure (Lex,8h)" for the time of impact. Standard requires measurements to be made with equipment conforming to IEC 804 Class 2 or better. The device must be directly measured equivalent continuous A-weighted sound pressure level $L_{Aeq,\ T}$. This parameter is calculated automatically by the device according to the following formula:

$$L_{Aeq,T} = 10\lg\left[\frac{1}{t_2 - t_1}\int_{t_1}^{t_2}\frac{p_A^2(t)}{p_o^2}dt\right] \ , dB\,, \quad 1)$$

where:

t_2-t_1 is the period T for which the averaging is made, starting from t_1, and ends in t_2;

p_A - A-weighted sound pressure in Pa;

p_O - reference sound pressure - (p_O = 20 μPa in accordance with ISO 1683);

If the noise is unchanging level for the specified period, the $L_{Aeq,\ T}$ [dB] is equal to L_{pA}, which is level A-weighted sound pressure is given by the formula:

$$L_{pA} = 10\lg\left(\frac{p_A}{p_O}\right)^2 \ , dB\,. \quad 2)$$

Calculation of "Level of noise impacts, standardized for nominal working day of eight hours - (Lex,8h)" is carried out according to the time impacted action. Calculation is made using the following formula:

$$L_{EX,8h} = L_{Aeq,T} + 10\lg\left(\frac{T_e}{T_O}\right) \ , dB\,, \quad 3)$$

where:

T_e is the effective length of the working day (time of impact) in h;

T_o - length comparison (8 h).

By that method, it is clear that for longer time impact, the driver will be exposed to higher exposure and at eight-hour working day, the exposure will be equal to the figure of the device equivalent continuous A-weighted sound level pressure $L_{Aeq, T}$.

When the duration of the impact is less than 8 hours, it is necessary to do calculation of "Level of noise impacts, standardized for nominal working day of eight hours - (Lex,8h)".

The methodology allows short high equivalent continuous A-weighted sound pressure level $L_{Aeq, T}$ over the limits of exposure, since calculating the impact of noise, standardized earlier for nominal working day of eight hours may be reduced values below-the-limit levels.

Methodology in BS ISO 1999:2004 requires the measurement noise, the microphone of the device to be placed at a distance 10 cm from the ear of the driver. Under this condition, the reported noise will be a total noise of the engine, transmission, movement of vehicles on the aerial resistance, etc.

The device used is an integrated meter volume 2238 Mediator, which was calibrated by an accredited laboratory for a period of calibration until 2016. Before each measurement, the device is controlled by an acoustic calibrator, which is also calibrated by an accredited laboratory valid until 2016.

The device automatically detects the peak sound pressure level and equivalent continuous A-weighted sound pressure level $L_{Aeq, T}$.

3. Analysis of the results of the manufacturing test

Therefore the objective of the study is to show the levels of noise to which drivers are exposed to machinery, without focusing on the duration of exposure, the research focussed reported and registered by the device "an equivalent continuous A-weighted sound level pressure" $L_{Aeq, T}$. and "peak sound pressure"

Conditions under which the measurements were performed are the same for the groups of machines – type and state of road surface, movement of the car (loaded or unloaded, in no time flat, horizontal gradients) and instantaneous technical condition of machines.

During the measurement, the nature of the noise was variable.

As the researches did not focus on determining of the exposure, which requires measurement of the noise level for the time of impact, ie for the entire period of operation of the machines, the data presented in this article apply only to the noise emitted by machines measurement time of 30 min.

Each machine has been tested several numbers, as the reported and registered by the device parameters are averaged.

The object of study in this article is the noise when working on these types of road-building machinery and vehicles:

- Excavator: excavator "JCB" - 4 pcs.; wheel excavator "ATLAS 1304" - 2 pcs.; front loader "ATLAS 52 D" - 2 pc.; mini excavator "Bobcat" - 2 pcs.;

- Tractors wheel - "Universal" 651 M - 2 pcs.; UMZ 6l - 2 pcs.; "TK-80" - 2 pcs.;

- Tractors chain - T 170-1 pc.; DT 75 – 1;

- Trucks: KAMAZ 5511-12 issue.; DAF cf 85-5 pc.; MAN TGS - 10 pcs.

In the process of manufacturing the experimental study are reported and the following parameters:

- Peak sound pressure (ppeak);

- Equivalent continuous A-weighted sound pressure level $L_{Aeq, T}$;

- Type and model of trucks;

- Type and model of road construction equipment.

Results obtained from the production study of changing noise of road-building machinery for the region of Smolyan region are subjected to statistical processing and are summarized in tabular and graphical relationships.

4. The value recorded noise

Table 1. Results of measurements

Types of machines	**Source of noise**	**Equivalent continuous A-weighted sound pressure level LAeq, T, dB**	**Peak sound pressure (ppeak), dB**
Excavators	Backhoe „JCB”	73	93
	Wheel excavator „ATLAS 1304	73	92
	Front loader „ATLAS 52 D	72	93
	Mini excavator "Bobcat"	85	104
Wheeled tractors	Universal 651 M	78	110
	UMZ 6Л	79	88
	TK-80	81	93
Crawler tractors	T 170	81	92
	DT 75	75	98
Trucks	KAMAZ 5511	78	91
	DAF cf 85	69	90
	MAN TGS	73	89

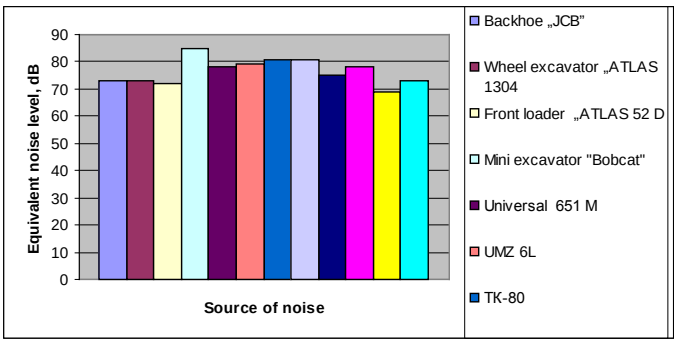

Fig. 1. *Equivalent noise level for various types of road construction machinery*

FIG. 1 shows the change of the equivalent noise level of the different road construction machinery in Smolyan. Adduced by the

histograms shows that the equivalent noise level is highest for tractors.

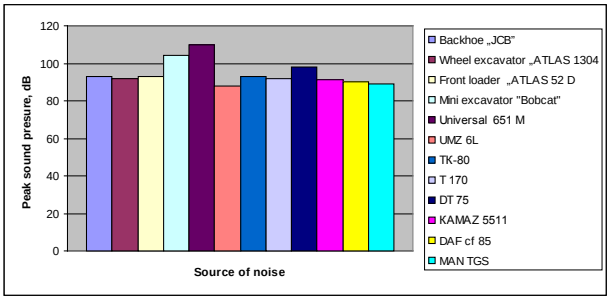

Fig. 2. *Peak sound pressure for different types of road construction machinery*

FIG. 2 shows the change in peak sound pressure various road construction machinery. From the displayed histogram shows that diesel engines of an older generation exhibited higher values of peak sound pressure.

5. Conclusion

1. It was made production experimental study of the noise effect on load drivers for various types of road-building machinery of Smolyan.

2. Incurred research and built graphical relationships indicate that drivers of tractors are subjected to higher noise levels than other drivers (Figure 1).

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Contacts:

Ognyan Slivarov, Technical College of Smolyan, Plovdiv University “Paisii Hilendarski”, 28 Dicho Petrov Str., 4700 Smolyan, Bulgaria. E-mail: oslivarov@dir.bg

Gergana Staneva, Department Engines & Transport Equipment – University of Rousse, 8 Studentska Str., 7017 Ruse, Bulgaria.
E-mail: glstaneva@uni-ruse.bg

A METHOD OF VEHICLE-PEDESTRIAN ACCIDENT RECONSTRUCTION

Eng. Lyubenov D.A., PhD

Faculty of Transport, Department of Transport – University of Ruse, Bulgaria

E-mail: dliubenov@uni-ruse.bg

Abstract: *This paper presents a method of vehicle-pedestrian accident reconstruction in case of vehicle low beam illumination and transverse movement of the pedestrian. This method allows to determine the pedestrian visibility time and pedestrian visibility distance in the case of nighttime accidents. The analysis of this type of accident is only possible if a certain shape and size of the illuminated area. This method can be very useful in the pedestrian accident reconstruction expert practice.*

Keywords: ACCIDENT RECONSTRUCTION, VEHICLE–PEDESTRIAN ACCIDENT

1. INTRODUCTION

In the Bulgaria alone approximately 130 pedestrians are killed as a result of motor vehicle crashes every year, and approximately 2000 are injured. In urban areas about half of vehicle accidents with killed people are pedestrian accidents. Pedestrian injuries from vehicle collisions arise from both the vehicle and the ground contact. Above 7 m/s collision speed, the vehicle impact is responsible for higher severity injuries [5]. The injury outcome in elderly pedestrians was more severe and the head severe injury proportion in children was more than that of an adult. Multiple injuries were common in pedestrians. The pedestrian injury outcome was relative to the impact speed [7].

Assessing the ability of a driver to see objects, pedestrians, or other vehicles at night is a necessary precursor to determining if that driver could have avoided a nighttime crash. The visibility of an object at night is largely due to the luminance contrast between the object and its background [6]. This difference depends on many factors, one of which is the amount of illumination produced by a vehicle's headlamps.

Vehicle-pedestrian accidents reconstruction is becoming critical in the field of traffic accident reconstruction [4]. Pedestrian accident reconstruction at nighttime differs from typical pedestrian accident reconstruction. Little attention has been paid to the investigation of such accidents in Bulgaria. The aim of this work is to be present a method of vehicle-pedestrian accident reconstruction in case of low beam illumination and transverse movement of the pedestrian.

2. METHOD AND DISCUSSION

Pedestrian visibility distance at night is limited in space, which is illuminated by the vehicle headlight beams (high or low). When the driver uses the vehicle's high beams, they illuminate the road over a distance of 100 meters and the driver can see and identify objects in this area. In this case the driver have enough time to react in case of hazard, provided that moves permitted by law speed. Furthermore, the pedestrian visible at a distance greater than the stopping distance for a car [3].

When the driver uses the vehicle's low beams the form of illuminated space in front of the car is asymmetric. In this case at transverse movement of the pedestrian the driver has a different time to see pedestrian and react. This time depends on the location at which the pedestrian crossing and enters the illuminated area in front of the car.

The main difficulty in this type of accident reconstruction is to determine the moment at which the pedestrian enters in the illuminated area where it is possible to be seen by the driver and pedestrian visibility time. Theoretically, this is the moment when the pedestrian crosses the 2,0 lx border luminance by a vehicle's low headlamps. The determination of this moment allows to determine the time at which the driver of the car has to perform action to prevent an accident.

The analysis of this type of accident is only possible if a certain shape and size of the illuminated area. Another prerequisite is known character of the movement of the car since the illumination of the pedestrian until the moment of impact - constant speed or deceleration.

Fig. 1 shows the low beams illuminated area in front of the car. The same figure shows and pedestrian that enters in the illuminated space.

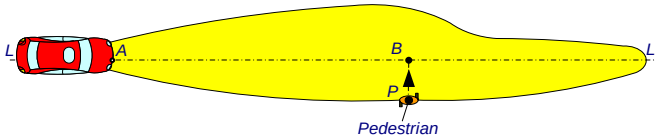

Fig. 1. *Low beams illuminated area and pedestrian*

With point ***A*** indicated the place of the vehicle, which hit the pedestrian. This point moves on the line ***LL***, provided that the vehicle moves rectilinearly.

From the moment of illumination of the pedestrian until the collision, vehicle travels a distance $\boldsymbol{D_v} = \boldsymbol{AB}$. For the same time the pedestrian travels a distance $\boldsymbol{D_p} = \boldsymbol{PB}$. Consequently, the time for movement of pedestrians from point ***P***, which is on the border of the illuminated area to point ***B***, located on the line ***LL***, can be calculated by the equation 1:

$$\boldsymbol{t_p = PB / V_p}, s \qquad (1)$$

where ***PB*** is the pedestrian distance $\boldsymbol{D_p}$, travelled from the moment of illumination of the pedestrian until the collision, *m*;

$\boldsymbol{V_p}$ - pedestrian speed, *m/s*;

Once known shape and size of the illuminated area can be calculated pedestrian movement time $\boldsymbol{t_{pi}}$ for each point $\boldsymbol{P_i}$ from the border of the illuminated area to the line ***LL*** and draw appropriate graphics. Practical for this purpose are required at least 8-10 points.

Fig. 2 shows a graph that displayed the pedestrian movement time $\boldsymbol{t_{pi}}$ from point $\boldsymbol{P_i}$ to point $\boldsymbol{B_i}$ in a certain interval $\boldsymbol{\Delta L}$ along the illuminated area.

Along the X axis is applied the illuminated area, and on the Y axis – the pedestrian movement time.

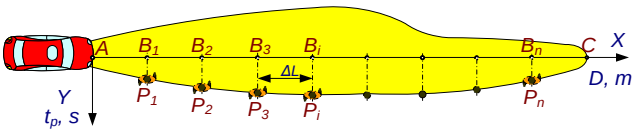

Fig. 2. *Pedestrian movement time in illuminated area*

The width of the vehicle $\boldsymbol{B_v}$ is given by the time for which pedestrians can travel that distance. It can be calculated by the equation 2:

$$\boldsymbol{t_{pv} = B_v / V_p}, s \qquad (2)$$

where B_v is the width of the vehicle, *m.*

If the vehicle is moving at a constant speed, it will go the distance $S_{vi} = AB_i$ (Fig. 2) for the time t_{vi}:

$$t_{vi} = S_{vi} / V_v, s \quad (3)$$

where V_v is the vehicle speed, *m/s*.

The time t_{vi} is equals to the time t_{pi}. These two times are equal to the pedestrian visibility time - t_{pvt} from the moment of illumination of the pedestrian until the collision.

Vehicle movements in the coordinate system "distance – time" at a constant vehicle speed is shown a straight diagonal line that passes through the coordinate system start.

2.1. Determination of the shape and size of the illuminated area on the road from vehicle's low beams.

The shape and size of the illuminated area on the road from vehicle's low beams is determined by measuring in 2,0 lx border luminance. Measurement data are filled in table 1.

Table 1. *Vehicle illuminated area*

№	1	2	3	...
D, m	5	10	15	...
$B_{r(l)}$, m				...

The symbols in the table 1 have the following meaning: D is the distance ahead of the vehicle; $B_{r(l)}$ - width of the right (left) half of the illuminated area in front of the vehicle.

2.2. Determination of the distance that the pedestrian travels in the illuminated area.

The distance D_p, which the pedestrian travels in the illuminated area is determined by considering the position of the impact point on the width of the vehicle relative to its longitudinal axis by the equation 4:

$$D_p = B_v \pm \Delta, m \quad (4)$$

where Δ is the distance between the longitudinal axis of the vehicle and the impact point on the width of the vehicle B_v, *m*.

Calculation data are filled in table 2.

Table 2. *Distance and time for the movement of pedestrians in the illuminated area*

№	1	2	3	...
D, m	5	10	15	...
D_p, m				...
t_p, s				

2.3. Determination of the time that the pedestrian travels in the illuminated area.

The time t_p that the pedestrian travels in the illuminated area can be calculated by the equation 5:

$$t_p = \frac{D_p}{V_p}, s \quad (5)$$

Pedestrian speed V_p is determined by the rate of movement, age and sex of the pedestrian. The results of the calculations for the time t_p, that the pedestrian travels in the illuminated area are filled in the last row in table 2.

2.4. Drawing of chart for the pedestrian movement.

Based on data from table 2 drawing of chart for the movement of the pedestrian according to the distance ahead of the vehicle (Fig. 3). X-axis is applied to the distance ahead of the vehicle D, and on the Y-axis - pedestrian movement time t_p in the illuminated area.

2.5. Drawing of chart for the vehicle movement.

By different vehicle accident reconstruction methods known in expert practice is determined the vehicle speed V_v [1]. Set value of time (for example, $t = 2{,}0$ *s* – Fig. 3) and calculate the distance that the vehicle trqveled for this time at constant speed by the equation 6:

$$D_v = tV_v \quad (6)$$

Using the coordinates of the value of the time (used for the above example $t = 2{,}0$ *s*) and the calculated distance D_v determined point in the coordinate system (poin A). Drawing a straight line through the coordinate system start and the point A (Figure 3). This straight line represents vehicle movement.

2.6. Determination of the pedestrian visibility time and distance.

The place, where are crossed the line 1 constructed in the order specified in paragraph 2.4 and the straight line 2 that describes the vehicle movement (paragraph 2.5), determine the pedestrian visibility time (Y axis) and the pedestrian visibility distance (X axis) – Fig. 3.

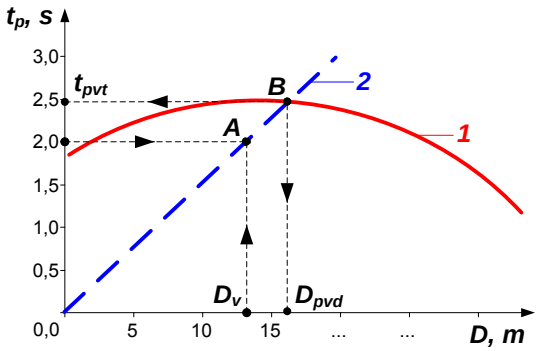

Fig. 3. *Determination of the pedestrian visibility time (t_{pvt}) and distance (D_{pvd}): 1- Pedestrian movement; 2 – Vehicle movement*

After determining the pedestrian visibility time and pedestrian visibility distance, analysis continues on known vehicle-pedestrian accident reconstruction methods [2].

2.7. Analytical determination of the pedestrian visibility time.

Based on data from table 2 to the time that the pedestrian travels in the illuminated area and the distance ahead of the vehicle can be obtained an equation by which discloses the graph that depicts the function of the time for the movement of the pedestrian according to the distance in front of the vehicle.

When a pedestrian has entered from the right side of the vehicle, equation which describes the movement of the pedestrian is equal to:

$$y = -ax^2 + bx + c \quad (7)$$

When the pedestrian has entered from the left side of the vehicle, for obtaining of the equation which describes the movement of the pedestrian are required from more points. It is a polynomial of the sixth degree:

$$y = -ax^6 + bx^5 - cx^4 + dx^3 - ex^2 + fx + g \quad (8)$$

Vehicle movement graphics is described by the equation of the first degree. This equation has the following form:

$$y = ax \quad (9)$$

By solving the equations 7 and 9 or 8 and 9 (depending on the direction of the pedestrian) was obtained value of the pedestrian visibility time.

Determination of the pedestrian visibility time by analytical method can be applied when is necessary determining at the visibility time for different variants of pedestrians movement.

3. CONCLUSION

In this paper, a new method for vehicle-pedestrian accident reconstruction in the case of nighttime accident was constructed.

The most important part of the paper is the possibility of determining the pedestrian visibility time and pedestrian visibility distance in case of vehicle low beam illumination and transverse movement of the pedestrian.

This method provides investigators a new possibility to reconstruct pedestrian–vehicle accident.

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CONTACT

Daniel A. LYUBENOV. Department of Transport – University of Ruse, 8 Studentska Str., 7017 Ruse, Bulgaria. E-mail: dliubenov@uni-ruse.bg

USE OF SCIENTIFIC APPROACHES AND METHODS FOR PERFORMANCE APPROVEMENT OF SAFETY MANAGEMENT SYSTEMS IN RAILWAYS

Assoc. Prof. N. Georgiev, PhD.[1]
Faculty of Transport Management – Higher School of Transport, Bulgaria [1]

safetyniky@mail.com

Abstract: *Recently, the issue of safety has not been whether or not Safety Management Systems are necessary to secure a high level of operational safety in railways but if they could eventually be improved. The answer is yes and that improvement can be done on the basis of well known (and adapted to the problems of safety) scientific approaches and methods. In other words, safety understanding will be developed into a new stage - Modern Safety Management System. The present paper discusses the possibilities for the introduction of some scholarly methods into safety management in railways.*

Keywords: RAILWAY OPERATING SAFETY, SAFETY MANAGEMENT SYSTEM, BAYESIAN NETWORK

1.Introduction

The understanding of railway operational safety and its primary role for securing quality of the overall transportation process has evolved over the past several decades. The process of evolution started at a stage when safety was identified only as the number of incidents (accidents) which occurred within a given period. Railway safety experts usually call this stage the traditional approach to safety understanding. This initial attitude to safety is characterized only by incident (accident) reporting, spontaneous (unplanned) inspections, design and enrichment of operational regulations on the basis only of accident consequences, poor level of awareness, separate examination of the human factor, equipment and technology, etc. The second stage of safety understanding is marked by evolution of the elements (separately or in combination) of the first stage, for example: complex analysis of the relation between staff and equipment, more comprehensive and developed on the basis of consistent analysis rules, increasing role of personal liability, planned supervision and increasing supervisor's role, etc. The third stage of safety understanding is called Safety Management. Safety Management is based on a system-based approach that stresses the interactive nature and interdependence of external and internal factors in a structure (for instance: railway undertaking). In this connection, all written procedures and regulations, operating (management) logic and company's strategy for decision-making is named Safety Management System (SMS). Recently, the question has not been whether or not Safety Management Systems are necessary to secure a high level of operational safety in railways but if they could eventually be improved. The answer is yes and that improvement can be done on the basis of well known (and adapted to the problems of safety) scientific approaches and methods. In other words, safety understanding will be developed into a new stage - Modern Safety Management System. The present paper discusses the possibilities for introduction of some scholarly methods into safety management in railways.

2.Fundamentals of SMS

2.1.Background

The idea of a Safety Management System is inextricably connected with the concept of system safety. This concept itself has a long history beginning in the late 1950s when it wss recognized as a separate scientific discipline. Prior to the 1950s, designers, engineers and managers relied mainly on a fundamental method of solving safety problems known as the *trial-and-error method*. Initially this simple approach gave a modest contribution towards the achievement of safety design. But with the growth of complexity of systems, this approach began to be unsuitable for qualitative decision-making process in the field of safety. The primary reason for this was the increased sensitivity of society regarding safety. The old model of creation of safety rules after a technical failure, incident or accident was no longer able to give enough positive results to prevent the future occurrence of similar failures or accidents. A new approach was necessary for better results in prevention.

Thus, *trial-and-error approach gradually* developed into a *system-based approach* of the attitude to safety. System-based approach to system safety considers safety problems in their entirety and its specific characteristic can be summarized as: *instead of waiting for something bad to occur it is better to take action to prevent this occurrence*.

All the above apply to a variety of industries including railways. It could be said that the increased complexity of railway technical and technological systems played the role of a catalyst for the origin, gradual adoption and present utilization of the concept of system safety in railway industry. Nowadays, the system safety approach is extensively used by a variety of railway undertakings and its practical realization is known as Safety Management System.

2.2.Pillars of Safety Management in railways

In order to illustrate the possibilities for the utilization of scholarly approaches and methods in design and functioning of a railway SMS, it is firstly necessary to define its nature and foundations. The next three items form the basics of the concept of Safety Management System:

-**Key definitions**:

-*System.* The term *system* is mentioned in [1], [7] and [8]. But from the point of view of railway technical exploitation and operational management, the following definition is probably more accurate: A *railway system is a combination of people, procedures and/or specific equipment all functioning within a specified working environment to accomplish a specific task or set of tasks for conveyance of people and commodities* (adapted to [6]). A railway undertaking (company) could be considered as a *technological system* including a variety of technical objects (also called *technical systems*/*subsystems*: vehicles, specific equipment, etc.), natural resources, people (designers, managers, operators, and customers), scientific and technical knowledge, regulations, norms of culture and behaviour, etc.

-*Hazard.* This is a situation that can occur within the transportation process capable of causing harm, injury, death, and/or damage.

-*Risk.* According to [2] risk is the probable rate of occurrence of a hazard causing harm and the degree of severity of that harm.

-*Safety management.* Application of engineering, technological, economical and management principles, criteria, and techniques to optimize the operating process of transportation on a

level where all potential risks are tolerable in line with predefined railway authority requirements.

-**Principles and related conclusions**:

-Every man-machine system entails some kind of risks (nothing can be perfect). As a matter of fact, whatever the railway undertaking (Carrier or Infrastructure operator), it consists of a variety of subsystems which are usually a complex mixture of man-machine systems and could be a source of risk. *Therefore, only a qualitative, profound and system based analysis will identify risks and assess their elements, probability of occurrence and possible consequences.*

-Identified and assessed risks do not require managerial confusion or relief (no need of prejudice). It is well known that within transportation process total absence of risks is practically impossible, a fact that should not be taken for granted or as source for panic. *Therefore, only a reasonable and well-balanced identification, monitoring and controlling of risks will lead to an adequate response (in compliance with company's features, knowledge and experience about safety, regulations, etc.) to whatever internal or environmental changes influencing the operating process.*

-There are no obvious safety issues within an operating process, just engineering, technological and managerial ones which could cause serious mishaps (nothing can be absolutely obvious). Therefore, It is very important to define clear purposes regarding subsystems to be analysed (including their attributes, components interrelations, role in the overall operating process, inherent potential risks, etc.) and employ appropriate scholarly analytical tools (econometric, statistical, probabilistic, simulation, etc.).

-Whatever safety issue leads to the necessity for solution (mitigation measure), that can never be the best, just optimal. Therefore, decision-making needs to be put in place in order to achieve a reasonably practicable option of possible solutions.

-Most events and conditions influencing safety have a stochastic and unique nature. Therefore, a knowledge based approach to decision making with permanent involvement of operating staff in it is very important in safety management.

-Hazards may happen any time (and also many times) and in transport industry they usually impact not only the system where they occur but others (other companies, local people, etc.). Therefore, continuous efforts for safety improvement with mutually beneficial results are needed.

-**Basic components**:

-Safety Policy - It is company's commitment that safety is a key element of the entire operating process. This commitment is usually in form of written document from highest level of management and should be circulated to all operating staff. The safety commitment has three elements: *design and future improvement of SMS (including all company's rules, procedures and standards), encouragement of the staff acting on all levels of the operating process* and *ensuring all needed resources are available to meet safety requirements.*

-Safety encouragement – It is a company's duty to promote the right understanding of safety at all levels of technical exploitation. It includes: *safety behaviour (safety culture), training of the staff regarding structure and requirements of SMS and the exchange of knowledge (communication).*

-Risk management – This is an analytical procedure used to make decision regarding the nature of potential risks and the necessity for their reduction, involving the following main subtasks: *hazard identification, risk assessment, defining* and *implementation of mitigation measures.*

-Safety monitoring – It is a general and permanently implemented procedure to ensure that a railway undertaking follows the defined safety policy. It includes: *company's scheme of periodical audits (internal or/and external)* and *procedure of corrective actions.*

3.Possibilities for monitoring of SMS components with utilization of scholarly methods

The achievement of a safe transportation process is a very important task. At the same time even with well-established and good working SMS, this is a complex requirement, not easily achieved. The main reason for that is that a variety of processes and events typical for the above-mentioned components of SMS are characterized by complexity, uncertainty and ambiguity. A number of scientific approaches and methods exist that could be successfully utilized in SMS design, implementation and further improvement. The application of a very popular analytical method to improve the functioning of SMS will be presented within this section.

3.1.Bayesian network relevance to SMS

3.1.1.Background

Bayesian networks (also known as Bayesian belief networks) are probabilistic graphical models that make it possible to arrive at a decision regarding the sequence and interdependence of defined events at the conditions of uncertainty and ambiguity [3], [4], [5]. A Bayesian network consists of nodes (vertices) and arcs (direct edges). The nodes $X = X_1,..,X_2,..,X_n$ of the network represent random variables (or events) whilst the arcs describe their causal relationship. In other words, the arc $X_i \rightarrow X_j$ represents a statistical dependence between events X_i and X_j , that is: the first event (also named *parent event*) can cause the second one (also known as *child event*). Due to the fact that an event may have some "parents", a Bayesian network can be deemed as a mixture of "descendant" sets (sets of nodes that can be reached by a direct connection from the considered node) and "ancestor" sets (sets of nodes from which the considered node can be reached by a direct connection). A basic property of Bayesian networks is their acyclic design - there is no causal feedback in their structure (the graph does not involve nodes which are their own ancestor or descendant).

Each event (variable) in a Bayesian network is characterized by a probability set (table). For a child event, the table consists of some conditional probabilities covering all combinations of states of an event's parents. Depending on the number of parents the probability tables can dramatically increase.

Events without parents have simpler probability tables consisting just initial probability distribution.

The design of a Bayesian network encompasses two basic stages:

-Definition of consequence (hypothesis) events. These are events for which the investigator wants to know the probability distribution allowing him to make a respective solution.

-Definition of initial events. These are events giving evidence (initial) information about the process under consideration.

-Definition of intermediate events. These are events providing additional information regarding the process under consideration.

-Graphical design of the network. Construction of the network is made by connection of events (arcs) having logical relationship (in the context of the investigated process). It is very important to follow causality direction.

-Constructing the probability tables. Tables can be filled by using subjective probabilities (on the basis of expert's knowledge), statistical methods and gathered data, simulation, etc.

-*Reasoning.* Depending on the analysis Bayesian networks can be used for two types of reasoning (conclusions):

-*Top-down reasoning* (follows the direction of the network arcs) – *predictive reasoning* from the information about causes to the beliefs (expressed by conditional probabilities) in effects.

-*Bottom-up reasoning* (follows the opposite direction of the network arcs) - *diagnostic reasoning* from consequences to causes

3.1.2.Feasibility

The ability to make effective SMS decisions largely depends on the presence of sufficient information about different operating situations. Unfortunately, due to the essence of the transportation process, it is almost impossible to gain as much reliable information as safety managers would like to have. Therefore, an appropriate analytical tool used to handle uncertainty (basic problem for an effective decision-making) is to be used. Due to the fact that Bayesian networks use probability to represent uncertainty and ambiguity (and in such a way the respective operating scenarios connected with them) they are a very good example of such an analytical tool.

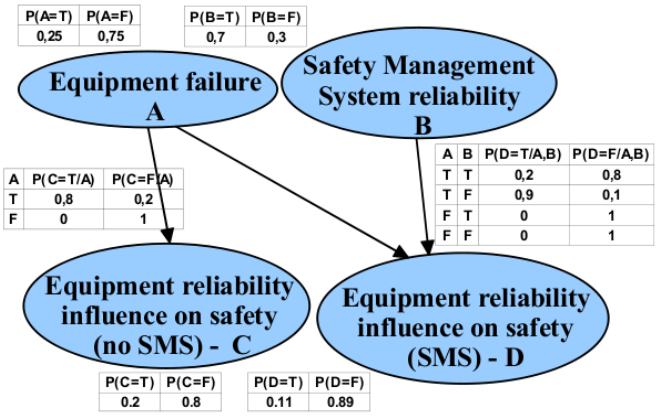

Fig.1. Exemplary Bayesian network

There are lots of possible applications of Bayesian networks within the procedures of implementation of SMS. Let us consider a simple example that illustrates some of the characteristics of Bayesian networks and their specific feasibility in railway SMSs (Fig.1). The example describes the influence of SMS over transportation process safety. More specifically, it considers railway technical equipment reliability and its impact on safety in two possible scenarios – with and without SMS - of the railway undertaking. Furthermore, the network takes into consideration the SMS reliability that can be defined as its possibility to encompass all possible safety issues (risk assessment, scope of safety rules, adequacy of procedures, etc.). So, in this operational diagnosis example, we might ask whether and to what extent SMS presence (and its efficiency) mitigates the equipment imperfection. All network variables (events) are binary, i.e.: they are either *TRUE* (denoted by "T") or *FALSE* (denoted by "F"). For instance: equipment reliability is described by event *A* - *"equipment failure"* with probability of occurrence $P(A=T)=0.25$, such as SMS reliability is represented by event *B* - *"SMS failure to detect and prevent an equipment failure from developing into a mishap"* with probability of occurrence $P(B=T)=0.3$. Conditional probability tables describing all possible scenarios of dependence between events are shown beside each node. Following the network topology and quantifying the relationship between connected events (by using conditional probability distribution about each one of the nodes) it is possible to determine the final events (effects). In the present example they are events *C* and *D*. There are two scenarios of equipment reliability influence over safety and it is very easy to notice the effect of SMS. The presence of a well-established and properly working SMS (within the operating process of a given railway undertaking) helps to diminish almost two times the impact of equipment over operating safety represented by the probability of accident occurrence $\rightarrow$ $P(C=T)=0.2$ and $P(D=T)=0.11$.

The example above of Bayesian network can be deemed as a causal model of relationship between some predefined safety attributes and their strengths. Similar models could be developed regarding many safety management problems and could successfully be used to implement qualitative decision-making.

3.2.Using simulation in Bayesian networks

As it is explained above, the inference through Bayesian network relies on a set of probability tables representing uncertain events. Sometimes, there is no need to compute the exact value of the unknown probability but only its approximate assessment (which could be improved later by using supplementary computing resources). That could be done by stochastic simulation and such an approach is applicable in safety management where a decision-maker must urgently respond to the occurrence of specific events (changes) within operating environment. Thus, the manager would have permanent knowledge (although not too precise) about the specifics of the operating environment. This approach will be illustrated in the following example.

Let us have a Bayesian network describing a given scenario of accident occurrence B caused by two causes A and C (Fig.2). Probabilities of occurrence of causes A and C which are under consideration regarding the investigated type of accident are $P(A=T)=0.75$ and $P(C=T)=0.25$. The conditional probabilities of event B are also depicted in figure 2. As a matter of fact, they represent all possible scenarios of accident occurrence B as a result of occurrence (or not occurrence) of cause *A* and/or cause *C*. The diagnostic reasoning of constructed in such a way Bayesian network allows obtaining probability of occurrence of cause *A* given that accident *B* has not happened - $P(A=T/B=F,C=F)$. In other words, this is the probability of occurrence of cause (causal factor) A which is under investigation within the operating process of transportation. The diagnostic reasoning could be implemented by simulation following the next algorithm involving three main steps:

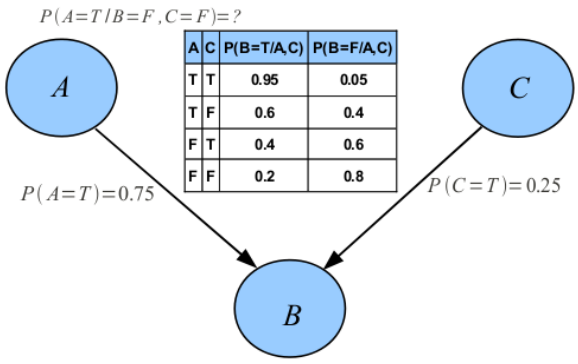

Fig.2. Accident scenario B with causes A and C

Step 1: Simulation of event A following previously predefined prior probability - $P(A=T)=0.75$.

For this purpose a random variable $R_A \in [0,1]$ is generated. Each value of R_A as a single representative of event *A* has to be compared to prior probability $P(A=T)$. If $R_A < 0.75$ event A can be considered as *TRUE* (A) otherwise as *FALSE* $(-A)$. The simulation process regarding event A is shown in figure 3.

Step 2: Simulation of event B.

Depending on the results connected with the first step of simulation, the respective conditional probability of event B has to be chosen for continuation of the simulation process following the same approach as this on step 1, namely:

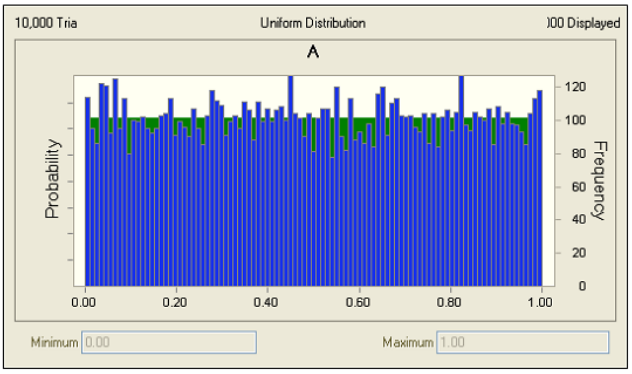

Fig.3. Simulation of event A

-If after the first step $A = TRUE$ then a random variable $R_B \in [0,1]$ is generated and compared to conditional probability $P(B = T / A = T, C = F) = 0.6$. If $R_B < 0.6$ event B can be regarded as TRUE (B) otherwise as FALSE $(-B)$.

-If after the first step $A = FALSE$ then a random variable $R_B \in [0,1]$ is generated and compared to conditional probability $P(B = T / A = F, C = F) = 0.2$. If $R_B < 0.2$ event B can be regarded as $TRUE$ (B) otherwise as $FALSE$ $(-B)$.

The simulation process including steps one and two should be fulfilled many times (K) and each iteration of implementation increments two counters - $K_1 = K_{A=TRUE,B=FALSE}$ and $K_2 = K_{A=FALSE,B=FALSE}$ with one, that is.:

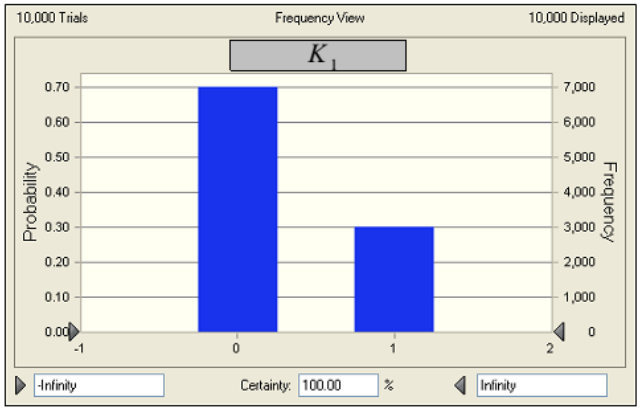

Fig. 4. Estimation of parameter K_1

- $K_1 = K_1 + 1$ if A=TRUE, B=FALSE;

- $K_2 = K_2 + 1$ if A=FALSE, B=FALSE.

The ratios K_1 / K and K_2 / K represent probabilities $P(B = F)$ and $P(A = T \wedge B = F)$. Having their values and by the usage of conditional probability formula the obtaining of probability $P(A = T / B = F, C = F)$ is very easy to calculate as the ration $K_2 / K_1 = 0.66$. The results about parameters K_1 and K_2 are shown in figures 4 and 5.

4. Conclusion and Discussion

The successful management of operational safety in railway industry requires understanding of railway undertaking as a complex system. Such a system could never be designed perfectly and every constituent of it can be subject to failure - technical equipment, operating staff, procedures and rules, etc. System failures entail incidents which are usually considered as normal to occur (it is impossible to absolutely prevent them from occurring). At the same time, serious ones (accident) could and should be prevented and that can be done by implementing certain measures, e.g. company's knowledge of incidents. On this basis and by the usage of appropriate scholarly approaches and methods, the risk management regarding incidents and serious accidents becomes not only possible but extremely effective.

The present article demonstrates that Bayesian networks are applicable in designing and functioning of Safety Management Systems of the railway undertakings. The possibility to manage reasoning and decision making under uncertainty is their main advantage. It all makes them appropriate tools for analysis of

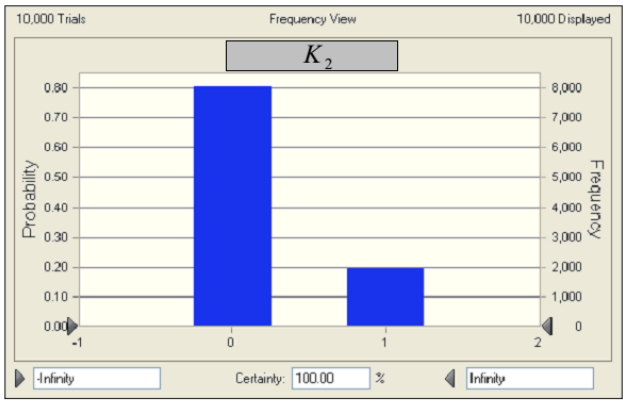

Fig.5. Estimation of parameter K_2

interactions and relationships characterising a railway undertaking which under certain conditions could turn into causal factors of accidents, e.g.: organizational deficiencies, operating environment influence, etc. Due to their simplicity to use, applicability and comprehensive results, Bayesian networks will become more popular analytical tool within all components of railway undertakings' SMSs.

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ROAD TRAFFIC SAFETY PERFOMANCE IN MONTENEGRO

Ass. Prof. Vladimir Pajkovic, PhD, Mirjana Grdinic, MSc
Faculty of Mechanical Engineering – University of Montenegro

pajkovic@ac.me; grdinicm@yahoo.com

Abstract: *According to WHO, more than 1.2 million people die in road traffic crashes every year and 50 million are injured or disabled. Over the last decade nearly all EU countries record a decrease in number of traffic casualties. However, in the same period Montenegro's figures generally point in opposite direction. The fatality rate on Montenegro's roads, measured as deaths per capita, is 50% higher than that of EU average; however, car ownership in Montenegro is considerably lower than the EU average. Having traffic safety figures so bad, efforts have been made in recent years to address this issue.*

Keywords: TRAFFIC ACCIDENTS, ROAD DEATHS, (COUNTER) MEASURES

1. Introduction

More than a million people die each year on the world's roads. According to World Health Organization (WHO), approximately 1.24 million people die every year in car accidents and more than 50 million are injured, /1/. Road traffic injuries take an enormous toll on individuals and communities as well as on national economies. At the national level, road traffic injuries result in considerable financial costs, particularly to developing economies. It is estimated to cost countries up to 4% of their gross national product. In high-income countries, number of road deaths is decreasing in last few years, but low-income countries, such as Montenegro, saw increases over the same period. Current trends suggest that by 2030 road traffic deaths will become the fifth leading cause of death unless urgent action is taken.

Road safety in Montenegro is at low level. One of primary reasons is poor road infrastructure. Montenegro has a road network totaling approximately 7,000 km – with approx. 900 km of main and primary roads, 950 km of regional and secondary roads, and around 5,000 km of local roads. This is equivalent to a road density of 500 km per 1,000 km^2. This figure is broadly consistent with the density of some new EU member states (see Table 1), /2/. Regarding road infrastructure quality, Montenegro ranked only 107th, of 131 countries surveyed, for the quality of its road infrastructure. 90% of Montenegro's road network is high risk, including those segments with a high traffic volume, /3/. Also, 47% of the entire road network is in poor or very poor condition, reflecting inadequate maintenance. To improve the road safety situation on the main road network, costs an estimated €105–138 million.

Table 1 *Road network density*

	Road density	
	km of roads per 1000 km^2	km of roads per 1000 inhabitants
Montenegro	500	11.1
Southeast Europe, average	555	5.9
Albania	657	3.5
Bosnia and Herzegovina	427	5.6
FYR Macedonia	513	6.4
Serbia	500	5.2
New EU member states	1427	19.9
Czech Republic	1646	12.5
Estonia	1320	41.2
Hungary	1733	15.7
Slovenia	1007	10.2
Croatia	506	6.4

Other factors, such as the distribution and density of population and the country's geography, play a considerable role in determining country's road network. These effects become evident when making the comparison on a different measure of road density – viz. road kilometers per 1,000 people.

With this measure, with more than 11 km of road per 1,000 inhabitants, Montenegro is ahead of most of its regional comparators and comparable to those of the new EU countries, /5/.

Table 2 *Number of vehicles in Montenegro*

	2010	**2011**	**2012**	**2013**
Registered cars	164653	171973	173865	178662
per 1000 inhabitants	266	277	279	286

During last few years, the number of registered vehicles is around 200,000 counting all vehicles category and about 85% are passenger cars. The rate is approx. 286 passenger cars per 1,000 populations, (see Table 2), /4/. Compared to both the EU average and neighbors in the region, Montenegro's level of motorization is moderate (Fig. 1).

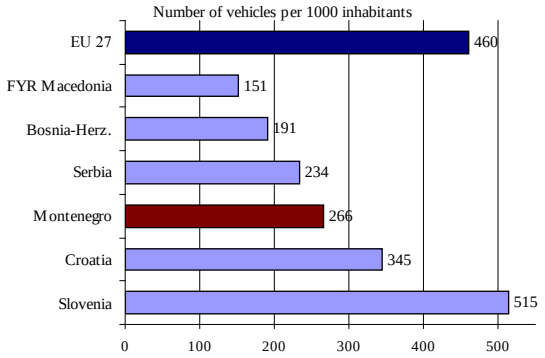

Fig. 1 *Number of passenger cars per 1000 inhabitants in 2010*

2. Road safety indicators

Number of road accidents, deaths and injures in OECD countries is decreasing, despite larger number of vehicles. Number of accidents reduced by 15% in period 1990-2010, fatalities by 25%, while number of injures remained the same. In EU-27 states in 2010 the number of fatalities was down to almost half of the figure from 2001, /5/. According to CARE – EU road accidents database, the largest reduction of number of fatalities achieved Malta, 48%, Cyprus, 28% Denmark 18% and Portugal, 16%.

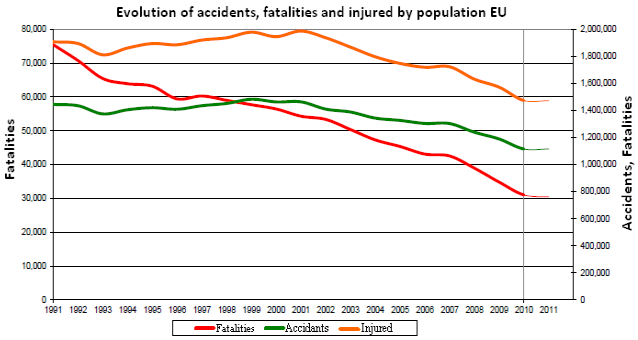

Fig. 2 *Accidents indicators in EU*

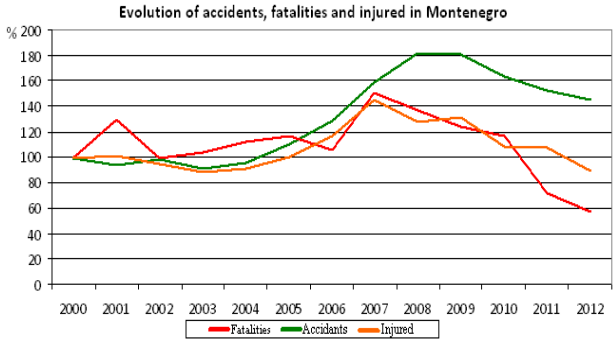

Fig. 3 *Accidents indicators in Montenegro (2000=100)*

Countries of West Balkans as developing countries are trying to comply with the rules and regulations of the EU, including those in the field of transport. Despite that, all indicators of road safety in Montenegro have been increased over the previous ten years. Compared to 2000, in 2010 the number of road accidents went up 63.2%, fatalities by 17.3% and number of injured by 8.5%.

Over the last decade more than 1,000 people died on Montenegrin roads and more than 23,300 were injured. Mortality rate was the highest in period 2007-2009, over 10.000 accidents in 2008 and 122 killed in 2007 (see Table 3 and Fig. 3), /4/. However, in 2011 and 2012 Montenegro reduced number of road accidents and fatalities. The percentage of fatalities that occurred in crashes in 2012 was reduced by 52% compared with 2010 and by 62% compared with 2007. In spite of encouraging dates in last few years, studies show that number of fatalities in first six month of 2013 is already as high as in 2012.

Comparison of road safety performance depends somewhat on what indicator is used as a measure of exposure to risk; population, number of registered vehicles or distance travelled by motorized vehicles.

Fatalities per 100,000 head of population. This rate expresses the mortality rate, or an overall risk of being killed in traffic, for the average citizen. This is a particularly useful indicator to compare risk in countries with the same level of motorization.

Fatalities per 10000 registered vehicles. This is more objective indicator of situation on the roads. However, it's useful only when comparing the safety performance between countries with similar traffic and car-use characteristics.

According to OECD 2012 statistics, /6/, the rate in terms of fatalities per 100,000 populations in Montenegro in 2010 was 29.6. Comparing to both EU countries and neighbours in region, the risk of dying as a result of a road traffic injury on Montenegro roads is significantly higher.

Figure 4 shows the evolution of mortality expressed in terms of deaths per 100,000 population in European countries in 2011, /7/, and in EU-27, Montenegro and its neighboring countries in 2010 (*), /6, 8/.

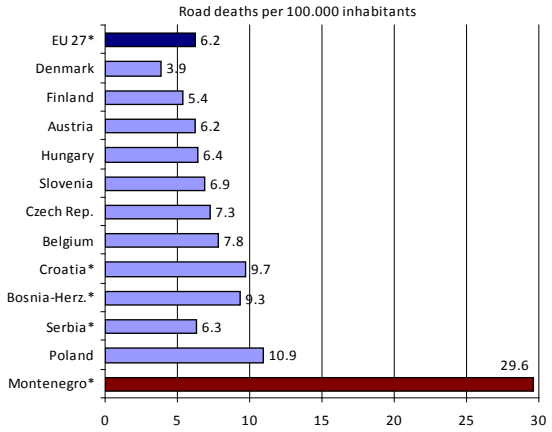

Fig. 4 *Fatalities per 100,000 head of population (2010/2011)*

Table 3 *Traffic accidents and casualties on Montenegrin roads*

Year	Accidents		Killed		Injured	
	Total	2000=100	Total	2000=100	Total	2000=100
2000	5597	100	81	100	1933	100
2001	5275	94.2	105	129.6	1957	101.2
2002	5503	98.3	81	100	1834	94.8
2003	5094	91.0	84	103.7	1702	88.0
2004	5377	96.0	91	112.3	1750	90.5
2005	6192	110.6	95	117.3	1942	100.4
2006	7185	128.4	85	104.9	2257	116.7
2007	8882	158.7	122	150.6	2796	144.6
2008	10170	181.7	111	137.0	2473	127.9
2009	10112	180.7	100	123.4	2542	131.5
2010	9138	163.2	95	117.3	2099	108.5
2011	8519	152.2	58	71.6	2075	107.3
2012	8103	144.7	46	56.8	1722	89.1

Number of fatalities per 10,000 registered vehicles is also higher comparing to other countries. However, there is a matter of vehicles from foreign countries in accidents on Montenegro`s roads during the tourist season which are not included in the number of 10,000. Considering that fact, this rate (in terms of fatalities per 10,000 registered vehicles) is at same high as neighbor countries (Fig. 5).

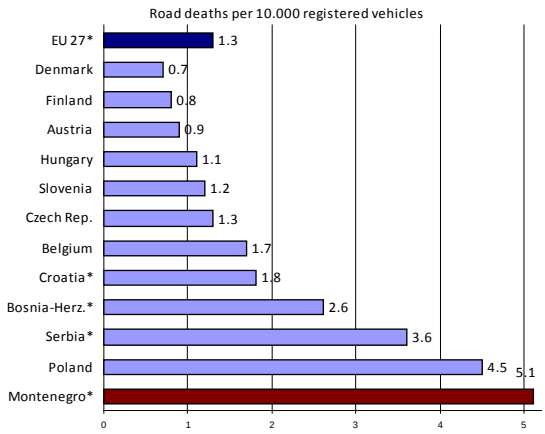

Fig. 5 *Fatalities per 10,000 registered vehicles*

All indicators show very poor road safety on domestic roads. Years 2007 and 2008 were particularly evil, which was the "price" of uncontrolled growth of motorization (in precedent years) and inadequate road infrastructure that couldn't "bare" an increasing traffic volume. The highest density of fatalities is found on main north-south route Border with Serbia − Bijelo Polje − Podgorica − Cetinje − Budva and Podgorica city zone.

According to WHO 2013 (World Health Organization), over one third of all road deaths in Montenegro is among drivers (34%), /1/. High mortality rate have both occupants and pedestrians, over 20% for each group (see Fig. 6).

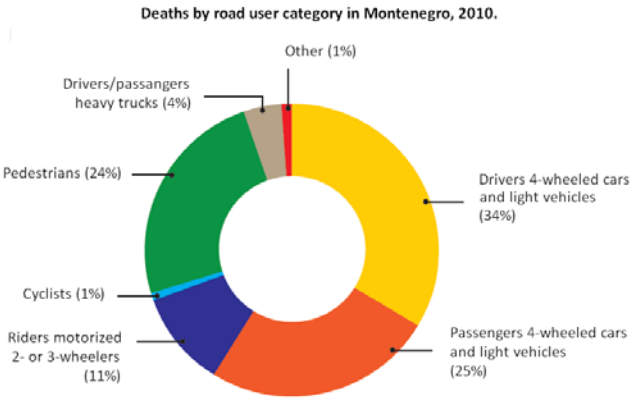

Fig. 6 Fatalities *per 10,000 registered vehicles*

3. Contrameasures

In May 2011, the United Nations launched a Decade of Action for Road Safety. The goal of the Decade (2011–2020) is to stabilize and reduce the increasing trend in road traffic fatalities, saving an estimated 5 million lives over the period. This report builds on the 2009 report, and provides additional data in a number of important areas. It is supported by a Global Plan for Road Safety. As a response, several countries released or updated in 2011 their national road safety strategies, /5/.

Although EU statistics clearly shows the progress that has been made over the last 10 years, road traffic safety performance in Montenegro is very poor.

Having traffic safety figures so bad, efforts have been made in recent years to address this issue. In 2010 National Coordination Board was established in Montenegro to monitor road safety parameters. In addition, government adopted Strategy for improvement of road traffic safety. Main goal of this strategy is to reduce number of fatalities by 30% and injuries by 20% before 2014 (compared to 2007). Long-term goal is to reduce these figures by 50% and 30% respectively by 2019, compared to the same year. Sadly, the growing interest in reducing road traffic risk is not accompanied with active road safety policies. Proposed measures are inadequate and insufficient – partly because addressing the situation properly requires considerable investments.

4. Conclusion

Over the last decade nearly all EU countries record a decrease in number of traffic casualties year after year. However, in the same period Montenegro's figures generally point in opposite direction – until 2007 – 2008 trend is towards an incline (with small exceptions) and declines only in last 2 – 3 years.

Dynamic growth of motorisation over the last 5-6 years took the government by surprise. With the road infrastructure unsuitable for the growing needs, a largely differentiated fleet of cars, difficulties with effective traffic enforcement and too few effective preventative schemes, the effects of growing motorisation have turned into a painful experience. In 2011 and 2012 Montenegro reduced number of road accidents and fatalities. The percentage of fatalities that occurred in crashes in 2012 was reduced by 52% compared with 2010 and by 62% compared with 2007. Major mortality rate is among drivers – about 34% of all road deaths.

Even though some improvements were made (government adopted Strategy for improvement of road traffic safety), the overall risk indicators in Montenegro remain above the EU average, not showing a decrease in their trend and a lot of work is yet to be done.

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NEW TRENDS IN TRAFFIC SAFETY

Ass. Prof. Dr Tomić-Petrović N.

Faculty of Transport and Traffic Engineering, University of Belgrade, Serbia

e-mail address: natasa@sf.bg.ac.rs

Abstract: *In this paper the important events in the auto industry all over the world, situation with automobile industry in Serbia, the concern for safety of drivers and other participants in traffic, with special stress on the protection of children in traffic, as well as the obligation of environmental protection are presented. Unfortunately, mortality in traffic is becoming epidemic. The interactive map showing the basic parameters of traffic safety in all countries in the world has been started. Every year on the roads throughout the world even 1.240.000 persons are killed. On the roads in Serbia the most frequent causes of traffic accident with serious consequences are: speeding, driving under the influence of alcohol and not fastening seat belts. Children in traffic are killed mostly as passengers. Reasearch shows that Serbia is positioned very low comparing to European Union countries when it comes to the safe transport of children in vehicles and the use of seat belts. Agency for Traffic Safety in the Republic of Serbia in December 2013 celebrated 4 years from foundation and on that occasion the importance and necessity of connecting and coordination in work of all subjects competent for the field of safety was emphasized.*

Key words: AUTO INDUSTRY,*TRAFFIC SAFETY,ENVIRONMENT,PROTECTION, SERBIA.*

1. Introduction

In March 2012, on the International Car Show in Genève, Serbo-Italian automobile "Fiat 500L" had its world's premiere and then it was stated precisely that this automobile is going to be produced only in Kragujevac, in Serbia.

The important changes are happening all over the world. During October 2013 public was informed about the action of the women from Saudi Arabia, who took the steering wheels in their hands in spite of the prohibition of the Government. Defying to the measures of the Government, threats of arrest and criminal prosecution, few women were driving cars in the streets of the Saudian towns. Then The King Abdulach gave support to some cautious reformes, such as the development of women's education and their employment, taking care to avoid the conflict with conservatives.

In this paper important events in the auto industry all over the world, situation with automobile industry in Serbia, obligation of the environmental protection, as well as the concern for safety of drivers and other participants in traffic, with special stress on the protection of children in traffic are presented.

Organization of Serbian drivers pointed out to their rights that they are also fighting for: - the obligatory privileged length of service, - recognizing of daily wages in foreign currency for drivers for the days spent abroad, - and to respect the rights of drivers and the help "friend on the road"

2. News in the world and in Serbia in the area of Auto Industry

Italian "Fiat"[1] has very strong presence on the American market. In 2013 in Detroit negotiations with trade union of automobile workers were successfully ended and conditions for Italian producer "Fiat"[2] to become 100% owner of the **"Crysler"** and car company with global reach were created. This agreement was realized and in 2014. "Fiat" completely took over "Crysler", the smallest member of the Detroit "big three", founded in 1925.

At the same time Serbian Auto-Moto Union reported that according to all criteria of the Euro NCAP tests for security the Chinese car **"Coros 3 Sedan**" was the best in 2013[3]. This car achieved the best result with maximal five stars in all segments of evaluation.

At the Serbian market models"**Nissan Qashqai 360 Family**" as well as "**Nissan Juke**", alluring from the advertisements in our surroundings at the end of 2013, are offered.

Cooperation with "Mercedes" company is dated from 1997.[4] when the long-term contract on cooperation in production and investment in the"Mercedes-Benz Icarbus" buses was signed. And the contract on strategic cooperation between the world's giant in auto industry "Mercedes" and domestic producer of buses "Icarbus" should be signed in the middle of 2014. and then in Zemun[5], near Belgrade the production of entire production program of Mercedes buses would start.

The first bus "Icarbus" was produced in 1954 by the license of the company **"Saurer"** from Austria. The founder of the "Icarbus" company was Dimitrije Konjović, a Serbian pilot and a maritime officer. In 1968 year the first bus with its own frame was produced and till today more than 80% of produced buses are with "Icarbus" frames. The production of the prototype bus on "Mercedes" frame has already started. This vehicle was made by the most modern standards and it was presented at the end of March 2014. on the International Fair of economic vehicles in Belgrade, Serbia. These are so called **gama models of buses** which meet strict professional but also ecological standards, because they have the motors of „euro 6" standard. The present production capacity of "Icarbus" is around 250 buses per year.

In the world, "**Detroit Auto Show",** was held in USA where the **"Lincoln**" motor company presented the most fuel-efficient, inspired, innovative, ingenious new **"Lincoln 2014 MKZ Hybrid**". But since its start, in 1911. **"Chevrolet"** has sold more cars than any other auto maker providing itself to be the "US brand" in these iconic models. In 2013 "**Ford"** fuel-efficient line[6] are as we know: "**Fiesta", "Focus", "Fusion", "C-max", "Escape", "F-150"** while they also must introduce all new 2015 **"Ford Mustang**" too.

It is interesting that competing with more than 1000 participants from the whole world Marko Luković [7] from Belgrade, Serbia, for the second time won prize on the contest in Detroit, that is, the automobile of the Serbian designer is among the best in the

[1] The greatest Italian employer in private sector was founded in year 1899.

[2] In 2009. "Fiat" bought 58,5% of "Crysler", the smallest member of the Detroit "big three" at that time in bankruptcy. The sale of "Fiat" and "Fijata 500" produced in Mexico and "Fiat 500 L" coming from Serbia (on the market from the summer 2013.) during year 2013. was 1,4% less.

[3] In 2012. year 33 vehicles were tested, and criteria were protection of adult passengers, children, pedestrians and safety equipment these vehicles have .

[4] It was predicted that "Merceds-Benz" delivers frames with agregates and other equipment, and in "Icarbus" the buses of European standard and quality with recognizable sign of "Mercedes" are installed. By the contract production of 5 types of buses, among which "Icarbus" took over 2-low ground bus for city transportation and high-tourist class bus, encircling with this the assortment of its products, was defined. After realisation of few buses according to this contract, further cooperation was abandoned because of too high price for domestic market.

[5] In Zemun section the most modern city, intercity and tourist buses, as well as pickup trucks will be made on "Mercedes" frames, while "Icarbus" would do the annex.

[6] **2013 C-max Hybrid** with fuel efficiency and smart technology too.

[7] In 2001, this professor at the Faculty of applied arts in Belgrade, won the first "Peugeot" contest at the Frankfurt Car Salon with the futuritic car concept for year 2020.

world At "Detroit Auto Show" cool colors and concepts of cars were exhibited.

The "Tokyo Motor Show 2013" took place in Japan and the new "**Toyota"** named **"Tundra"** is at disposal in 2013. and "**Toyotathon"** and all new **Nissan Rogue R.**

In September 2013. the public was informed about all innovations in auto industry at the Car Salon in Frankfurt /Germany/. **"Forester**", the new "Subara" model was presented.

The technological company "Google"[8] appeared in the world of automobilism i.e. auto-moto industry came to an agreement with big producers (partnership was concluded with companies "Audi", "General Motors", "Honda" and "Hundai") at the opening of Auto Show in Las Vegas. Partners will think out together how to include mobile operative system "android" in cars operation, what should make operation more simple and improve safety. In that way, "Google" tends to reach the competitor "Apple" which has already been working on this with "Mercedes" company.

3. Importance of Environmental Protection

In the middle of May 2013. the draft Program for environmental protection of the city of Belgrade for the period of 10 years was presented with the aim to define directions of development and environmental management politics on the whole territory of the city and after the adoption it will be an obligatory document in the process of local policy creation in all 17 municipalities of Belgrade. This project predicts realization of several projects, the adequate treatment of waste waters and waste disposal being some of them. The city transportation company points out that the total consumption of fuel is about 100.000 liters on work days .

In our country, Pančevo will become the only local autonomy in Serbia with 7 vehicles with electric drive, and simultaneously the first charging spot[9] for electrical cars.

The vehicle of the Chinese company "BID" that will be included in public transportation is currently being tested in our capital Belgrade. We speak about the new generation of high technology ecological buses, the use of which considerable reduces maintenance costs and improves air quality, because there is no emission of harmful gases.

It is well known that Germany is the residence of big car producers **("BMW", "Wolkswagen", "Deimler")** and that the drafts of new EU regulations might endanger industrial production and its business sector.

Anyway, "Mercedes" has the famous bus brand **"Setra"** under its wing which currently produces the most modern and "the greenest" buses that do not in the least pollute the environment. In October 2013. the public found out that Germany protected its car industry from European Union (EU) regulations.

The Ministers of environmental protection of member countries of the European Union adopted the German request to alter already reached agreement on the introduction of the new regulation on the emission of harmful gasses of the new automobiles in June again. This agreement which is now going to be altered, would limit emission of CO2 from new cars to 95 gr per covered kilometer by 2020. The implementation of the decision was prolonged by 4 years and activists for environmental protection have criticized that decision and the European Commissioner for climate changes, as well as director competent for EU transportation policy at "Greenpeace".

According to the European directives, by the end of 2020 we should increase the share of biofuels in public transportation fuel consumption. It is well known that the advantages of hybrid vehicles are at lower level of harmful gasses emission, smaller consumption of diesel fuel and lower noise level, while the shortcomings are certainly their high price, they are considerably heavier than classic buses, the battery duration is limited and they require special maintenance and additional caution measures because they operate under high voltage of around 600 Volts (hybrid buses are used most in North America, where passengers are transported by around 6.200 buses, while they appeared in Europe not until 2007. and for the first time in London).

4. Traffic Safety - risks and solutions

Unfortunately, mortality in traffic is becoming epidemic. The interactive map showing the basic parameters of traffic safety in all countries in the world has been started. Every year on the roads throughout the world even 1.240.000 persons are killed. On the roads in Serbia the most frequent causes of traffic accident with serious consequences are: speeding, driving under the influence of alcohol and not fastening seat belts.[10] Children in traffic are killed mostly as passengers. Reasearch[11] shows that Serbia is positioned very low comparing to European Union countries when it comes to the safe transport of children in vehicles and the use of seat belts.

It is interesting that in Serbia during the last 4 years, around 300 drivers have passed "corrective" tests because their driving licence has been taken away for received 18 negative points. In the same period, close to 3000 drivers lost their licences because of violent driving.

Agency for Traffic Safety in the Republic of Serbia in December 2013 celebrated 4 years from foundation and on that occasion the importance and necessity of connecting and coordination in work of all subjects competent for the field of safety was emphasized.

However, thanks to the Law on traffic safety which came into force in December 2009, this year 176 persons less were killed in traffic accidents compared to the same period 4 years earlier.

During 2013 according to the newest data that number was reduced by more than 9%, i.e. 59 persons less were killed compared to the same period in 2012. We should point out that 2.813 pedestrians were killed in Serbia in the period from 2001 to 2012, and more than 13.000 were seriously and more than 28.000 slightly injured.Only last year 165 pedestrians were killed, that is by 10 more than in 2012. The results of this research are also the base for further activities of the Agency for Traffic Safety on the protection of pedestrians.

The UN action for traffic safety on the Planet is under way. United Nations have started global initiative titled **"My world after 2015"** in which they call for citizens of the Planet to choose the priorities for the better world and life in it (16 priority goals of human community development were offered, among which voters should choose the 6 most important).

The International Automobile Federation /FIA/ and Serbian Auto-Moto Union joined the action of the United Nations, because one of its parts is related to the improvement of road traffic safety. That is connected with the preparation of the Resolution on Global Road Traffic Safety in the framework of the 10 year-lasting action of the United Nations for traffic safety on the Planet from year 2011. to year 2020.

The idea to drive auto-plane that would be a combination of aircraft without pilot and car-robot coming from Technological Institute in Masachusets is interesting, but this is not favorite in public, because it is understood as the carrier of spy equipment. Those special machines would be computer-operated. Technology of wireless guidance is used by all "Airbus" and many "Boing" planes. Experts of aeronautics and astronautics consider that there

[8] The American internet giant „Google" intends to expand its popular operative system „android" in the cars.

[9] This is the present of the Italian province Ravena in order to protect environment.

[10] Examples of France and Germany show that in these countries 95% of passengers fasten seat belts also on the back seats in the vehicle, while in Serbia that percentage is barely 4% of passengers.

[11] Project with title "Methods of monitoring indicators of road safety and their importance for the strategic management of traffic safety" done by the Faculty of transport and traffic engineering in Belgrade on the request of the Agency for Traffic Safety, which is a member of the European Council for Road Safety.

are no obstacles for starting road-air traffic by flying cars – **DRONES**. However, there are certainly some cultural and psychological obstacles, because we are not ready to give up cars (published by **"**Tanjug" from London, at the beginning of November 2013.).

It is planned that **drones** will soon start to be part of the everyday life, for example, for delivering packages[12], but also as the assistance in space orientation. The laboratory of the American University MIT constructed a robot with the aim to help people, but it takes time to find the interaction between people and robots.

5. Conclusion

This paper is written with a wish that the cited newest improved models of automobiles throughout the world lead to as little as possible traffic accidents, injuries and destruction, to increase traffic safety in all countries, and also to reduce pollution that trafic causes. It should be insisted on the reduction of CO2 emission by year 2025 and of course on its inclusion in the regulations. It is interesting that the position of Germany was supported by Great Britain and Poland, while France, Belgium and Italy took the original agreement's part.

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

At the opening of Auto Show in Las Vegas company "Google"[13] appeared in the world of auto-moto industry coming to an agreement with few big producers (partnership was concluded with companies "Audi", "General Motors", "Honda" and "Hundai"). Partners will think out together how to include mobile operative system "android" in cars operation, what should make that operation more simple and improve safety. It is well known that the price of the secret program of drones is high and that in the world debate "for drons and against them" is lasting. In the era of sophisticated technologies however humans are irreplaceable.

In the Republic of Serbia a lot is invested in the traffic safety on the national as well as on the local levels all over the country. Cooperation between countries is something we should lean on more in the future in order to find solutions for environmental and traffic safety problems easier and fight them together.

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[12] Company „Amazon" will use these aircrafts for delivering packages up to weight of 5 kilograms.

[13] American internet giant „Google" intends to expand its popular operative system „android" in the cars.

THE USING OF SOLVER SOFTWARE AND VEHICLE ROUTING FOR THE TRAVELING SALESMAN PROBLEM

M.Sc. Krstev D. PhD.[1], M.Sc. Pop – Andonov G.PhD.[2], Prof. Krstev A.PhD[3], Prof. Djidrov M.PhD[2],Prof. Krstev B.PhD[1], M.Sc Sashe Pavlov[1]
Faculty of Mechanical Engineering, University "Cyril and Methodius"-Skopje, the Republic of Macedonia[1]
Faculty of Mechanical Engineering, University "Goce Delcev"-Stip, the Republic of Macedonia[2]
Faculty of Computer Science, University "Goce Delcev"-Stip, the Republic of Macedonia[3]
Faculty of Natural and Technical Science, University "Goce Delcev"-Stip, the Republic of Macedonia[1]
E-mail: krstev.deni@gmail.com E-mail: goran.pop-andonov@ugd.edu.mk E-mail: misko.djidrov@ugd.edu.mk E-mail: boris.krstev@ugd.edu.mk E-mail: aleksandar.krstev@ugd.edu.mk

Abstract:*The traveling salesman problem (TSP) is one of the most studied problems in management science. Optimal approaches to solving traveling salesman problems are based on mathematical programming. But in reality, most TSP problems are not solved optimally. When the problem is so large that an optimal solution is impossible to obtain, or when approximate solutions are good enough, heuristics are applied. Two commonly used heuristics for the traveling salesman problem are the* ***nearest neighbor procedure*** *and the* ***Clark and Wright savings heuristic.***

In this paper will be present using of the solver software and principles of TSP for optimal solution of vehicle routing for domestic bottled water and different juices in the different parts of the Republic of Macedonia.

Key Words: TSP, NNP, CWSH, routing

1. Introduction

Logistic system of a company contains a fixed number of places where raw materials, materials, semi-finished and finished products remain appropriate time, whether they are in undergoing treatment or in the warehouse. The link between fixed locations is provided by the transportation system. Transport provides goods to move between various fixed points which bridges the space between buyer and supplier .For efficient and economical operation of the logistic system it is necessary to have knowledge of the transport system . The role of transport is especially important today in terms of globalization , when companies are geographically dispersed or are distant from the sources of supply , causing dependence of transport whose task is to connect companies with sources of supply on the one hand and consumption on the other.

The goal of most transportation problems is to minimize the total cost of providing the service. It includes capital expenses for the vehicle, mileage and distance or personal expenses. But other goals may also come into play. In [6], [7] and [8] vehicle routing problem is solved using different optimization methods as dynamic optimization, linear optimization, graph theory, game theory. For optimization criterion is chosen transport costs [6, 8] or fuel consumption [7].

Problems of Routing and Scheduling are commonly displayed in graphical networks. Using networks to describe these problems take precedence over allowing decision makers to visualize the problem under study. The given picture below, which consists of five circles called nodes from which four nodes (2-5) represent the locations of delivery, and the fifth node (1) represents a node of the store or warehouse, where the tour begins or ends of vehicles.

Whit bonding of these nodes is obtained line segments called arcs. They can mark time, cost or distance required to pass from one node to another. Arches can be direct or indirect. Indirect arcs are represented by simple line segments.

Direct arcs are displayed in brackets. These brackets represent the direction of the drive in case of problems in routing (e.g., one-way streets) or preferential treatment in case of problems in the schedule (where a pick-up or delivered quantity must prevail over the other).

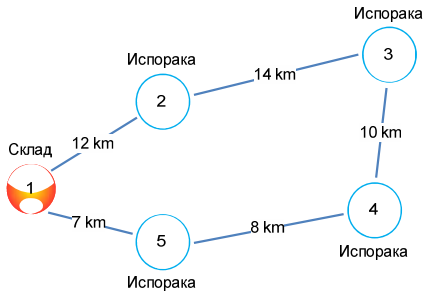

Figure1. *Routing Network Example*

From the image can be seen the simple routing of the single vehicle. Road that the vehicle passes is called the tour, and that is the direction $1 \rightarrow 2 \rightarrow 3 \rightarrow 4 \rightarrow 5 \rightarrow 1$ or when arches are indirect, $1 \rightarrow 5 \rightarrow 4 \rightarrow 3 \rightarrow 2 \rightarrow 1$. The total length of either of the two tours is 51 km. The feasibility depends on the type of problem, but in general, it implicates: The tour must include all nodes; node must be visited only once, tour must start and end in the store or warehouse. In the simplest case, you should start with a network of nodes that must be visited by a vehicle. Nodes can be visited in any order, no priority, travel expenses between two nodes is also irrelevant to the driving direction. In addition, the bearing capacity of the vehicle is not taken into account. The performance for the problem of single-vehicle road or tour where each node is visited only once and routing begins and ends at the warehouse. The tour is being created in order to minimize the total cost of the overall tour. The simplest case is known as the Traveling Salesman Problem (TSP). Traveling Salesman Problem (TSP) is one of the most studied problems in management science. Optimal achievements to solve traveling salesman problems are based on mathematical programming. But in reality, most of TSP problems cannot be solved optimally. When the problem is real big and complex, then an optimal solution is impossible to obtain, in these cases programming techniques and principles are applying. Two techniques are generally used for TSP problems including: Nearest neighbor procedure and Clark and Wright savings heuristic.

Nearest neighbor procedure (NNP) builds a tour only in accordance with the cost or driving distance from the last visited node to the nearest node in the network. In this case, the technique is simple, but it has the disadvantage of having nearsightedness or inaccuracy, which is evident from the following example. The procedure is outlined in the following: Start with the top node of the tour (warehouse or storage node), finding the closest node to the last node added to the tour, a return to step 2. Whilst all nodes are added, connecting the first and last nodes to create a complete tour.

The table below provides the complete distance matrix for symmetric six-node network shown in the figure below.

Table1. *Distance matrix for symmetric six-node network*

Од јазол	До јазол (дистинацијата во километри)					
	1	2	3	4	5	6
1	-	5.4	2.8	10.5	8.2	4.1
2	5.4	-	5.0	9.5	5.0	8.5
3	2.8	5.0	-	7.8	6.0	3.6
4	10.5	9.5	7.8	-	5.0	9.5
5	8.2	5.0	6.0	5.0	-	9.2
6	4.1	8.5	3.6	9.5	9.2	-

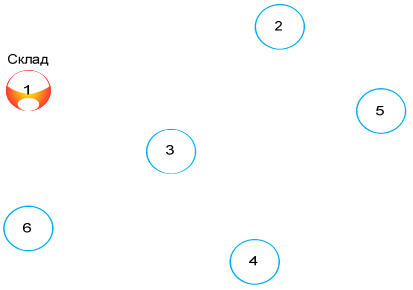

Figure2. *Traveling Salesman Problem*

According to the picture, the solution is determined as follows: Beginning at the initial node (node 1) and it is examined and considered the distances between one node and every other node. The created complete tour is 1 → 3 → 6 → 2 → 5 → 4 →1. The length of the tour amounted is 35,4 km.

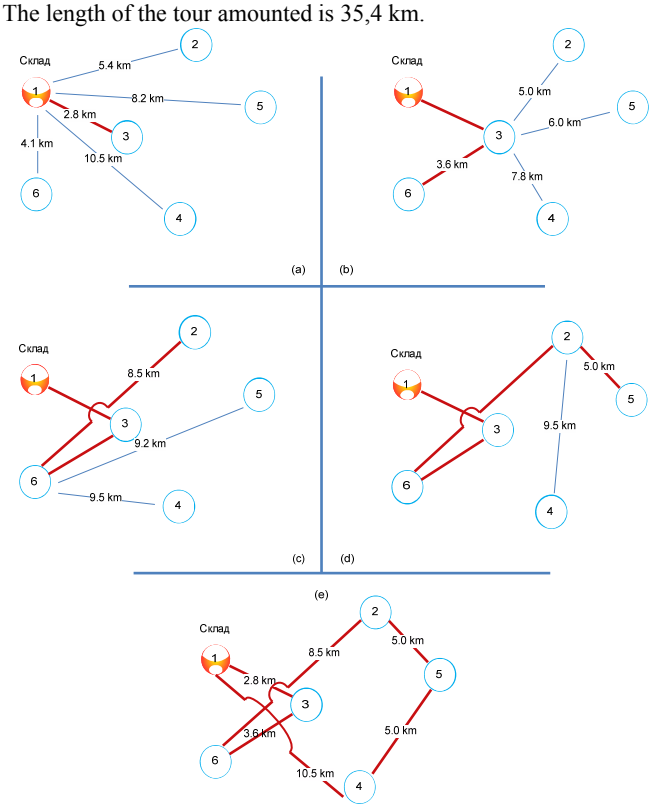

Figure 3. *Nearest neighbor Procedure*

However, the question is whether this represents the best tour or driving route? Consider again the network and try to find a better tour. Such as 1 → 2 → 5 → 4 → 3 → 6 → 1? The total length of this tour is 30.9 vs. 35,4 km to Nearest neighbor-constructed tour. This results in limitations of the technique and the principle or the application of this technique does not guarantee optimality. In this small network, it would be possible to re-label all possible tours. However, a number of problems with 100 to 200 nodes, re-labeling or renumbering every possible combination would be impossible. Before leaving this technique (NNP), it is necessary to note that, in practice, the techniques are applied to denote repetition by every possible initial node to node, resolving the problem, and then selects the lowest cost tour as a final solution . For example, if you repeat the procedure using the node 6 as the starting node, the tour will result in another length or 6 → 3 → 1 → 2 → 4 → 5 → 6 and a length of 31,3 km.

Clark and Wright savings heuristic procedure is one of the best known techniques and methods to solve TSP problems. It begins with the selection of a node as the starting node and marking the node first then it is assumed, for the moment, there are available n-1 cars, where n is the number of nodes. In other words, if we have 6 nodes in the network, then there are 5 available vehicles. Each vehicle travels from the warehouse or from the starting node to another node and returns to the starting node. But this is not practically possible solution because the purpose of TSP-problem is to find a tour in which all the nodes will be visited by a vehicle, rather than two separate vehicles, as shown in the picture. To reduce the number of vehicles required, it is necessary to combine n-1 tours originally specified.

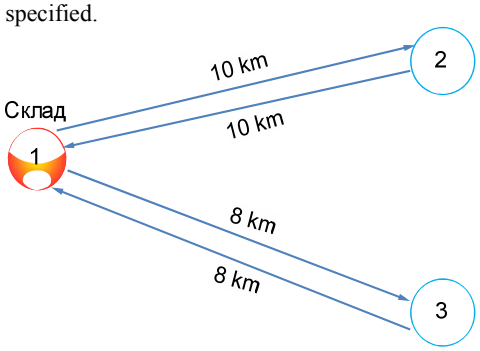

Figure4. *Initial C&W Network Configuration: Three-Node Problem*

The key to Clark and Wright savings heuristic procedure is to calculate savings. "Savings" is a measure of how much the driving range or cost can be reduced with "hooking up" - hanging a pair of nodes (in the case of the picture above nodes 2 and 3) and to create a tour 1 → 2 → 3 → 1, which can be marked for one vehicle. "Saving" is calculated as follows: By connecting nodes 2 and 3, add 5 km (distance from node 2 to node 3), but save 10 km of road from node 2 to node 1 and 8 km route from node 3 to node 1, total distance or length of tour 1 → 2 → 3 → 1 is 23 km. "Saving" which is obtained with the new configuration is 13 km. For a network with n nodes, calculate savings for each possible pair of nodes, and the amount of savings reaches Descending savings, so tours are constructed by linking the different possible pairs of nodes until a complete routing is obtained. The exhibit S & W savings heuristic procedure is as follows: Select any node as the starting node (node 1) Calculation of savings, Sij for linking the nodes i, j, and Sij = c1i + c1j-cij for i, j, = nodes 2, 3, ..., n, where cij = cost of driving from nodes i → j, Order of the savings from the biggest to the smallest, Starting at the top of the list of most sub-tour by connecting the appropriate node s and j. Stop when full tour is formed. As a demonstration of this procedure a TSP-problem is used, the network shown in the image below. It is assumed that there is one vehicle for each node (excluding the starting node) in the network. Full drawn lines show arches in use when starting with S & W savings heuristic procedure. Dashed lines show the arches that can be used, but are not currently used.

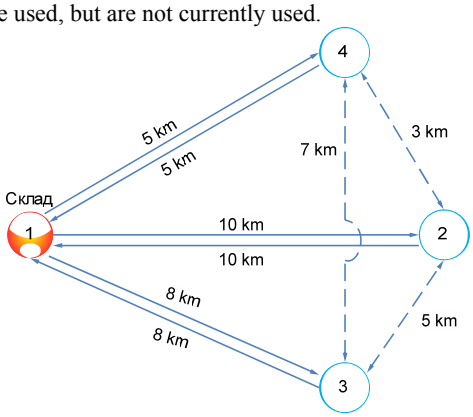

Figure 5.S & W savings heuristic procedure.

The next row of the savings for each pair of nodes is still connected. In order to save, the couples [2,3], [2, 4] and [3, 4]. The first step in the specification of a tour is to connect nodes with the highest savings, which are nodes 2 and 3. The resulting path is shown in Figure (a) below. Processing the future top savings, nodes 2 and 4 are connected according to Figure (b) below. The tour is now complete, as the last pair of nodes, 3 and 4 cannot be merged without disruption of the tour. The complete tour is 1 → 4 → 2 → 3 → 1, which has a total length of tour of 21 km. The total savings obtained for the configuration "one vehicle per node" which is shown in the picture is 25 km.

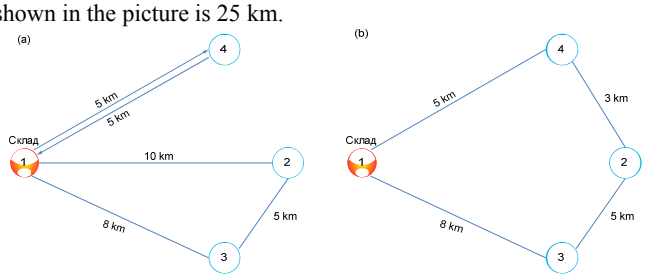

Figure 6. (a) *2-3 node connection, (b)2-4 node connection*

In general, because S & W savings heuristic procedure takes into account the cost when construct the tour; achieve better quality solutions compared to the nearest neighbor procedure (NNP). However, both procedures can easily be adjusted to suit the problems with direct arcs.

2. Traveling Salesman Problem (TSP)

When the problem is real big and complex, and it is a transportation of juices or carbonated mineral water, energy drinks Gorska - Koding - Skopje, then an optimal solution is impossible to obtain or when sufficient or sufficiently accurate approximate solutions are apply, than programming principles and techniques are used. Generally are used for solving TSP problems and the technique is: Nearest neighbor procedure.

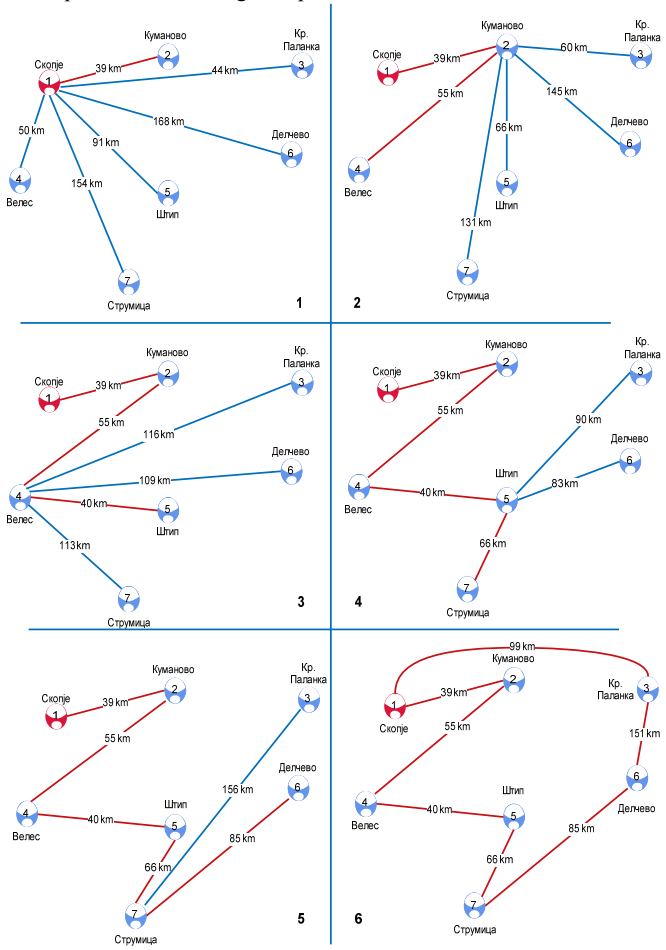

Figure 7. *Regional distribution network in Eastern part of Macedonia using the TSP*

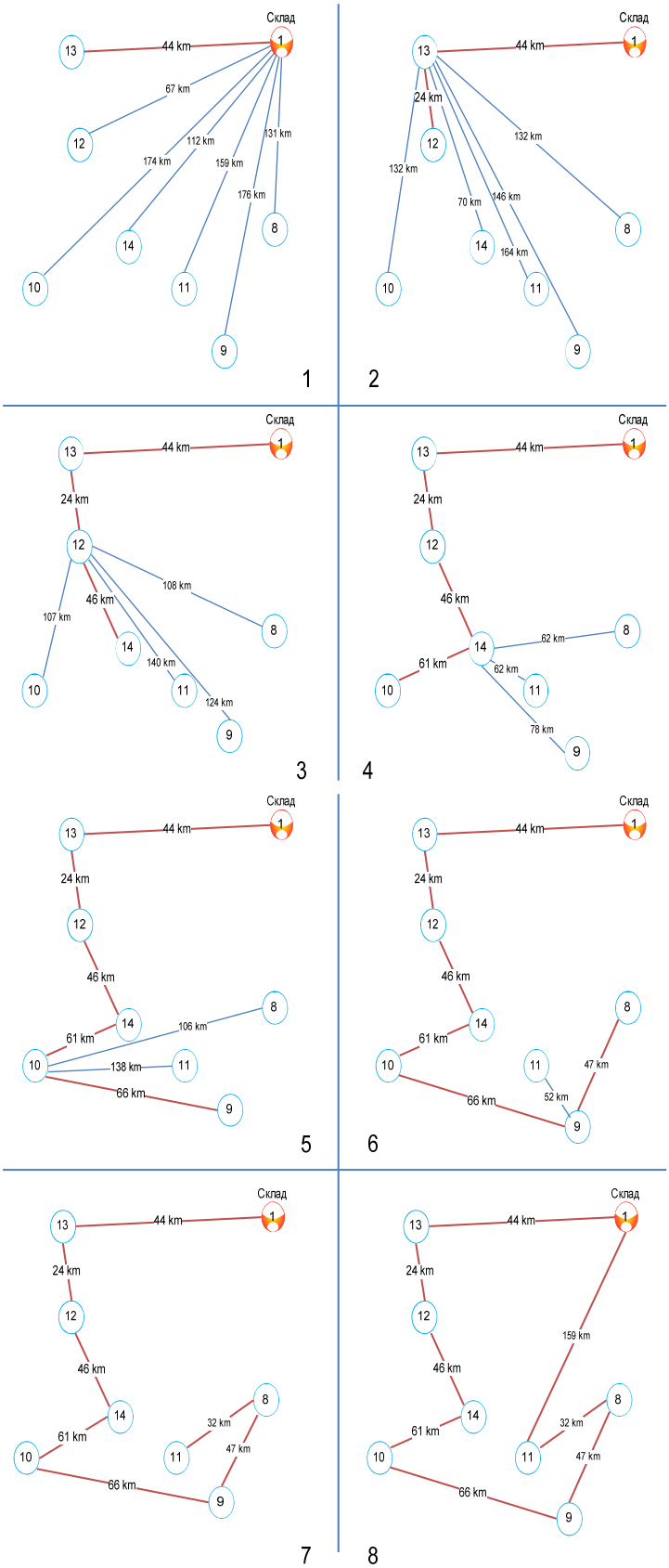

Figure 8. *Regional distribution network of Western part of Macedonia with TSP*

Conclusion

Reviewing the solutions of vehicle routing above picture you can create a complete tour 1 → 2 → 4 → 5 → 7 → 6 → 3 → 1 whose length is 535 km. Because this method does not always give the optimal value of the tour, we will again consider the network and try to find a better tour, such as 1 → 4 → 6 → 7 → 5 → 3 → 2 → 1. Total length of this tour is 461 km, versus the previous 535

km, or 48 km difference. Reviewing the solutions of vehicle routing as in picture 45, we can create a complete tour 1 → 13 → 12 → 14 → 10 → 8 → 9 → 11 → 1 whose length is 479 km. Because this method does not always give the optimal value of the tour, we will again consider the network and try to find a better tour, such as 1 → 13 → 12 → 14 → 10 → 9 → 11 → 8 → 1. The total length of this tour is 456 km, versus the previous 479 km, or difference 23 km.

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THE INTELLIGENT TRANSPORT SYSTEMS – RISKS AND BENEFITS

M.Sc. Krstev D. PhD.[1], M.Sc. Pop – Andonov G. PhD.[2], Prof. Krstev A. PhD[3], Prof. Djidrov M. PhD[2],Prof. Krstev B. PhD[1],
Faculty of Mechanical Engineering, University "Cyril and Methodius"-Skopje, the Republic of Macedonia[1]
Faculty of Mechanical Engineering, University "Goce Delcev"-Stip, the Republic of Macedonia[2]
Faculty of Computer Science, University "Goce Delcev"-Stip, the Republic of Macedonia[3]
Faculty of Natural and Technical Science, University "Goce Delcev"-Stip, the Republic of Macedonia[1]
E-mail: krstev.deni@gmail.com E-mail: goran.pop-andonov@ugd.edu.mk E-mail: misko.djidrov@ugd.edu.mk E-mail: boris.krstev@ugd.edu.mk E-mail: aleksandar.krstev@ugd.edu.mk

Abstract: *Effective deployment of ITS technologies depends in part on the knowledge of which technologies will most effectively address the issues of congestion and safety. Thus, it is important to understand the benefits or risks of both existing and emerging technologies. Based on documented experience locally and throughout the country, ITS deployments in urban areas have the potential to offer the following benefits:*
• Arterial management systems can potentially reduce delays with the implementation of advanced control systems and traveler information dissemination.
• Freeway management systems can reduce the occurrence of crashes, increase capacity, and decrease overall travel times.
• Freight management systems reduce costs to motor carriers with the implementation of the commercial vehicle information systems and networks.
• Transit management systems may reduce travel times and increased reliability with automatic vehicle location and transit signal priority implementation.
• Incident management systems potentially reduce incident duration and offer numerous other benefits.
There is a wide range of benefits that can be obtained from ITS deployments. For example, fuel consumption, travel time, and delay can be reduced. ITS deployments can also result in higher travel speeds, improved traffic flow, and more satisfied travelers for all modes.

Keywords: ITS, RISKS, BENEFITS, DEPLOYMENTS

1. Introduction

The use of information technology is implemented and expanded in almost all areas and fields of human labor, so any transport not an exception. Intelligent Transport Systems (ITS) is the application of information technology in the transport sector. Intelligent Transportation Systems are defined as:

"Application of advanced sensors, computers, electronics and communication technologies and management strategies - in an integrated manner - to increase the safety and efficiency of surface transportation system"

This system can help transportation planners and operators. Accordingly tackles congestion, pollution, poor accessibility, may also help to reduce travel time, provide reliable, safe and convenient transport while reducing energy consumption and protecting the environment and working environment.

Figure 1*. Intelligent Transport System*

1.1 Intelligent Transport System

Most cases occur is creating problems with crowds and delays in road traffic. Therefore, it is necessary to find ways to manage traffic more efficient ways of existing roads. In all this, ITS can contribute to solving these problems. In the 60s of last century to optimize the traffic in the cities were designed computer control systems. More recently emerging and developed a range of sophisticated products and systems , which appears in a wide range of systems for commercial transport services for freight and public transport , the occurrence of ITS in our vehicles and informing the passengers in them. They extend to all modes of transport such as road, rail, water and air. Of course you need full coordination to exploit the full potential of ITS in the transport network both national and European level.

It must be mentioned that the existence of ITS software and hardware (architecture) allows a systematic basis for expansion of all possible systems and applications to be interoperable.

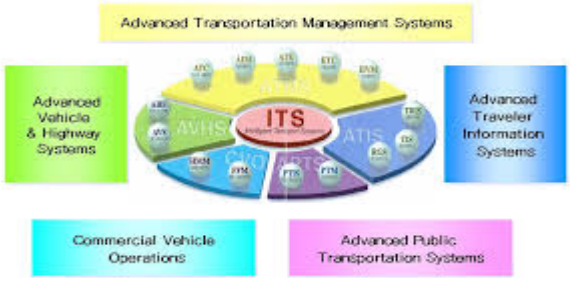

Figure 2. *Application of Intelligent Transport System*

2. Possible long-term problems and risks

The biggest change in the development of road safety is a change of focus and philosophy of integrated traffic system and traffic parameters of the process. Vehicle safety, internal passive occupant safety and road improvements in the existing environment, with specific targets risk groups (young drivers) and risk behaviors (drunk driving, speeding) - and prudent levels sanctions - are activities and synergies in integrated access systems. The development of intelligent transportation systems (ITS) suggests that road transport will become increasingly dependent structured by new and additional requirements for vehicle safety and driver / operator.

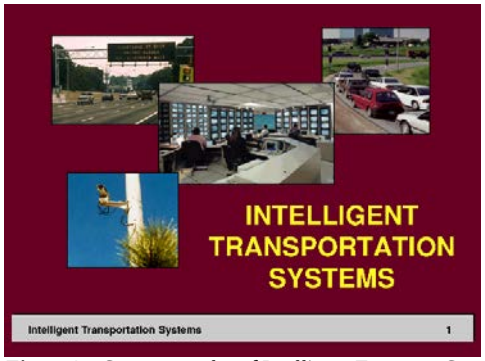

Figure 3a*. Some examples of Intelligent Transport System*

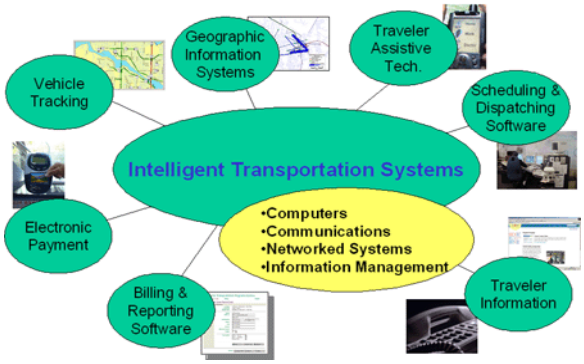

Figure 3b. *Some examples of Intelligent Transport System*

Intelligent Transport Systems ITS is widely known as Supervisory Control and Data Acquisition (SCADA) systems, which are designed for operations and safety. These systems are now connected to the internet and use available commercial technologies that introduce new security risks and threats.

In June 2010, anti-virus Security Company announced the first detection of the virus (malware) that attacks SCADA systems. The virus called Stuxnet was discovered and initially 14 systems internationally.

Brisbane City Council and Department of Transport and Main Roads stressed the need for implementation of secure information technology with full protection against malicious attacks on the system. According to the Brisbane City Council and Department of Transport and Main Roads was established high susceptibility of attacks on road systems in Brisbane,Australia. "The systems for traffic management of critical infrastructure in Brisbane were obviously not as secure as they should, and they were vulnerable to targeted attacks." The report presented by the Brisbane City Council and Department of Transport and Main Roads showed that the sensitivity of the system lies largely in the use of common information technology and internet connectivity .

Just like Australia in Brisbane and Israel learned this lesson the cruel way when virus was used to access and closing the network of cameras on a major arterial tunnels in Haifa. Consequently it was disabled and paralyzed highway in periods of two hours.

Also in Germany there are doubts about the abuse with changes in light of lights so drivers can create confusion, delays, congestion or causing accidents and incidents. With the introduction of ITS vehicle is expected to have a very positive safety improvements, which may contribute drivers to change their ways of taking along not intended for system engineers and implementers design. Identified downsides and unintended effects of ITS include:

• *Risk and taking along satisfactorily*. ITS can change the perception and the perception of risk drivers from driving , bringing up taking along risky driving , if their level of risk sensitivity is lower than their preferred level of risk. Drivers can also engage in the risky driving desire for compensation of reduced mobility (at low speed driving). According to US Federal Highway Administration Speed Management Information, accelerating too fast and driving under the circumstances given the speed limits are a factor of nearly a third of all fatal accidents. In 2011 there were 32,367 deaths on the roads, of which 9944 were associated with accelerated drive, which means a decrease of 5 % from the previous year. Driving too fast is a problem with the safety of all roads. Although much of the public concern and is associated with premature focused driving, almost half of the fatal cases are due to this.

• *Excessive confidence*. Drivers can take much greater responsibility for driving certain of the existing system and can leave you indifferent to accountability system without it being designed for such an undertaking. Excessive trust in ITS can create problems when the system is active while, so when driving a vehicle without ITS staffed, or if the system gives up and the driver should re-gain control.

• *Subtract attention*. ITS can overwhelm the driver to drivers if they wish to pursue more information in long periods of time. The National Highway Traffic Safety Administration reported that in 2010 drivers were the cause of 18 % of the total fatal accidents, killing 3092 people and themselves accidents resulted in 416 000 people injured . Forty percent of American teens say most were in cars or vehicles when the driver used a cell phone, GPS and other devices, putting people in danger. According to research at Virginia Tech Transportation Institute6, shown that text messages generate 23 times more likely to crash than driving without such activities. Eleven percent of drivers aged 18 to 20 years who participated in a car accident and survived, admitted that the accident had been accepted or sent emails or texts, monitoring, commands etc.

In [9] and [10] is presented experiment of observation and analysis of the movement of means of transport in real time through the application of GPRS. A method for controlling the movement of a road train with minimum fuel consumption is experimented with optimization of technical and operational parameters.

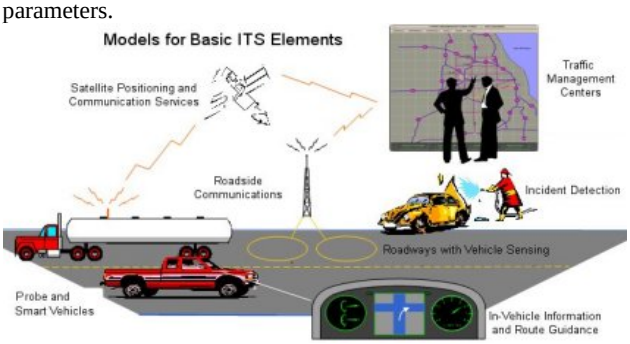

Figure 4.Models for Basic *Intelligent Transport System* Elements

The biggest risk serious deficiency can be detected in the overall application failed because ITDZ assessment of the full implications of its integration into existing or additional components. At the same time it is possible to ascertain that no valid technical application which is effectively impossible to apply due to organizational reasons. And to work for government, public administration or provider of ITS, ITS architecture helps in the long run to get the best value for the investment and effort invested in this whole effort. Risk and lack of ITS architecture that can create" islands of technology". However, the time when their boundaries will merge as a result of the need for expansion or connection will appear incompatibility.

Conclusion

The goal of intelligent transportation systems (ITS) is to improve the efficiency and safety of the transportation system. Effective scheduling of ITS technologies depends in part on the knowledge that the technologies most effectively answering questions about congestion and safety. In addition, it is important to understand the benefits from both, existing and emerging technologies.

The problems and risks must be disclosed by users of intelligent transportation systems (ITS), in order to make a real assessment of their resolve and overcome. After the assessment, you will surely get the desired result, i.e. the correct technical solution for removing them.

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ВЪЗМОЖНОСТИ ЗА ПОВИШАВАНЕ НА КАЧЕСТВОТО В ГРАДСКИТЕ АВТОМОБИЛНИ ПРЕВОЗИ

POSSIBILITIES OF IMPROVEMENT OF THE QUALITY OF CITY AUTOMOBILE TRANSPORT

ВОЗМОЖНОСТИ ДЛЯ ПОВЫШЕНИЯ КАЧЕСТВА В ГОРОДСКОЙ АВТОМОБИЛЬНЫХ ПЕРЕВОЗОК

Assoc. Prof. Eng. Dragneva N. PhD,

Bourgas Free University

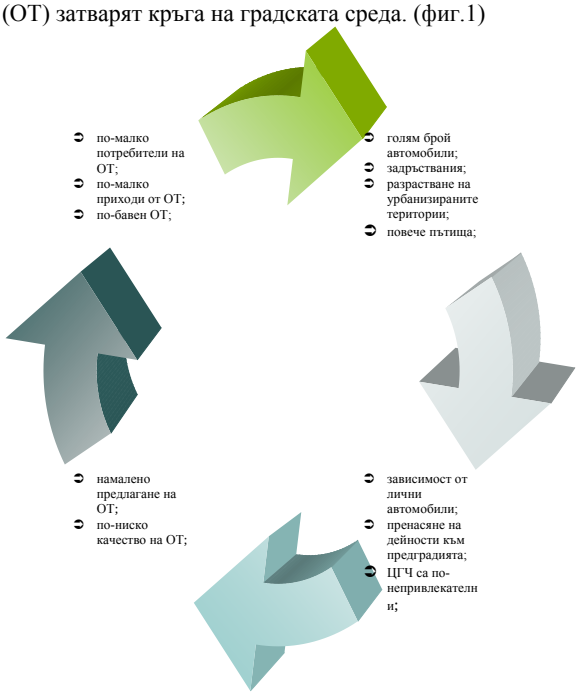
E-mail : dragneva@bfu.bg

Abstract: *In order to improve the quality of the city automobile transport, it is necessary to identify the problematic fields in the transport system such as events, bad weather and road conditions, emergency and repair activities, as well as some economic factors. Through the city mobility plans and the positive change of the public transport characteristics, the conditions shall be substantially improved upon finding out the reasons and solving the existing transport problems.*

Keywords: QUALITY, PUBLIC TRANSPORT, CITY MOBILITY

1. *Увод*

Бързото, удобно и безопасно придвижване от една точка до друга може да направи един град много по-привлекателен за живеене. Добре развита пешеходна и вело инфраструктура мотивира повече хора да използват алтернативни методи на придвижване и допринася за по-чиста, здравословна и приветлива градска среда. Все по-голямото разрастване на градските агломерации, проблемите от масовата автомобилизация и обществения транспорт (ОТ) затварят кръга на градската среда. (фиг.1)



Фиг.1 Затворен кръг на проблемите в градската среда

Европейските градове все повече и повече се сблъскват с проблеми, причинени от транспорта и трафика. През март 2011 г., ЕК публикува Транспортната Бяла Книга „Пътна карта за единна Европейска транспортна област – към конкурентноспособна и ефикасна транспортна система.” Тя предлага разработката на програми за обществения транспорт и планове за градска мобилност за градове с определена големина, според националните стандарти. Ползите от програмирането, за градовете и тяхното население, Европейската комисия формулира в няколко основни насоки:

- Подобрен имидж на града;
- По-добро качество на живот;
- Подобрена мобилност и достъпност;
- Ползи за здравето и околната среда;
- Потенциал за привличане на повече хора;
- По-конкурентен град и достъп до финансиране.

В ежедневния си живот 80% от населението на Европа живее в градска среда и споделя едно и също пространство, а за тяхното придвижване – една и съща инфраструктура. Това е причината за 70% от емисиите от въглероден двуокис от автомобилния транспорт и до 60% от други замърсяващи околната среда вещества от транспорта.[1]

2. *Предпоставки и начини за разрешаване на проблема*

Програмата за развитие на обществения транспорт е ефективно и стабилно подобрение на системата, съобразено с разрастването транспортните потребности на жителите и гостите на града. Това може да се осъществи, чрез развитието на четири ключови характеристики:

1. **Устойчивост** -Устойчивото развитие е една дългосрочна концепция, която включва търговски, социални аспекти, както и тези свързани с опазването на околната среда. Техническото състояние на превозните средства и предлагания комфорт се оценява от потребителите дори като по-важно от стриктното спазване на времевите разписания. Новите превозни средства са гаранция за намаляване на шумовите и праховите замърсявания и гарантират

както комфорта на пътниците така и на гражданите чиито жилища са в непосредствена близост до елементите на инфраструктурата на обществения транспорт.

2. **Иновации** - развитие и интегриране на две основни автоматизирани информационни системи, свързани с масовия градски транспорт както и на системите за предоставяне на информацията за услугите на обществения транспорт:

- Автоматизираната система за таксуване на пътниците /АСТП/;
- Изграждане на Автоматизираната система за контрол и управление на трафика, която ще осигури по-равномерно разпределение на всички превозни средства по пътната мрежа, а от там и възможност за безпрепятствено движение на масовия градски транспорт.

Тези две системи позволяват гъвкаво и ефективно развитие на обществения транспорт, като осигуряват надеждна, точна, своевременна и обхватна информация както за процесите, свързани с условията за движение, така и за извършената дейност от транспортните оператори базирана на брой превозени пътници и изминат пробег както и възможности за ефективни политики за ценообразуване на услугата.

- Развитие на електронните услуги, позволяващи на потребителите на услугите свързани с паркиране, обществен превоз както и търсещи информация свързана с постоянна или временна организация на движение или моментни затруднения в трафика, за получаване на бърз и качествен достъп до актуална и напълно достоверна информация.

3. **Удовлетвореност на потребителите**- все повече хора да се убедят да ползват градски транспорт основано на подобряване на качеството на обслужване на пътниците чрез:

- информационните системи за пътниците;
- осигуряване на регулярен и надежден транспорт;
- създаване на удобни и функционални връзки между отделните линии;
- изграждане на модерни, добре осветени и достъпни спирки;
- изграждане на спирки ориентирани към безопасността на групи пътници със затруднено придвижване и на децата;
- въвеждане в експлоатация на превозни средства, осигуряващи бърз, безопасен и комфортен превоз;
- изпълнение на мерки за достъпност;
- подобряване на квалификацията на кадрите.

4. **Ефективност**

- изграждане на оптимални връзки между различните видове транспорт;
- автобусния транспорт да обслужва райони и осъществява връзки на пътуващите в зоните, които не са обхванати от друг вид транспорт;
- поетапна реорганизация на мрежата с цел висока експлоатационна скорост и ефективност

В последните години се наблюдава влошено качество на превозите в общоприетия смисъл – висока скорост на придвижване, малки интервали на движение, регулярност на превозните средства. Скоростта на движение по маршрутите на обществения транспорт е в пряка зависимост от растящата моторизация и произтичащото от това увеличено време за изчакване по кръстовищата. Усилията в посока увеличаване на скоростта по маршрутите на градския транспорт въвеждат обществения транспорт в конфликт с останалите участници в трафика. Балансирането на интересите на пътниците с лични превозни средства и тези с обществен транспорт е основен проблем в транспортната политика на всеки голям град.

Една от целите на Програмата за развитие на градския транспорт е реализирането на мерки за подобряване на качеството на услугата с цел привличане на повече клиенти от икономически активното население на града. Усилията са съобразени с изискванията на потребители с по-висока мобилност. Същевременно трябва да се поддържа и политика на достъпност на градския транспорт за всички слоеве на населението чрез провеждането на подходяща тарифна политика. [1]

3. Резултати и дискусия

Обективните тенденции за повишаване на подвижността на населението и с увеличението на взискателността по отношение на качественото задоволяване на нуждите от превози изискват развитие и усъвършенстване на транспортната система.

Общественият транспорт има много предимства, които го правят по-предпочитан.(табл.1):

Табл.1 Предимства на обществения транспорт

↓ по-малко	↑ повече
цена	безопасен
пространство	достъп до работното място
енергийни ресурси	мобилност за всички
замърсяване	

В световен мащаб се търсят решения за реализирането на ефективен обществен транспорт (табл.2). Безспорните ползи от тези решения показват, че дейностите в дългосрочен план ще решават все по-успешно проблемите в градската среда.

Табл.2 Световен опит [3]

Градове	Мероприятия	
Мадрид, Испания	Резултата	• Удължаване на метро-мрежата (+10 км/година) • Реорганизация на автобусната мрежа и въвеждане на автобусни коридори • Усъвършенстване функционирането на възловите

	т	точки • Единно таксуване +60% в използването на ОТ (1986-2003)
Богота, Колумбия	Резултат	• Създаване на високоскоростна транзитна автобусна мрежа (41 км през 2002, 388 км през 2015) • Реорганизация на автобусната мрежа (линии за камиони, линии за зареждане) • Ограничаване на автомобилното движение -32% във време за пътуване -40% замърсяване на въздуха -93% брой катастрофи
Дъблин, Ирландия	Резултат	• Създаване на 100 км автобусни коридори • Създаване на система “Паркиране и ОТ” с интегрирано таксуване • Скоростта на автобусите е с 30 до 50% по-висока от тази на личните автомобили +29.7% пътници в автобусите (+38% в пиковите часове) 65% нови потребители за сметка на личните автомобили
Брюксел, Белгия	Резултат	• Увеличаване на предлаганите услуги в ОТ • Подобрено качество (нови автобуси, честота, нощни услуги) • Нова тарифна политика +50% ръст в използването на ОТ в периода 1999- 2004
Сеул, Южна Корея	Резултат	• Създаване на високоскоростна транзитна автобусна система (84 км през 2005) • Реорганизация на автобусната мрежа (ленти за камиони, ленти за зареждане, местни линии) • Интегрирана система смарт-кард (таксуване според изминатото разстояние) • Информация в реално време за местонахождението на автобусите и информация за пътуването +11% потребители на ОТ за една година Удовлетвореност на клиентите
Хонг-Конг	Резултат	• Лесен достъп до ОТ и подобрени условия • Ускорен достъп до влаковите перони (100 ms/pax) • По-добра информация за клиентите • Спестяване на разходи за администрация и поддръжка с въвеждането на магнитни билети • Засилен контрол срещу гратисчии
		7.5 милиона издадени карти *Octopus* 6 милиона сделки на ден 90% от всички пътувания се заплащат с карти *Octopus*
Големи градове България		• Подмяна на автомобилния парк; • Изграждане на велоалеи • Нови спирки; • Информационно обслужване чрез ЦГМ; • Автоматизирани системи за таксуване на пътниците • Реорганизация на автобусната мрежа; [2]

4. Заключение

Задръстванията струват 2% от БВП на ЕС, т.е. 4 пъти повече от издръжката на обществения транспорт. Затова е необходимо да се търсят начини за прилагането на следните решения:

- Въвеждане на транспортни схеми, които да ограничават използването на лични автомобили в централните градски части ;
- Въвеждане на цена за използването на личен автомобил, като компенсация на неудобствата (напр. Заплащане на такса за причинените задръствания);
- Контролирано паркиране (на работното място, в жилищните и релакс зони) ;
- Обособяване на пешеходни зони .

Обществения транспорт трябва да бъде допълнен от гъвкави решения, за да може да предложи цялостно транспортно обслужване като например:

- Интегрираната схема “Паркиране + обществен транспорт” създава стимули за любителите на лични превозни средства да използват обществен транспорт;
- Кар-шеъринг (от англ. “споделено пътуване”) предлага използването на лични превозни средства от лоялни клиенти на обществения транспорт при нужда;
- Съвместното използване на таксита и трапспорт на повикване са подходящи решения за зоните с малка гъстота.

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IMPACT OF RAILWAY INFRASTRUCTURE PARAMETERS ON SAFETY OF GOODS TRANSPORTATION BY RAILWAYS

assoc. prof. Kendra M. PhD., Ing. Mašek J. PhD., Ing. Babin M. PhD.
Faculty of Operation and Economics of Transport and Communications –University of Žilina, the Slovak Republic

martin.kendra@fpedas.uniza.sk

Abstract: *It is important to load and fix goods in railway wagons in well done way to reduce the number of accidents on the railway. The bad way of loading and fixing of the goods in the railway wagons can bring a very dangerous results as a damage of the transported goods or accident of the train. This paper deals with the analysis of the railway infrastructure parameters which affect the well done way of loading and fixing of goods in railway wagons.*

Keywords: LOAD, FIXING, GOODS, RAILWAY INFRASTRUCTURE, PARAMETERS, SAFETY

1. Introduction

The basic rules for loading and fixing of goods in railway transport are Regulations UIC. Their application ensures operational safety and avoids damaging of transported goods and wagons. Consigner of sent goods is responsible for the observance of the rules. If the provisions of regulation directives are not respected, railway operators are entitled to not accept the shipment for transportation. Rules of regulations are valid for international as well as for national transportation. They are the higher legal standard than the operator`s transport rules and the lower legal standard than laws. Operator`s transport rules have to accept loading and fixing rules of regulations. Therefore their knowledge and application is a prerequisite to make good contract of goods transportation and safety transport. Railway operators may also use their own, supplemented and modified rules (examples of loading), which in their entirety may or may not be mandatory for all railway undertakings.

2. Loading regulations

Loading regulations were issued by the International Union of Railways (UIC) and are applied since the 1st January 1999. They were issued in UIC official languages - French, German and English but there are also national translations. For example holder and the main responsibility of loading rules in Slovakia is Railway Cargo Company of Slovakia, Inc. About 20 changes were received till today and range of rules is about 350 pages.

Loading directions consist of three volumes:

- Volume 1: Principles - contains binding principles that must be followed by fixing and loading of goods.
- Volume 2: Goods - provides methods for loading different types of goods which correspond with principles of Volume 1 or which have been developed on the basis of practical tests.
- Volume 3: Line category - contains information about the railway lines of UIC stakeholders. They are currently published on the website of the UIC (LOCA).

3. Rules of loading and fixing of goods

Nature of the goods, the technical characteristics of the wagon and used railway line must be taken into account at the time of loading. The railway operations may not be endangered by:

- bad stowage of goods,
- bad location of goods gravity center,
- the effect of wind, ice and snow on the loading ramp or goods etc.

Therefore the goods must be stably stored and fixed against raising, falling, sliding, rolling off and overturning not only in the longitudinal as well as in transverse direction. At once the goods may not be damaged by its mounting and fixing. There are used walls, side walls, stanchions and integrated locking devices in wagons to fix goods. Side walls and stanchions are therefore fundamentally bring into the active position. If this is not possible, for example transported goods exceed the width of the wagon, the goods must be fixed with the consent of the sending railway undertaking by the special fixing devices. In this part of the direction there is loading and fixing of the goods dividing by the various kinds of goods:

- goods loaded freely and disordered,
- bulk goods,
- compact or rigid mounting,
- loading with mass displacement in the longitudinal direction,
- goods that can roll,
- goods that can be inverted,
- stacked goods,
- goods loaded on more than one vehicle,
- solid loading units,
- flexible loading units.

If a new way of goods loading is used it is necessary the security of loading proved:

- in the longitudinal direction of the wagon by the crash tests based on the corresponding table,
- in the transverse direction of wagon by the driving tests or by the tests on a test stand.

Safety of railway operation must be always guaranteed in each case.

4. Basic parameters

There are several parameters which could affect safety and quality of goods transportation by railway transport. They could be divided into two categories of parameters:

- track parameters,
- train parameters.

The basic track parameters are:

- number of the track lines,
- track speed limit,
- traffic signaling system,
- track leaning ratios,
- minimum curve radius,
- track resistance (slope, curvature, crossovers, tunnel).

The basic train parameters are:

- load capacity (per axle, per usual loading meter),
- maximum train weight,
- maximum train length (in meters, in number of the axles),
- train driver (driving style, driver skills),
- pull force of the locomotive engine (indicated, circumference of the drive wheels, at coupler, adhesion).

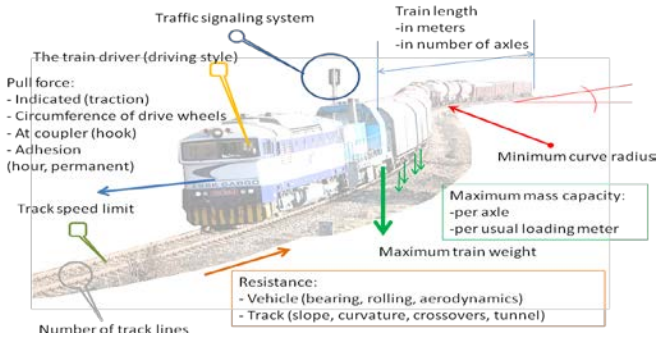

Fig. 1 *The track and train parameters*

5. Dependence of the observed indicators on changes of the railway infrastructure parameters

Description of the main parameters, which are necessary for the railway transportation:

- minimal transport time ($T_{\min}$):
  - maximum of the track speed limit ($V_{\max}$),
  - minimum of the track curve radius ($r_{\min}$),
- maximum capacity ($n_{\max}$):
  - number of the track rails (TR),
  - minimum of the track curve radius ($r_{\min}$),
  - maximum of the track speed limit ($V_{\max}$)
- maximum capacity of the transported wagon units per track relay (N_{wu}^{T}):
  - number of the track rails (TR),
  - minimum of the track curve radius ($r_{\min}$),
  - maximum of the track speed limit ($V_{\max}$),
  - maximum track mass capacity ($M^{\max}$)
  - maximum train length ($L_{tr}^{\max}$),
  - maximum number of axles ($N_{axle}^{\max/tr}$),
  - maximum train weight ($M_{tr}^{\max}$).

6. Relationship between transport time and infrastructure parameters

If we simplify the train drive just to a drive with a fixed speed and zero acceleration, then the travel time is proportional to the train passed distance and inversely proportional to its maximum speed.

$$T_{\min} = \frac{l}{V_{\max}} \qquad (1)$$

Than we can calculate the travel time for each track section and the total travel time on the passed track by adding the partial travel times.

$$T_{\min}^{T} = \Sigma T_{\min}^{i} \qquad (2)$$

In the curve ride with the radius r (m) by a fixed speed v ($m.s^{-1}$), we must add also the centripetal force to the tractive force acting in the same direction as the curve tangent (Majerčák, J. et al. 2008). The centripetal force is directed into the curve center and it makes the trajectory curvature. Then the dimension of the centripetal force is:

$$P = \frac{m.v^2}{r} \text{ [N]} \qquad (3)$$

This force causes the vehicle response, which is equal to the size of the centripetal force but has the opposite direction – centrifugal force. This force is reflected at the railway vehicle on its wheel flange and gives the vehicle curvilinear movement. The centrifugal force and the vehicle weight together make the resultant into three typical aspects:

- resultant cuts the drive plane in the middle of rails – the equivalence is stabilized,
- resultant cuts the tangent point between the vehicle wheel and head of the rail – the equivalence is labile,
- resultant cuts the drive plane in general out of the rail track – the turnover of the vehicle:
  - inside the curve – the track camber is abnormally high,
  - from the outside of the track – the camber is abnormally low.

For the smooth curve ride and also the stabilized vehicle ride position we must eliminate the negatives of the centrifugal force effect:

$$\sin\alpha = \frac{p}{s} \qquad (4)$$

The dimensions of the superelevation can be figured out of the resultant of the vehicle gravity and the centrifugal force which is perpendicular to the drive plane and axis of it. The pressure on the rails is the same.

The resultant R consists from centrifugal force P and the gravity force ($G=m.g$) which acts on the ride plane.

$$tg\alpha = \frac{v^2}{g.r} \qquad (5)$$

The angle α can be described also from the range of the liaison circles of the wheel set and the superelevation

$$\sin\alpha = \frac{p}{s} \qquad (6)$$

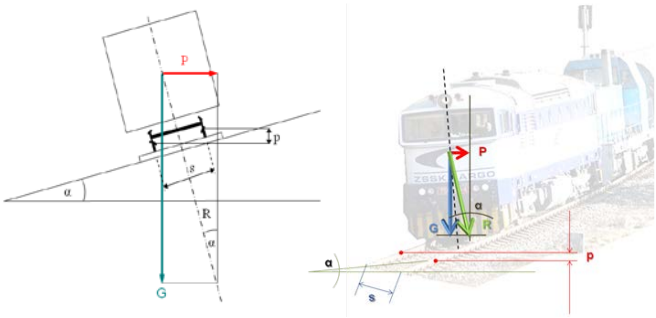

Fig. 2 *The superelevation of the track in the curve (left: ideal situation; right: common situation)*

Because the dimensions of angle α are too small, it can be written with the sufficient accuracy *sin α=tg α* and than

$$\frac{p}{s}=\frac{v^2}{g.r} \qquad (7)$$

from this situation, the superelevation is

$$p_t=\frac{s.v^2}{g.r} \qquad (8)$$

For the railway needs better suits the using of the superelevation in *mm* and the speed in $km.h^{-1}$.

We can describe this superelevation as theoretical and we mark it p_t. The theoretical superelevation is used for the ideal situation – all the trains travel at the same speed. Generally the trains don't ride at the same speed, however, so this equation must be transformed (slower trains can damage the lower rail in the curve superelevation). The transformation is made multiplying with $\frac{2}{3}$. This superelevation can be denoted as normal and sign it p_n.

$$p_n=\frac{2}{3}.\frac{s.v^2}{g.r}=\frac{2}{3}.\frac{s.\frac{V^2}{3{,}6^2}}{9{,}81.r}=\frac{2.s.V^2}{381{,}41.r} \qquad (9)$$

The superelevation of the curve rails can be stated by each country on its own decision. That's why we can count the maximum speed in the curve ride in the general conditions

$$p_n^{\max}=\frac{2.s.V^2}{381{,}41.r_{\min}}\Rightarrow V_{\max}^{T}=\sqrt{\frac{381{,}41.r_{\min}.p_n^{\max}}{2.s}}=13{,}81.\sqrt{\frac{r_{\min}.p_n^{\max}}{s}} \qquad (10)$$

Maximum (theoretical) volume of the capacity is proportional to the calculated time and inversely proportional to the occupation time of the track per one train.

$$n_{\max}=\frac{T}{t_{occ}} \qquad (11)$$

The resulting track volume capacity is given by the volume of the capacity of the constraining section (it is the section with the lowest capacity)

$$n_{\max}^{T}=\min\left\{n_{\max}^{i}\right\} \qquad (12)$$

7. Comparative indexes

The logistics performance index (publish by World Bank) is composed by 6 pillars. The second one is infrastructure. The infrastructure means in this case – quality of infrastructure based on evaluation of the quality of trade and transport related to infrastructure in country. The quality of infrastructure shows situation in each country in ports, airports, roads, rails, warehousing/ transloading facilities and telecommunications and IT. The global competitiveness index framework is based on three sub indexes – the basic requirements, the efficiency enhancers and the innovation and sophistication factors. Those three sub indexes can be split deeper into 12 pillars, 4 pillars are required for basic, 5 pillars for efficiency and 2 pillars for innovations. The second pillar in sub index basic requirements is infrastructure. The infrastructure pillar is calculate by ranking of quality of overall infrastructure, quality of roads, quality of railroad infrastructure, quality of port infrastructure, quality of air transport infrastructure, available airline seat kilometers, quality of electricity supply, mobile telephone subscriptions and fixed telephone lines. The Global innovation index is composed by two sub indexes (innovation input and innovation output). Innovation input is based on five indicators. The third one is infrastructure which consists from ICT, energy and general infrastructure. Three global comparative indexes which show competitiveness in different type cases use one very similar indicator – the infrastructure. This indicator is compiled three times but every time by different procedures. The result from this comparison is knowledge that infrastructure is very important for each country for own development and international competitiveness.

8. Decisive infrastructure parameters

Every infrastructure is a system of components – energy supply network, communication network, system of safety devices and tracks (paths, roads, waterways, pipelines, airways). Each parameter from those main systems influences final product of transporters/ carriers (Gogola, M. 2005). Carrier can offer services just in size which enable the infrastructure parameters in each country. Carrier's services are different for example in provided feeder systems, payment system possibilities, the highest measure/ volume/ size of one package (consignment), 24 day services, distribution system, delivery system, time of delivery etc. The resulted quality of performed service is directly depended on the real time situation on infrastructure, its current operation parameters and limits for different type of reasons.

The railway infrastructure parameters which are directly connected to quality of provided services are:

- Type of locomotive (pull forces of locomotive engine – indicated, circumference of the drive wheels, at coupler, max. adhesion forces), type and system of driving, driving style, drivers experiences;
- Number of track lines, track speed limits, traffic safety system, track leaning ratios, minimum curve radius, track resistance (slope, curvature, crossovers, tunnels);
- Loading capacity (per axle, per usual loading meter), maximum train weight, and maximum train length (in meters, in number of the axles).

More about infrastructure parameters can be found in (Kendra, M., Babin, M. 2012) and (Kendra, M., Babin, M., Barta, D. 2012).

9. Dependence between railway infrastructure parameters and quality of provided services

Dependence between railway infrastructure parameters and quality of provided services can be explained with following example. Consignee and also consignor expected high quality service – compliance of delivery time (on right time), right volume (mass/ pieces/ etc.), right place (door2door/ freight village/ etc.) and fair prices (Nedeliaková, E. et al. 2013). Fair prices depends on many factors – especially energy consumption, volume efficiency - unit costs. Delivery time is depending on traffic schedule, real time traffic management, train ride, operational problems, working (building) shutdowns and others. Right volume (mass…) is close depending to efficiency (economic, energetic) – but shipper requirements are usually not in conformity with carriers requirements (unit parameters) – feeder and delivery system problem. The efficiency problem is also closely connected to vehicle and track path (route) parameters (loading capacity – track/ vehicle, minimum curve radius, track leaning ratios, track speed limits etc.). Most of these parameters depend on right type locomotive (carrier's ownership) with well experienced driver. Conclusion for this part is knowledge that quality of transportation services is closely depended to infrastructure parameters, which means direct impact to country competitiveness in global market.

***Fig. 3** Stress analysis*

10. Conclusion

Loading of goods onto railway freight wagons and its fixing is a very important issue, which is directly related to protection of the transported goods, saving lives endangered by accidents, safety of operations and also the economic and commercial interests of the carriers. The proposed solution and additional information is useful for railway transportation and elsewhere as well. One of the most important areas of implementation is the transportation of dangerous goods (inflammable, explosive etc.) and prevention of danger by clear information how to load and fix the goods. The result of LOADFIX project will be a powerful information tool based on universal international data warehouse. It will allow a structured approach to complex data on goods loading. It will provide structured and up-to-date info for managers, staff and the professional public. It is especially intended for the employees of the carriers who deal with the issue of how to load and secure the cargo safely and economically. The info will also be useful to the professionals who deal with the method of storage and fixing (safeguarding) of cargo in the vehicle as a part of their job, particularly the specialists and institutes dealing with transportation such as sales agents, staff of non-standard shipment services and security advisors. Furthermore, the data is especially to be used by the operations staff who carries out the activities connected with handover of shipments and cars from the carriers and the inspections of the vehicles and goods during transport – wagon master, transport workers, transport warehousemen. It mainly covers inspection of storage and securing of goods during loading and the subsequent care of the transported goods during transport.

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THE ROLE OF TRAFFIC SIGNALIZATION ON REDUCTION OF ACCIDENTS ON THE CROATIAN ROADS

Darko Babić Ph.D[1]., Mario Fiolić mag.ing.traff.[2], Petr Prusa, Ph.D.[1]
University of Pardubice, Jan Perner Transport Faculty[1]
Studentská 95, 53210 Pardubice, Czech Republic
University of Zagreb, Faculty of Traffic and Transport Science[2]
Vukelićeva 4, 10000 Zagreb, Croatia
E-mail: darko.babic@fpz.hr, mario.fiolic@fpz.hr, petr.prusa@upce.cz

Abstract: *Safety of all road users on the roads is one of the fundamental social objectives. Measures for improvement or remediation of dangerous sites (black spots) in Croatia are carried out in several phases, from planning the envisaged measures, valuation measures, the implementation of measures to observation and assessment derived measures. Certain dangerous places are repaired only by changing traffic signalization and those sites and measures are described in this paper. In last eight years on the roads in Croatia, 215 dangerous places were repaired and partial restoration was carried on the 46 dangerous places. The success of provided measures, expressed through an analysis of the number and consequences of accidents on dangerous places for three years before and three years after restoration, shows the drastic reduction in traffic accidents on this places. The conclusions and solutions of these measures are presented in this paper.*
KEYWORDS: BLACK SPOTS, TRAFFIC SIGNALIZATION, RETROREFLECTION, MEASUREMENTS

1. Introduction

The National Program of road safety in Croatia was first planned and implemented in 1994. Since then, it has been conducted the four National Programs, and the latest, fifth, is in force since April 2011. (Period 2011-2020).Considering the positive experience in the implementation of these programs, which have resulted decreasing fatal casualties and decreasing injuries in traffic accidents, it has continued with the adoption of the program, with addition to tracking the latest trends in increasing road safety and compliance with best practice in European countries, which recorded the best results. In determining the cause of the accident or wrong behavior of participants that started the accident event is of crucial importance.Is it for wrong behavior that caused the accident responsible only the subjective factor, i.e. direct participant in traffic, or the incorrect behavior that caused the accident occurred in some form of interaction between subjective and objective factors.

2. Defining black spots in Croatia

There are several definitions of “black spots“ and two of them are most commonly used: 1. „Black spot is a place, location in the road network (point or road section), or the streets network where is more likely thatan accident will happen, depends on the other network elements.
2. In accordance with the methodology of traffic safety, the "black spot" can be called an intersection or road segment lengths up to 300 m, or "dangerous section" can be called a part of the road length of 300 m to 1000 m, with conditions that they have to comply in following criteria:
• If at the critical location in the last three years occurred 12 or more accidents with injuries,
• If at the monitoring location in the previous three years recorded 15 or more accidents, no matter the consequences,
• If at the critical location in the previous three years happened three or more identical traffic accidents, with the same group of participants, same direction of movement, on the same conflict areas etc.

In Croatia, since 2001 was detected 220 black spots (on 95 remediation is completed or is in progress). In 2012 was detected 45 new black spots, mostly in the Splitsko-dalmatinska (16) and Krapinsko-zagorska (7) county. Figure 1 shows the network of national roads and highways on the Croatian territory with the risk assessment of the causing accidents. The risk assessment is carried out in accordance with the rules of EuroRAP (European Road Assessment Programme), and it can be seen that on the majority of the network of national roads there is a very high risk of causing accidents, and the majority of black spots are just on the network of national roads.

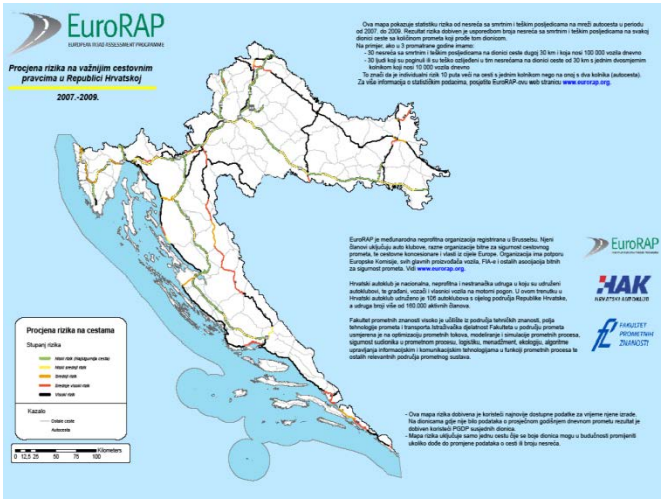

Figure1. *Risk assessment on the major roads in Croatia*

Source: http://www.hak.hr/vijest/176/eurorap-mapa-rizika-za-3400-kilometara-nasih-cesta

3. Elimination of black spots

3.1. Methodological approach

Determination of dangerous places or "black spots" on the roads is an important aspect of managing traffic at places that represent a potential threat. Situation analysis of traffic safety on all roads in Croatia was carried out in three phases:

1. The general analysis of the situation and tendency of traffic safety has enabled the understanding the size of the problem, international comparisons, review the structure of accidents, the time distribution of accidents, trends and other general characteristics of the condition.

Quality information base for the analysis and identification of critical points in the transport system requires the following information:

- Types of accidents (according to the consequences, type of collision, vehicles participants, etc.)
- Type of location (rural/urban, road, street type and class, crossing/not crossing etc.),
- Time (day time, day in week, date)
- Environment (physical conditions, light, visibility, wind, temperature, rain, snow, etc.),
- Participants characteristics (age, ability, experience, behavior, status, influence of alcohol, drugs, etc.)
- Vehicle characteristics (type, age, technical requirements, etc.)
- Road characteristics (the precise location, geometry, visibility, surface quality and condition, equipment, clarity, etc.)
- Traffic characteristics (intensity and structure of the flow, average speed, etc.)
- Expert opinion (factors that have contributed to the accident, estimated speed, position and behavior of participants)...

2. Situation analysis on the traffic sections and risk mapping by sections enabled the betterunderstand the spatial distribution of traffic accidents and specificity of certain road sections in terms such as risk of accidents, risk of injury, the most common types of accidents, the categories of participants, the most common mistakes etc. Thus, the conducted analysis allows the definition of the most dangerous sections or "black spots". For the detection of critical points on the road network it is used different types of criteria:

- Number of accidents during a certain period that is higher than certain norms,
- Weight of accidents during a certain period,
- Combination of the number and severity of accidents during a given period,
- Number of accidents at the point that we observe in relation to other points along the road,
- Opportunities for reducing accidents
- Accidents costs during a given period,
- Danger indicators method
- Rating according to characteristics of place, not byhistoryof accidents,
- Current annual cost of accidents that occur at this point, based on the average cost of accident and by type of accident.

3. Situation analysis by the road kilometer and determination of “dangerous kilometers”. Based on a detailed analysis of accuracy, condition and quality of data on accidents it was observed the precision of the location of the accident. In the accidents analysis there are two phases:

- Phase when the driver detects a situation that leads to accidents
- Phase when the driver is trying to avoid accidents.

These phases are related with the appropriate categories of measures that seek to improve safety. One group consists of active safety measures. These are measures that help to stop the occurrence of accidents, help driver to avoid them or to put him to know that there is a situation of increased risk and the possibility of accidents (information about the risk, improving of visibility, controlled direction, etc.). Another group, measures of passive safety, are those measures which are becoming an indicator during the accident. They prevent the serious consequences of accidents (road safe environment without hard solid objects or trees, the equipment on the road that will cause serious injury, etc.). Identifying method of "black spots" on the roads is based on a previous analysis of data on traffic accidents, road and traffic. The aim of implementation method is to highlight the meaning and importance of establishing "black spots" on the roads and stimulate further theoretical and practical work on the consideration of these issues. Interventions at places of accumulation of traffic accidents are considered one of the most effective approaches in prevention of traffic accidents on the roads. Considering the scientific literature there has been a series of attempts to find and define the most effective method, which would enable the measurement of the security of certain road sections and identify the most vulnerable and dangerous place, or "black spots" of traffic on the roads.

3.2. Traffic signalization

Croatian roads ltd. continually since 1998 in cooperation with the competent police authorities, collects data on the number and consequences of accidents on the micro locations of state roads where is noticed certain grouping of traffic accidents. The collected and processed data basically contains information about accidents, casualties, and micro-location where the traffic accidents occurred. Besides there are collected and processed data on traffic density, road and its surroundings, equipment and road signaling, etc. Data on the road and its surroundings include geometric characteristics of the road alignment (horizontal and vertical), construction elements (longitudinal and transverse slopes, type of paving, drainage), paving condition (cracks, potholes, the state of the macro and micro texture), road equipment (fences, poles, street signs Retro-reflection), visibility, road marking and lighting, etc. In this system very important role is on traffic signs, which represents the basic meaning of communication between road authorities and road users. Factors that help to identify the sign and his understanding are:

- Size of sign
- Simplicity of symbols or used text
- Color of the sign
- Retroreflection.

One of the most important properties of the retroreflective foil for drafting traffic signs except the clarity is ability to restore lights, i.e. reflectivity.There are several principles of classification retroreflective foil depending about the institution which it specifies, but the most common and used by CEN are:

- Class I (closed glass beads, at the present time and micro prisms)
- Class II (embedded glass beads, at the present time and micro prisms)
- Class III (micro prisms).

Materials class I are retroreflective sheeting’s made of a durable material with the bounded glass micro beads or prisms. Retroreflection of materials class I with glass micro beads is about 70 cd•lx-1•m-2 and because of its low retroreflection it is in most cases used in areas with low-speed and calmer traffic flow. Materials class I that have bounded micro prisms have significantly higher retroreflection (around 200 cd•lx-1•m-2) than materials with glass micro beads.

Materials class II are retroreflective sheeting’s that contains encapsulated glass micro beads or micro prisms that are three times brighter than materials class I. The signs made from materials class II are clearly visible, even from a wide viewing angle, and the lighted environment, effectively warning drivers of approaching danger on the roads. Retroreflection of materials class II with glass micro beads is around 250 cd•lx-1•m-2 and 500 cd•lx-1•m-2 for materials with micro prisms.

Materials class III are retroreflective sheeting’s that are made of highly effective micro prisms that enables retroreflection around 700 cd•lx-1•m-2. Therefore, they provide the drivers with adequate visibility in all day and night and adverse weather conditions. The prerequisite for safe driving at night is a sufficient level of visibility for the driver which is consistent with the permitted speed.The different qualities of materials enables certain traffic signs to adjust on higher or lower levels of luminance. Some materials are designed to maximize the durability of the traffic signs, while another intended for short-term use.The different quality of materials for traffic signs, different sign production processes and selection of materials for the surface of the sign will have an impact on the ultimate lifetime of traffic signs. By being placed on the open road signs are exposed to the impact of unfavorable atmospheric conditions; their unfavorable factors such as the influence of

ultraviolet rays in sunlight, humidity, and large differences between day and night temperatures. Such negative effect of weathering at the end reduces transparency, color and integrity of the materials used in retro-reflective road signs and thereby reduces their visibility at night.

The dynamics of "black spots" remediation in Croatia was conducted in a way that in 2001 was remediated 4 dangerous places, during the 2002 remediated 15 dangerous places, 2003 remediated 36 dangerous places, 2004, 51 dangerous places, 2005, 26 dangerous places, 2006, 13 dangerous places, 2007 remediated 12 dangerous places, 2008 remediated 19 dangerous places, 2009 remediated 15 dangerous places, 2010, 8 dangerous places, and 2011 was remediated 16 dangerous places. The most common causes of traffic accidents that occur on the roads which must be taken into consideration in the selection of measures that should be applied are:

- The conflict level in traffic regime,
- Clarity of the road,
- Inappropriate speed (poor conditions that contribute to driver defective estimating of safe speed)
- Conditions imposed by the environment (visibility, slippery, lighting, etc.).

Measures for short-term and long-term remediation of dangerous places can be systematically divided according to time and place of origin and the manner of elimination. With regard to the duration may be temporal or permanent.

I. Class of measures (temporary measures, mostly traffic-technical properties) - those that result from occasional or periodic condition at a specific location (ice, driving traffic, temporary blockages, etc.) or a result of various of other causes (the inevitability of taking action, additional land acquisition , lack of resources, etc.). Traffic signs on the road must meet the following conditions:

- alert the driver to any unusual and non-standard solution,
- inform drivers about road conditions that a driver must be considered at time, and they must adapt,
- guide the driver through an unusual situation (it clearly focus on appropriate behavior)
- direct its movement in zones of conflict and at other road surfaces,
- compensate for certain errors and behavior by drivers with elements that mitigate the effects and help to avoid accidents.

This class of measures are undertaken at those locations where they are not needed construction works, and where are already adequate road signs (better class to create traffic signs, new traffic signs, maintenance ...) sufficient to achieve a higher level of safety in road traffic. Examples of such repairs are shown in Table 1 under regular maintenance program (Karlovac D3, Čibaća, Velika Mučna...), which includes the maintenance or replacement of existing traffic signs. Picture 2 gives an example of taking measures for the rehabilitation of a first-class dangerous place where the existing signs are replaced and supplemented with new traffic signs and road markings.

Picture 2. *Displaying dangerous place before and after the implementation of measures of class I*

Source: http://www.skyscrapercity.com

II. Class of measures (permanent measures) - measures that should completely eliminate the condensation of traffic accidents. This class includes construction-technical measures and adequate traffic signs and represents the most expensive but also the best solution for the remediation of hazardous places. Building technical measures include:

- Extension of the roadway,
- Correction of cross slope,
- Creation of visibility in curves,
- Construction of the rotor,
- Setting of additional protective fence,
- Changing the roadway with new asphalt layer
- Milling of asphalt surfaces to increase friction road surface during the summer rains and winter ice...

In Croatia, this type of measures is usually implemented through programs Betterment and national road safety program (Table 1). The national program of road safety of Croatian basic document and a platform to raise the level of road safety in our country to a higher, more acceptable level than current, while the Betterment Program (a program of increased maintenance and project specific rehabilitation) is the rehabilitation of the road network, and is funded partly of loan funds from the European Investment Bank, and partly from its own resources Croatian Roads ltd. Picture 3 gives examples of taking action of II. Class measures that include building technical measures and traffic-technical characteristics (Betterment Program).

Picture 3. *Displaying dangerous place before and after the implementation of measures of class I*

Source: http://www.skyscrapercity.com

These measures in the short-term and long-term remediation of dangerous places are based on:

1. Established conflicting events observing traffic on that place;

2. Mentioned traffic technical deficiencies and irregularities of the road, affecting traffic safety;

3. Justification of the measures by the valuation methodology (cost – benefit), established traffic technical irregularities of the road and considering the dangerous behavior of road users.

Table 1. provides data of traffic accidents and the consequences of these accidents (number of minor and serious injuries, and the number of fatal accidents and easier injuries) for the period from the last 3 years (data for the 2012 and 2013 year are processed completely) which include information on traffic accidents three years ago and three years after the measures implemented. Under the program, there are measures which were taken at each dangerous section. On some sections it was enough to replace existing traffic lights, with adequate new traffic signs (regular maintenance program), and in this way reduce the number of fatally injured persons, while individual stocks require more remediation and construction-technical measures and also adequate traffic signs.

Table 1. *List of remediated dangerous places in last 6 years (Source: Croatian Roads ltd.)*

REMEDIATED 2009													
DESCRIPTION OF LOCATION	CHARACTERISTICS OF ROAD	POSITION OF DANGEROUS PLACE	COUNTY	ROAD	SECTION	CHAINAGE	NUMBER OF TRAFFIC ACCIDENTS		TRAFFIC ACCIDENTS				MAINTENANCE PROGRAM
									DIED		INJURED		
							3 YEARS AGO	3 YEARS LATER	3 YEARS AGO	3 YEARS LATER	3 YEARS AGO	3 YEARS LATER	
Karlovac D3	intersection	settlement	Karlovačka	D23	Karlovac (D6) - Josipdool (D42)	od km 1+315 do km 1+465	23	11	0	0	9	1	REGULAR (traff. signalization)
Plominsko zagorje	section	outside settlements	Istarska	D66	003 Vozilići (D64) - Matulji (D8)	od km 9+050 do km 10+050	9	3	0	0	1	0	Betterment
Ferovac	section	outside settlements	Požeško-slavonska	D51	001 Gradište (D53) - Požega (D38)	od km 9+600 do km 9+800	3	1	0	0	2	0	Extraordinary maintenance
Beketinci	curve	outside settlements	Osječko-baranjska	D7	005 Čepin (Ž 4105) - Đakovo (D38)	od km 8+350 do km 8+652	2	2	0	0	0	2	Betterment II
Dubrova	intersection	settlement	Istarska	D66	002 Most Raša (D421) – Vozilići (D64)	od km 11+200 do km 11+400	8	1	1	0	2	1	Remediated OM
Vukušića strana	curve	settlement	Splitsko-dalmatinska	D39	002 Cista Provo (D60) - Šestanovac (D62)	od km 7+500 do km 8+000	4	1	0	0	3	0	Betterment II
Plominsko zagorje	curve	outside settlements	Istarska	D66	003 Vozilići (D64) Matulji (D8)	od km 2+000 do km 2+200	9	0	0	0	3	0	Betterment
Čepin	intersection	outside settlements	Osječko-baranjska	D7	004 Osijek (D2) - Čepin (Ž4105)	od km 12+540 do km 0+050	14	6	0	0	9	3	Project NPSCP, HAC
REMEDIATED 2010													
Srebreno	intersection	settlement	Dubrovačko-neretvanska	D8	029 D223 - Krasovići (D516)	od km 3+200 do km 3+500	24	4	2	0	11	2	Project NPSCP
Budačka Reka	section	outside settlements	Karlovačka	D1	011 Krnjak (D6) Grabovac (D217	od km 2+700 do km 3+900	2	1	0	0	1	0	Remediated OM
Žudetići	curve	outside settlements	Istarska	D21	004 Ponte Portone (D44) - Višnjan	od km 2+150 do km 2+500	4	2	0	0	1	1	Project NPSCP
Starigrad, D2	intersection	settlement	Koprivničko-križevačka	D2	005 Koprivnica (D41) - Đurđevac (D43)	od km 0+900 do km 1+150	12	4	0	0	5	3	Project NPSCP
Čibača	intersection	settlement	Dubrovačko-neretvanska	D8	029 D223- Krasnovići (D516)	od km 1+300 do km 1+500	21	6	0	0	11	2	REGULAR (traff. signalization)
Velika Mučna	section	outside settlements	Koprivničko-križevačka	D41	003 Koprivnica (D2) - Križevci (D22)	od km 7+530 do km 8+130	0	3	0	0	0	0	REGULAR (traff. signalization)
Vukovar	intersection	settlement	Vukovarsko-srijemska	D57	001 Vukovar (D2) - Orolik (D46)	km 0+680	7	2	0	0	4	1	Project NPSCP
Vinkovci-Nuštar	section	outside settlements	Vukovarsko-srijemska	D55	001 Borovo (D2) - Vinkovci (D46)	od km 12+550 do km 13+100	8	3	0	1	4	2	REGULAR (traff. signalization)
Palešnik	curve	settlement	Bjelovarsko-bilogorska	D45	001 Veliki Zdenci (D5) - Garešnica	od km 13+900 do km 14+200	3	1	0	0	1	0	Remediated OM
Plovanija	intersection	settlement	Istarska	D200	001 GP Plovanija (gr. R. Slov.) - Buje (D21)	-	23	3	0	0	3	1	REGULAR (traff. signalization)
Zapadna obilaznica Osijeka	intersection	outside settlements	Osječko-baranjska	D7	003 Osijek (D2) - Beli Manastir	od km 22+200 do km 22+500	24	4	0	0	11	1	Remediated OM
Vodinci-Ivankovo	section	outside settlements	Vukovarsko-srijemska	D46	001 Đakovo (D7) - Vinkovci (D55)	od km 24+700 do km 25+300	7	2	0	0	7	1	REGULAR (traff. signalization)
Veliki Zdenci	curve	settlement	Bjelovarsko-bilogorska	D5	003 V. Zdenci (D28) - Donji Daruvar (D34)	od km 0+950 do km 1+250	2	0	2	0	0	0	Remediated OM
Most Raša	curve	outside settlements	Istarska	D66	001 Pula (D3) - Most-Raša (D421)	od km 31+800 do km 32+000	16	0	0	0	3	0	Remediated OM
Obilaznica Vinkovaca	intersection	settlement	Vukovarsko-srijemska	D46	001 Đakovo (D7) - Vinkovci (D55)	km 39+048	16	2	1	0	8	2	Project NPSCP
Bjelopolje 2	curve	settlement	Ličko-senjska	D1	013 Korenica (D52) - Udbina (D522)	od km 9+000 do km 9+081	10	0	2	0	3	0	REGULAR (traff. signalization)
Barban	curve	outside settlements	Istarska	D66	001 Pula (D3) - Most-Raša (D421)	od km 30+000 do km 31+000	26	2	0	0	11	0	REGULAR (traff. signalization)
Pisarovina	intersection	settlement	Zagrebačka	D36	001 Karlovac (D1) - Cerje Pokupsko (D31)	od km 31+500 do km 31+650	11	4	0	0	8	2	REGULAR (traff. signalization)
REMEDIATED 2011													
Rovinjsko selo	section	outside settlements	Istarska	D303	001 Rovinj - čvor Kanfanar (D3)	od km 3+000 do km 4+000	16	2	1	0	6	1	Remediated OM
Cerje Nebojse	curve	settlement	Varaždinska	D35	001 Varaždin (D2) - Lepoglava (D508)	od km 14+600 do km 15+200	10	1	0	0	4	1	Betterment II
Karlovac - Smičiklasova	intersection	settlement	Karlovačka	D1	010 Čvor Karlovac (D3) - Krnjak (D6)	od km 3+000 do km 3+150	15	2	1	0	2	0	Project NPSCP
Predavac	intersection	settlement	Sisačko-moslavačka	D28	003 Žabno (D22) - Bjelovar (D43)	od km 4+600 do km 4+750	6	0	0	0	1	0	Remediated OM
Split, Put Trstenika	intersection	settlement	Splitsko-dalmatinska	D410	001 Split(trajektna luka) - Split (D8)	km 1+930	37	0	1	0	15	0	REGULAR (traff. signalization)
Veliko Brdo	intersection	settlement	Splitsko-dalmatinska	D8	020 Dubci (D39) - Makarska (D512)	od km 15+000 do km 15+300	2	0	0	0	2	0	Extraordinary maintenance
Rijeka, raskrižje Zvonimirove i Benecove	section	settlement	Primorsko-goranska	D8	003 Matulji (A8) - Rijeka (D403)	-	19	5	0	0	9	4	REGULAR (traff. signalization)
Čakovec D208/Ž2031	intersection	settlement	Međimurska	D209	001 G.P. Mursko Središće - Nedeliščе (D3)	od km 15+700 do km 15+850	11	4	0	0	7	2	REGULAR (traff. signalization)

4. Conclusion

Safety of all road users on the roads is one of the fundamental social objectives. Traffic accidents related to some area, are due to unfavorable interactions between subjective and objective "factors - the road" to "dangerous place", meaning that the some road characteristics have a significant effect on driver behavior, and that such behavior would result in a traffic accident. The road and its effects are not the only or the biggest factor in road accidents. Most common cause is the human factor, but eliminating possible causes of the events of traffic accidents due to road conditions, appropriate amendments to traffic signs and road equipment is quickest and most efficient way to affect the reduction in the number and consequences of accidents at critical locations. Determination of "black spots" on the roads on the basis of registered safety indicators (number of traffic accidents, the number of deaths, and the number of minor and injured people on certain sections of the road) is the first step to be taken in order to later be determined and implemented preventive and repressive measures to increase traffic safety.

Measures for improvement or remediation of dangerous spots in Croatia are carried out in several phases, from planning the envisaged measures, valuation measures, the implementation of measures to observation and assessment derived measures. In the previous period, Croatian Roads, through various programs, have spent to complete the remediation of 215 dangerous spots and partial rehabilitation of 46 dangerous spots around 24 million Euro, while for the same purpose from the funds of the National program of road safety in Croatia, was allocated 0,7 million Euro, which makes a total of 24,7 million Euro spent for remediation of dangerous spots on state roads of Croatia. The success of the remediation projects, expressed through an analysis of the number and consequences of accidents on retrofit dangerous places for three years before and three years after remediation, is evident through a drastic reduction in traffic accidents on those dangerous spots.

In the period since 2001. until 2011., was huge reduction of number of traffic accidents (from 6326 to 1568, which is 75.2% less accidents). The number of deaths on retrofit dangerous places was reduced from 131 to 12 (90.8%), serious injuries from 548 to 141 (74.2%) and the number of light injuries decreased from 1,980 to 555 people (71.9%). This results clearly shows that with even small measures (like changing traffic signalization on some dangerous spots), great reduction on traffic accidents number can be reached.

Acknowledgement

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PROCEDURE FOR THE SEPARATION SEQUENCE OF VERTICES IN DIFERENT ROUTES

Assist prof Berov T.,
VTU Todor Kableshkov, Sofia
E-mail: tberov@vtu.bg;

Abstract: *The objective of vehicle routing problem (VRP) is to deliver a set of customers with known demands on minimum-cost routes originating and terminating at the same depot. Similar to most GA that a chromosome S is a permutation of n positive integers, such that each integer is corresponding to a customer without trip delimiters. Christian Prins proposed an optimal splitting procedure to get the best solution, respecting to a given chromosome. In this paper, application of this splitting procedure to get the best solution, respecting to a sequence of vertices, produced by the heuristic approaches(or a new chromosome produced by the mutation procedure), is considered.*

***KEYWORDS**:* TRANSPORT, VEHICLE ROUTING, HEURISTICS, GENETIC ALGORITHMS, SPLIT DELIVERY

1. Introduction

In the vast majority of the literature, finding tours visited by commercial vehicles is considered as a Vehicle routing problem. The vehicle routing problem (VRP) consists of designing *m* vehicle routes of least total cost and: each starting and ending at the depot, such that each customer is visited exactly once; the total demand of any route does not exceed the vehicle capacity, and the length of any route does not exceed a preset maximal route length. The basic VRP can be extended by taking into account: time windows of customers' requests, heterogeneity of vehicle fleets, tasks conducted by vehicles, the number of home depots, and operational restrictions faced by vehicles.

A large number of algorithms have been developed to solve the VRP problem. Depending on whether an exact optimal solution or an approximate solution is reached, they can be categorized as the exact algorithms or the heuristic methods.

There are different families of heuristics for the VRP. They can be classified into two main groups: the classical heuristics, developed mostly between 1960 and 1990, and the metaheuristics, developed after this period.

The classical heuristics perform a relatively limited exploration of the search space and generally produce good quality solutions within modest computing times. The typical classical heuristics include the well-known savings algorithm (Clark and Wright, 1964), the sweep algorithm (Gillett and Miller, 1974), the petal algorithms (Balinski and Quandt, 1964; Ryan et al., 1993; Renaud et al., 1996), the cluster-first-route-second algorithms (Fisher and Jaikumar, 1981), and the improvement heuristics (Lin, 1965; Thompson and Psaraftis, 1993).

Compared with classical heuristics, metaheuristics perform a much more thorough search of the solution space, allowing inferior and sometimes infeasible moves, as well as recombinations of solutions to create new ones.

Exact algorithms: Branch-and-bound; Branch and Cut Method etc.

Classical heuristics: Route construction heuristics; Savings algorithm - Clarke and Wright (C&W); Two-Phase Methods; sweep algorithm; Solution Improvement; λ-opt heuristic etc.

Metaheuristics: Simulated Annealing; Deterministic Annealing; Tabu search; Genetic Algorithms; Ant System; Neural Algorithms etc.

Metaheuristics commonly used the initial solutions, typically created with some cheapest insertion heuristic.

In this paper is proposed a method for evaluation of the heuristic approaches (or new sequence, obtained by the procedure of mutation), in order to optimize them.

2. Problem Description

As mentioned above, for usage of sequence of vertices, derived from the use of heuristic approaches, we need of splitting procedure, that give an adequate solution, ie with a cost equal to or better obtained by using the initial Heuristic approach. Based on a literature review, widely used is *Splitting algorithm* [6]. In its application, it was found that the result obtained by the algorithm, was not adequate to that, obtained of the used heuristics, as shown in Table 1. If output routes and their first-last vertex are arranged in a certain sequence, i.e. last vertex of a route and first of the next route are in the same cluster, then the result could be with even greater differences. For example, about the problem R101 [7] was obtained:

- „Clarke & Wright", classical: 10 routes, total mileage - 892,464;
- „Clarke & Wright" + opt.: 17 routes, total mileage – 1 361,639.

Table 1: *Problems and result from used models for optimization*

prob.	method	R,*nr*	cost	method	R,*nr*	cost
C1	C&W	10	892,464	+ opt.	11	1 070,284
C1	Sweep	10	1 096,739	-	22	1 860,281
R1	C&W	8	888,266	-	10	1 094,554
R1	Sweep	8	1 029,858	-	10	1 150,004
C2	C&W	3	632,432	-	3	740,894
C2	Sweep	3	800,268	-	5	950,471
R2	C&W	1	523,204	-	1	523,204
R2	Sweep	1	620,492	-	1	620,492
RC1	C&W	6	676,175	-	6	834,543
RC1	Sweep	5	556,480	-	18	1 738,847
RC2	C&W	2	693,330	-	2	724,657
RC2	Sweep	2	809,187	-	2	809,187

To improve the result, we will investigate the possibility of using two main parameters - the distance of each vertex from the Depot and the distance from the previous one, according to the proposed order. They are applied to modernize the classic algorithm of Clarke & Wright [1]. Using these two parameters is shown in (3).

$$S_{ij}=C_{i0}+C_{0j}-C_{ij} \quad (1)$$

here S_{ij} is the corresponding savings and C_{ij} – corresponding cost.

Several improvements to the C&W algorithm have been proposed, to lead to better results overall.. Gaskell and Yellow (1967) have suggested using a positive parameter λ (the *route shape parameter*), through which taken of the relative importance of direct arc between two customers in the calculation of "savings". Paessens (1988) introduce in the model weight μ , for " asymmetric" solving (the distance from the depot for each of the pairs considered customers). The formula for the resulting savings is as follows:

$$S_{ij}=C_{i0}+C_{0j}-\alpha C_{ij}+\mu(C_{i0}-C_{0j}) \quad (2)$$

Here λ is a parameter that controls the relative significance of direct arc between two customers and μ is the asymmetry between two customers with respect to their distances to the depot.

To take into account the use of the vehicle capacity, Altinel and Öncan introduce another parameter, aiming at increase the loading of vehicles. The principle is – „*larger combined route is better*“.

$$S_{ij}=C_{i0}+C_{0j}-\alpha C_{ij}+\mu\left(C_{i0}-C_{0j}\right)+\gamma\left(d_i-d_j\right)/\bar{d} \quad (3)$$

here $\bar{d}$ is the average demand of all customers, d_i is the demand of customer *i*.

Since the chromosome may be broken into several diferent routes, Prins [6] proposed an optimal splitting procedure, which can find the optimum split, ie routes, by minimizing the total cost. The main idea can be described as follows. Let *S* = (1,2,3..,n) be a given chromosome. Based on the auxiliary graph *H* = (*V'*,*E'*), where vertices *V'*={0,1,2..,n}, and arc $E_{ij} \subset E'$:

$$E_{ij}=c_{0,i}+\sum_{k=i+1}^{j-1}(t_k+c_{k,k+1})+t_j+c_{j0}\le L;\ \sum_{k=i+1}^{j} q_k \le Q \quad (4)$$

here t_i is the service time at customer, q_k - the demand for customer.

Then E_{ij} is the total travel cost (time) for the route (*i*+1, *i*+2,.., *j*). An optimal split for *S* corresponds to shortest path *P* from vertex 0 to vertex *n* in *H*.

```
V0 = 0;
for (i = 1;i<n; i++){Vi = +∞; Pj = 0;}
for (i = 1;i<n; i++){
      cost = 0; load = 0; j = i;
      repeat
            load = load + qsj;
            if ( i = = j)   cost = C0,sj +dsj + Csj;0;
            else {   cost = cost – Csj-1;0 + Csj-1,sj + dsj + Csj,0;
                  cost' =  α. Csj-1,sj + μ.(abs) (Csj-1;0 - Csj,0);
                   cost = cost + cost'; }
      if ((cost ≤ L) && (load < Q)) {
            if  ((Vi-1 + cost) < Vj ) {
                                    Vj = Vi-1 + cost;
                                    Pj = i – 1;   }
            j := j + 1;
      }
      until ((j > n) || (cost > L) || (load > Q))
}
```

***Figure* 1** *A modified algorithm by using of the coefficients*

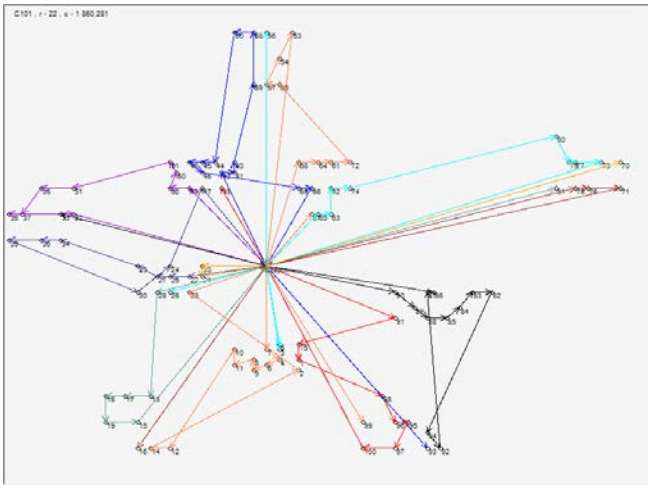

***Figure* 2** *Routes for C1-Sweep, produced by splitting procedure*

In [6] by example the method was demonstrated. The auxiliary graph helps us understand the idea how to split a given chromosome S into optimal routes. But, we do not have to construct such graph *H*. It can be done by a labeling algorithm and a splitting procedure [2]. Let *S* = (1, 2, .., n) be a given chromosome. Two labels V_j и P_j for each vertex *j* in *S* are computed. V_j is the cost of the shortest path from node 0 to node *j* in *H*, and P_j is the predecessor of *j* on this path. The minimal cost is given at the end by *Vn*. For any given *i*, the increment of *j* stops when *L* or *Q* are exceeded. The labeling algorithm is shown in Figure 1.

3. Application of the proposed algorithm

The influence of the coefficients α and μ was studied, for variant C1 Sweep with 22 routes, Figure2.

In Table 2 gives the parameters for the routes of the viewed variant.

Table 2: *Routes for C1-Sweep, produced by splitting procedure*

№	sequence	$Q_{nc.}$	cost
1	0, 90, 89, 88, 85, 84, 83, 82, 94, 92, 87, 86, 0	190	130,061
2	0, 91, 75, 1, 98, 96, 95, 97, 100, 0	150	111,786
3	0, 93, 0	40	86,023
4	0, 99, 0	10	67,082
5	0, 5, 3, 0	20	32,257
6	0, 7, 4, 6, 9, 8, 11, 10, 12, 14, 2, 23, 0	170	119,064
7	0, 26, 0	10	31,623
8	0, 28, 13, 17, 18, 19, 15, 0	140	90,800
9	0, 16, 0	40	80,623
10	0, 20, 21, 0	30	22,198
11	0, 22, 25, 27, 29, 34, 36, 39, 30, 24, 47, 0	160	105,041
12	0, 49, 52, 50, 51, 31, 35, 37, 38, 32, 0	150	97,873
13	0, 33, 0	40	67,052
14	0, 43, 0	10	33,106
15	0, 42, 41, 40, 59, 58, 60, 44, 45, 48, 46, 69, 66, 0	180	117,468
16	0, 68, 64, 61, 72, 55, 57, 54, 53, 0	150	105,164
17	0, 56, 0	30	90,000
18	0, 67, 0	10	24,413
19	0, 65, 63, 62, 74, 80, 79, 77, 73, 0	170	122,431
20	0, 81, 0	30	94,868
21	0, 78, 76, 71, 0	50	114,298
22	0, 70, 0	30	117,046

The results obtained are shown in Tables 3,4,5,6.

Table 3: *Results for the influence of the coefficient* ***α***

α	routes	cost	α	routes	cost
0	22	1 860,281	2	19	1 450,715
0,2	22	1 866,047	2,5	20	1 439,570
0,4	20	1 735,151	3	21	1 459,526
0,6	17	1 571,181	4	22	1 498,915
0,8	15	1 473,184	10	35	2 039,400
1	14	1 435,887	20	75	4 013,692
1,2	15	1 393,637	30	91	5 111,453
1,6	16	1 323,340	105	100	5 770,962

Table 4: *Results for the influence of the coefficient* ***μ***

μ	routes	cost	μ	routes	cost
-1	24	1 891,373	4	19	1 433,824
-0,6	25	1 923,156	5	20	1 454,848
-0.4	25	1 901,894	10	31	1 875,220
0	22	1 860,281	15	44	2 533,716
0,2	20	1 808,386	30	70	3 950,366
0,6	16	1 548,751	50	84	4 682,807
1	15	1 480,879	100	94	5 300,032
1,5	15	1 448,808	200	95	5 402,110
3	17	1 401,447	300	97	5 529,406

Table 5: *Results for the influence of the coefficients* ***α*** and ***μ***

μ	α	routes	cost
0,15	1	14	1 349,104
0,5	1	15	1 382,475
0,8	1	17	1 462,267

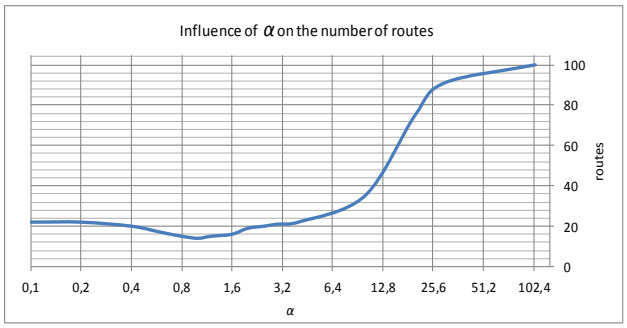

***Figure* 3** *Influence of α on the number of routes*

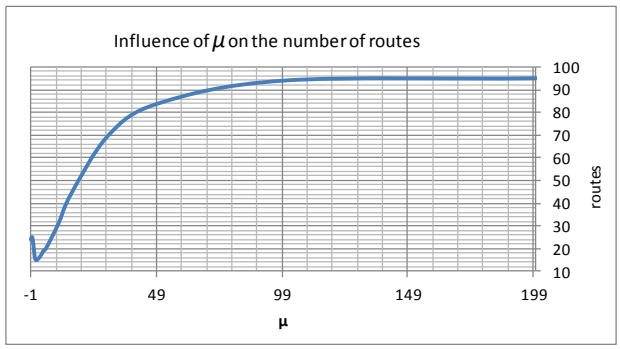

***Figure* 4** *Influence of μ on the number of routes*

4. Results

The influence at issue parameters, independently apart, on the number of received routes are illustrated in Figure 3 and 4. In Table 5 is shown the results obtained when combining them, and in table 6 are the routes and cost, corresponding for the best combination. When comparing the obtained results with those of Table 7, we see the difference in the number of routes - 4 and about 23% in cost.

The results obtained at researches done with other test examples, shown in Table 8, are closer to the input variants.

Table 6: *Routes for C1-Sweep, produced by splitting procedure and* $\alpha = 1$, $\mu = 0{,}15$

№	sequence	$Q_{nc.}$	cost
1	0, 90, 89, 88, 85, 84, 83, 82, 94, 92, 0	160	116,723
2	0, 87, 86, 91, 75, 1, 98, 96, 95, 97, 100, 0	180	123,730
3	0, 93, 99, 0	50	87,733
4	0, 5, 3, 7, 4, 6, 9, 8, 11, 10, 12, 14, 0	150	97,423
5	0, 2, 23, 26, 28, 0	70	66,007
6	0, 13, 17, 18, 19, 15, 16, 0	160	93,117
7	0, 20, 21, 22, 25, 27, 29, 34, 36, 39, 0	160	83,916
8	0, 30, 24, 47, 49, 52,50,51,31,35,37, 38, 32,0	180	124,161
9	0, 33, 0	40	67,052
10	0, 43, 42, 41, 40, 59, 58, 60, 44, 45, 48, 46, 0	170	104,449
11	0, 69, 66, 68, 64, 61, 72, 55, 57, 54, 53, 0	170	107,745
12	0, 56, 0	30	90,000
13	0, 67, 65, 63, 62, 74, 0	140	43,056
14	0, 80, 79, 77, 73, 81, 78, 76, 71, 70, 0	150	143,989
	Total		1349,101

Table 7: *Optimal routes for C1Sweep*

№	sequence	$Q_{nc.}$	cost
1	0, 90, 89, 88,85,84,83 82,94, 92, 87,86, 91, 0	200	133,756
2	0, 75, 1, 98, 96, 95, 97, 100, 93, 99, 0	190	106,068
3	0, 5, 3, 7, 4, 6, 9, 8, 11, 10, 12, 14, 2, 0	180	106,141
4	0, 23, 26, 28, 13, 17, 18, 19, 15, 16, 0	200	100,336
5	0, 20, 21, 22, 25, 27, 29, 34, 36, 39, 30, 24, 0	180	88,037
6	0, 47, 49, 52, 50, 51, 31, 35, 37, 38, 32, 33, 0	200	102,594
7	0, 43, 42, 41, 40, 59, 58, 60, 44, 45, 48, 46, 0	170	104,449
8	0, 69, 66, 68, 64, 61, 72, 55, 57, 54, 53, 56, 0	200	111,568
9	0, 67, 65, 63, 62, 74, 80, 79, 77, 73, 0	180	122,831
10	0, 81, 78, 76, 71, 70, 0	110	120,957
	Total		1096,739

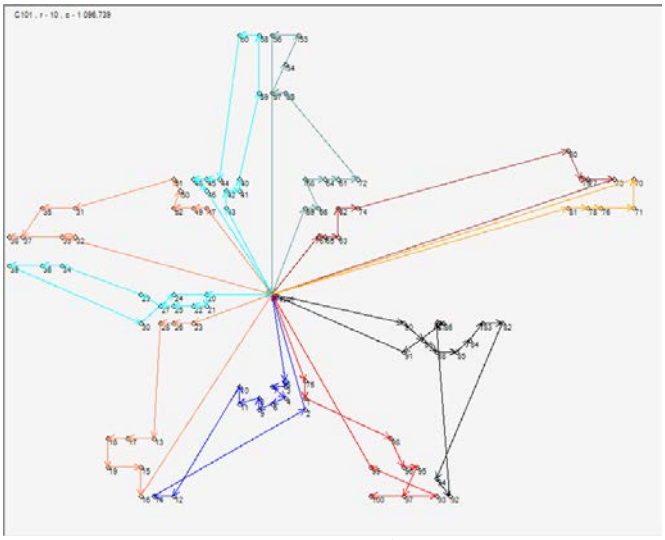

***Figure* 5** *Optimal routes for C1Sweep*

Table 8: *Problems and results of applications optimization model*

Пробл.	Method	rout.	cost	μ	α
C1	C&W	10	922,619	0,3	0,2
C1	Sweep	10	1349,101	0,15	1
R1	C&W	9	949,878	0,2	0,4
R1	Sweep	9	1 088,836	0,2	0,4
C2	C&W	3	632,432	0,2	0,4
C2	Sweep	4	869,468	0,2	0,4
RC1	Sweep	7	830,142	0,2	0,7

From these results is seen that with the introduced modifications, we do not achieve the desired final results.

We can get the desired final results, using these coefficients with higher values, and achieve variant with more routes. Through an additional procedure for their optimization (applied to the "label" array P_j ,Figure 1), was prepared desired result.

5. Conclusions

A large number of algorithms have been developed for obtaining the routes of commercial vehicles, ie to solve the VRP problem. При мета-евристиките широко се използва евристика за получаване на изходен вариант. Particular attention must be paid to then local search method.

The proposed modification, by examining the two parameters to the decoupling algorithm generally has a positive effect, and through subsequent optimization, we obtain the result, with the parameters of the heuristics.

The proposed modification, using two parameters examined, to the splitting algorithm generally has a positive effect, and through subsequent optimization, we obtain the result, with the parameters of the initial heuristics.

The method is used for splitting a sequence of vertices resulting from the procedures for the drawing-up of new sequences by genetic algorithms, and also as a procedure for getting the routes after the use of the algorithm for the Traveling salesman problem.

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NATURE, TOPICAL ISSUES AND GUIDELINES TOWARDS RESEARCH OF FUNCTIONAL RELIABILITY OF TRANSPORT SYSTEMS

Nikolay Georgiev, Silviya Krasteva
University of Transport 'Todor Kableshkov', 1574 Sofia, 158 Geo Milev str., Bulgaria

safetyniky@mail.com, silviya_krasteva1987@abv.bg

Abstract: *One of the most important characteristics of transport systems is the reliability of their performance. Significant global efforts are being made in this direction, both by the relevant government structures, and individual transport operators. These efforts are justified because improvements in the sphere of safety and reliability entail considerable benefits to transport users (reducing the waiting time of passengers, improving the quality of service in general, increasing supply chains reliability level, etc.) and for operators offering such a service (higher level of competitiveness, more revenues, etc.). This article examines the nature, existing problems and opportunities for improvement of approaches and methods of analysis, evaluation and management of exploitation reliability (and respectively transport service quality) of transport systems.*

Keywords: FUNCTIONAL RELIABILITY, TRANSPORT, TRANSPORT SERVICE QUALITY

1. Introduction

One of the most important characteristics of transport systems is the reliability of their performance. Significant global efforts are being made in this direction, both by the relevant government structures, and individual transport operators. These efforts are justified because improvements in the sphere of safety and reliability entail considerable benefits to transport users (reducing the waiting time of passengers, improving the quality of service in general, increasing supply chains reliability level, etc.) and for operators offering such a service (higher level of competitiveness, more revenues, etc.). This article examines the nature, existing problems and opportunities for improvement of approaches and methods of analysis, evaluation and management of exploitation reliability (and respectively transport service quality) of transport systems. It must be recognized that the management of functional reliability of transport systems is not unequivocal and cure for the problem solving. This is because transportation systems are complex hierarchical structures distinguished for their the availability of a wide variety of technical devices (rolling stock, means of communication and information management, special equipment, etc.) located and operated a large area. Nay, the normal work (and respectively offered by these systems transport service) could be impaired due to effects of great variety of influencing factors: technical refusals of the means of transport and / or other equipment and devices operating conditions (to which the transport process), characteristics of the organization and management of the transport system itself, etc. There are rare cases where single and seemingly insignificant events exploitation activities give rise to serious operational disturbances of transport systems. The problem of functional reliability of transport systems is not new to exploitation science and practice. Today, however, when the national and global economies are highly dependent on transport, this problem is becoming more and more relevant and significant. Undoubtedly, its solution implies a systematic approach and taking of adequate decisions (including measures to improve) requires adaptation to the problem on known or developing of new methods models for analysis and management of functional reliability. In this article are examined the nature and characteristics of the functional reliability of different types of transport systems, the guidelines and the problems of her the research.

2. Nature of the functional reliability of transport systems

Through physical movement of people and goods transport systems play an important role in the economic development of the country, linking social and economic interaction. Key element of every transport system is the functional reliability. The market of functional reliability is determined by the demand and the level of the proposed reliability, which inevitably change over time. Functional reliability is at once product and factor contributing to the trends in the development of the transport sector. [1]

It should be recognized that today the development of reliable and quality transport services is spent substantial funds globally each year. As a result of the increasing complexity of transport systems and supply chains in combination with rising consumer expectations, functional reliability becomes increasingly necessary and important. On the other hand the vulnerability of the system also increases. Functioning of transport systems can be disrupted by various types of errors, leading with her problems to solve that there are different models.

Some of the primary sources of reliability problems associated with rail schedules are unexpected events such as lack of rolling stock and locomotives, lack of crew or long delays at border stations. For public transport sources of reliability problems can be connected with lack of capacity, lack of drivers, repair of the road network and congestion.

Most of us are faced with unreliable transport services in their everyday life expressed with unexpected delays, leading to a later arrival to school or work or to a missed train or bus. Whether for business or social event or supply of goods reliability is a key quality of movement. The success of rail and road transport is highly dependent on the ability of a transport system to deliver reliable customer service. Transport operators aim to provide higher levels of reliability for consumers, because reliable services are more attractive and can also reduce operational costs.

It must be acknowledged that there have been significant efforts by transport operators and agencies for increasing the quality and reliability of services. Improvements in reliability beneficial both for consumers and for transport operators (fewer variables services reduce the waiting time of passengers and allow efficient use of resources by the operators). This is a situation where everybody wins.

The reliability is a term that may be defined in different ways. This article will examine the reliability in terms of quality of travel, travel time meet the needs of consumers and enabling them to organize their activities.

3. Defining the problems of reliability and guidance to solve them

In order to define the problems associated with the reliability of transport systems must be determined:

• the role and tasks of transport in the lifestyle of the individual and society as a whole;

• the influence of unreliable transport systems on personal and commercial activities.

• measures to be undertaken for the development in the field of transport.

Transport systems are vital arteries of modern economies that facilitate the lifestyle of modern man. A transport enables economic development and enables travelers to travel, socialize and have fun. Transport is vital for our personal and commercial prosperity. Therefore, reliability of transport systems is gaining more importance.

The main function of the transport system is facilitating movement of people and goods between chosen destinations. Insignificant damages can lead to a serious deterioration in state of the entire functionality of the system. Unreliable transport systems have an impact on both personal and on commercial activities. Consumers of transport systems rely on reliable schedules and delays, as well as the early arrivals on the selected route adversely affects the commercial and personal activities. Unreliable transport system increases the time to reach the desired destination. The consequence of delayed transport leads to disappointing trip causing stress.

When talking about the reliability of transport systems, it is important to mention that can be defined in terms of transport operators and from that of consumers (fig.1) using the service.

Transport operators responsible for the designated transport lines are interested in the probability that the means of transport (trains and buses) used for the service will be operated in accordance with a pre-planned schedule (which may be designated as a reliable schedule). For them reliability involves costs as they have to devote part of their resources to deal with the consequences of unreliability. The user on the other hand is interested in the probability that he or cargo will reach its destination at the desired time.

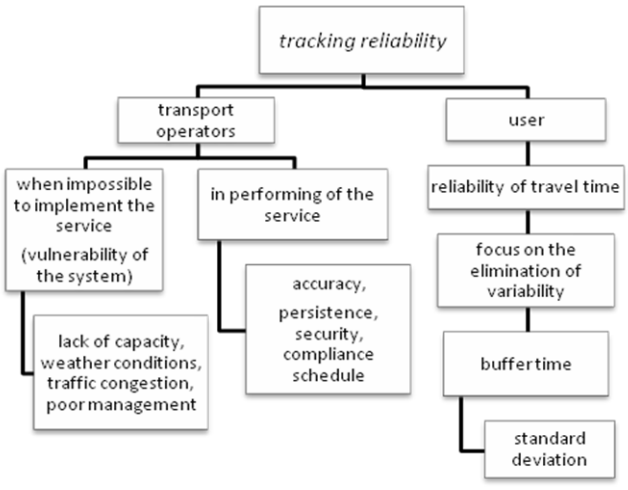

Fig.1 *Tracking reliability in terms of transport operators and users.*

It should be noted that the reliability of a given transport system influences the decision of the trip (time of departure, those decisions are made in order to reach the defined destination at a specific time). This is particularly relevant for business trips when the delay shall be adopted that there is a very high value of the harm. When deciding on departure time traveler strives to minimize the waiting time (futility) in his journey. The traveler should plan extra time for travel since it is forced to leave early to add buffer time and thus devour the unreliability of the transport system in time. This extra time the passenger is considered as costs of the person as taken away his time traveler can use for other potentially more productive activities.

Lack of reliable transport services can have a significant impact on costs and may also affect the transport system. On the other hand, the increase of reliability allows the operator to optimize the use of resources. By reducing the recovery time, operators can increase the availability of drivers and vehicles. Observance of schedules allows the operator to reduce the number of spare vehicles and drivers. The improvement of regularity will reduce the average waiting time of passengers and improve the efficiency of capacity utilization of vehicles. According labor [2] by improving the infrastructure can increase capacity: enhance transport service lines and transfer points, building new highways and roads, improving and constructing new railway lines and terminals. Increase the supply reliability of transport systems leads to reduced likelihood of an unexpected meltdown in service.

Reliability of the various transport systems can be defined in different ways. In the labor [1] reliability defined as the probability of realization of trips within a specified period of time. Travel time depends on many factors. It must be recognized that there are many indicators which are used for expression of efficiency of system reliability. Reliability of public transport is often expressed by the accuracy of the arrival and/or departure of stops and stations. In the railway transport accuracy can be defined as the number of trains run on time.

Unlike rail, the reliability of the road sector is often measured by the average travel time. Average travel time is determined by the expected and unexpected delays (fig.2). Unexpected delays lead to differences in the trip any subsequent trip. Can be identified two forms of unexpected delays. The first concerns the travel time for trips taken at the same time each day (variability) and the second, which concerns the random delays that are the result of accidents or repairs.

Given that the user of the transport system must take into account the expected average travel time and its variability.

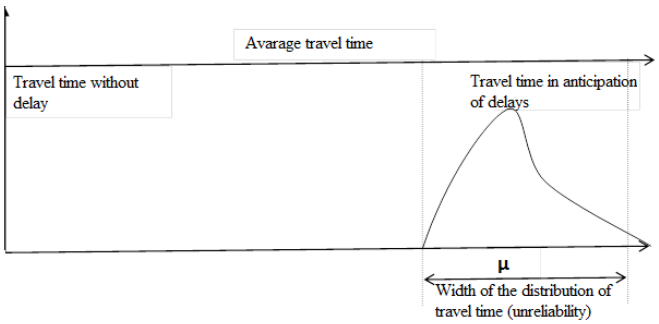

Fig.2 *Travel time distribution*

To reduce the risk of delay to reach the desired destination, the traveler must provide more than the average travel time. This is shown in Figure 2, where μ represents the average travel time. User expectations in terms of travel time are related to the variable of parameter μ.

Common featured indicator for the reliability of the transport system is that they do not relate to possible options of travel time (day to day), its distribution or particular form of distribution. The distribution of travel time from day to day can be characterized by two features of this trip-width (variance of travel time) and the distortion (the model of distribution of travel time) or more widely or more distorted timing travel to definitely time of day and day to day of the week, less reliable travel time.

By increasing the quality of transport infrastructure that provides the ability to cope with the consequences of extreme weather conditions the probability of reliability (safe travel, meeting the requirements of the traveler, and allows you to organize activities) increases. Bad weather conditions affect the reliability of the transport system. On the one hand deteriorating road conditions leading to a reduction in speed and delays, and the other severe weather conditions increase the likelihood of accidents, leading to disruption of traffic flow and unreliability. The provision of higher capacity may also improve the reliability of the transport system, especially when the unreliability arises from high levels of traffic. The extra capacity can also lead to less vulnerability of the system, if they are provided with alternative connections.

Information plays an important role in the management of reliability. The provision of information to the user who uses a transport system, gives the opportunity to organize your trip (choose another route to arrive on time to the selected destination; delay may be inevitable, if no there is an alternative route). In this case the provision of information can soothe the user and reduce the stress of unforeseen delays. The information can be divided into pre-and during the trip. Probably consequences of delay can be reduced by both forms of information. Information before traveling enables the planning of the trip and thus avoids the possibility of unreliable trip. Information during the trip allows the user of the transport system to change initial planned trip according to current traffic conditions. The provision of information is helpful for both consumers and operators of transport systems. The prediction of travel time allows the operator to plan the response time to incidents and operational problems, while real-time information allows effective monitoring of events development. Reliability of transport systems can be influenced by the quality of information. The more accurate the information provided to the consumer, the more expected travel time approaches the actual travel time and leads to higher reliability of transport systems.

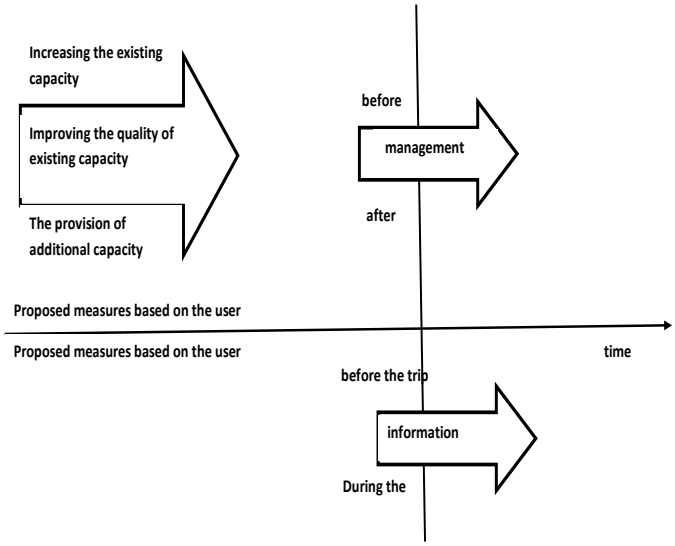

Fig.3 *Optimized reliability of transport systems*

4. Conclusion

We can conclude that in terms of solving the problems of reliability, (fig.3) a transport system can be optimized by:

- Increasing the physical infrastructure capacity or by providing additional capacity or improving existing capacity;
- Better management of existing capacity. This can increase the reliability as well as poor management can increase unreliability;
- Provision of information to consumers, which enable them to reduce the adverse effects of reduced reliability. This can be a cost-effective way to reduce the unreliability and possible impact of unexpected delays in business or personal travel.

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STUDY AND COMPARATIVE ANALYSIS OF THE MODELS FOR TRAFFIC SAFETY PREDICTION

Violina Velyova
University of Transport 'Todor Kableshkov', 1574 Sofia, 158 Geo Milev str., Bulgaria

vili_tuk@abv.bg

Abstract: *The need of development and implementation of effective measures to increase the level of traffic safety is of utmost importance when it comes to road transport. Numerous studies on factors affecting road safety are the core of transport approaches and models made to reduce the occurrence of accidents. The purpose of this article is to make a comprehensive study of the models for analysis of the traffic conditions and their impact on traffic safety and to define the fundamental ones for implementation in Bulgarian conditions.*

Keywords: TRAFFIC ACCIDENT, TRANSPORT, TRAFFIC SAFETY, PREDICTION MODELS, ROAD TRANSPORT SAFETY, APPROACHES, VEHICLE

1. Introduction

Reducing the number of road accidents and their consequences can be sought in the amendment of factors, which determine the accidents rate, such as behavior of road users, the level of conflict of road infrastructure and its active and passive safety.

The purpose of this article is to explore accident prediction models in order to be considered working methods for predicting traffic accidents in Bulgaria and to reduce their number. By examining the current state of the problem, the interrelationships with other types of accidents and the overall situation on the road, the resources and tools that would lead to an integrated, safe, responsible and maintained transportation system, can be identified.

In recent years engineers tend to focus on human and technical errors as causes of accidents. Responsibility for the accident should not be thrown solely on drivers, but also on other elements that build the transport system: planning and maintenance of the infrastructure, organization and traffic conditions in the settlements, increased knowledge of the population and specialists who define harmony in movement and the degree of conflict of infrastructure.

The reduction of casualties on the roads requires the combined efforts of a large number of institutions and the will to undertake specific activities for better performance and decrease errors in system 'Driver - Vehicle - Road'.

This study examines models for prediction of accidents (Accident Prediction Models) for signalized intersections and crosswalks. These models are developed to calculate the likely change in accidents involving motor vehicles and pedestrians and also the degree of risk of accident to one participant, even in case of his transport mode. Large flows of vehicles can often compete with moving pedestrians, mutually cross their planned directions, which in turn leads to delays and creates conditions leading to the separation of the city to different areas.

2. Choice of method for traffic safety evaluation

2.1 General characteristics of road accidents

Scientifically based system for limiting and eliminating the negative effects of the increasing number of vehicles on the road can be built only after a thorough and comprehensive study and analysis of the causes and conditions, facilitating the occurrence of accidents. The analysis of accident allows detection of the organization of traffic and pedestrian flows, verification of planning effectiveness, reconstruction and control events.

The analysis can be done by studying in detail an individual or a group of accidents that occurred on a section of the road network. The purpose of the analysis is to provide information for the majority of accidents to find out whether the statistical data actually contributes to the occurrence of the accident, what are the trends, if this process continues, what to expect, how to concentrate and allocate the available forces and means of prevention.

Traffic safety can be evaluated using statistical data and by measuring the parameters of indirect assessment.

2.2 Statistical Methods

Statistical methods allow researchers to obtain the summary and accurate assessment of road safety and should be used for controls of indirect estimates. The use of these methods is associated with certain difficulties - the need of accident data for 1, 2 or more years, without change in the traffic conditions. Since these methods are used in many countries, there is a possibility to make a comparative analysis of individual indicators.

2.3 Indirect methods

Indirect methods for the evaluation of traffic safety have one very important advantage over statistics – there is no need for data on accidents.

a) Method of conflict points - this method is used to assess the potential risk of an intersection or junction [8, 15]. It has been discovered that the degree of risk of a conflict point of intersection depends on the angle between the trajectories of the two vehicles.

b) Method of conflict situations - this method was proposed by C. Perkins and J. Harris (USA) in 1968. Specialized organizations connected with traffic safety appreciate the positive qualities of the method and it is one of the most used and the most promising for visual assessment of road safety nowadays. According to the authors of the method, conflict situation is a situation that can lead to accidents if the participants do not take protective actions or adequate rescue maneuvers. There are still differences in terminology, methodology and grading the risk of conflict.

c) Method 'sound/noise on acceleration' - the basis of the method lays on the hypothesis that travel is safe and that the relative speed between the vehicles is close to zero. Dispersion of the longitudinal acceleration of the vehicle while driven is used as evaluation indicator. Increase in 'sound/noise on acceleration' is a sign of potential danger to traffic.

d) Methods of complex measurements - in these methods quality parameters are used, which are obtained from the values of the various parameters of the movement - time, path, speed, deviation of the steering wheels etc. [9, 13].

2.4 Registration and analysis of traffic accidents

A traffic accident is an event that occurs during the movement of the vehicle and causes death or injury, damages to the vehicle, road, road infrastructure, cargo or other property damage [12]. The definition shows that in order an event to be classified as a road accident, it is necessary a vehicle movement and harmful effects to take place.

- *Registration and reporting of accidents* - the total number of accidents that are not subject to registration is from 6 to 8 times greater than officially recorded. Although the damages are smaller, their analysis would contribute to a more objective assessment of safety and a more precise determination of the causes for accidents. Accident register is enrolled in the 'traffic police' of the territorial unit. They do not keep records of accidents, which started deliberately in order to suicide, homicide, injury or damage caused by natural disasters and others. Operating services prepare daily, weekly, monthly and annual report of the accident area or for the country. A detailed compendium on traffic accidents' statistics is issued every five years.

- *Analysis of data on accidents* - the main objective of the data analysis for accidents is to obtain complete information on the conditions and causes of accidents. Achieving this goal is limited by two reasons. It is practically impossible to get all the information about an accident because the elements of this event pass irreversibly with time and purely due to technical reasons. The second reason is related to the accuracy of the information and its transmission. The main tasks of the analysis of accidents are: receipt of sufficient quantity and quality of information, processing of the information by various methods (statistical probability, topographical characteristics, etc.), analysis of groups of accidents, analysis of individual accidents.

Quantitative method - the purpose of this analysis is to obtain estimates of absolute and relative indicators of safety using accidents data. Absolute statistical indicators are: total number of accidents, deaths and injuries. They are calculated for a given period and comparing them with past years allows conclusions about the level of safety to be made. The comparison can be done for the same periods between separate administrative territories or countries in comparable conditions.

Topographic analysis - the purpose of topographical analysis is to identify the places where road accidents are concentrated. These places are called black spots, hazardous areas and outbreaks of accident record, but their essence is one - places where accidents occur frequently. Areas with a concentration of accidents can be separated into two groups. The first relates to intersections and junctions, railway crossings, bridges, tunnels and other road facilities. The nature of traffic on such sites is determined uniquely by the highest probability of occurrence of accidents. The second group should join the rest of the roads and streets. Analysis of individual accidents is to identify its causes, mechanisms of development and possibilities for its prevention and to provide a so called expertise of accidents.

2.5 Literature review of sources related to accident prediction models

There is a large number of scientific papers and publications on methods and approaches for assessing road safety and influencing factors. What unites all of them is the search for an appropriate solution for improving road safety depending on individual characteristics: areas designated as hazardous after conducted surveys (black spots or black sites); roads and areas associated with particular types of accidents at a number of individual sites throughout the area.

The issue of safety is reviewed in [4]. The main purpose is development of reliable transport system on the territory of Sofia Municipality in the Republic of Bulgaria as well as detailed analysis of the contemporary transport system and projections for future growth and development of the city. During the development of the plan some key conclusions are made: the density of the road network in the city is unsatisfactory; the structure of the network traffic is not complete; the frequency and duration of trips, as well as the number of private cars, are increased; there is a decline in people traveling by mass public transport at the expense of private car users. The main priorities for the city are to improve the living conditions and quality of the environment in Sofia.

Studies [5], [17] and [18] analyze traffic counts and data of signalized intersections in many urban centers in New Zealand. In different periods of time accident prediction models for common types of accidents were developed. One of these models was adopted in the present article for safety assessment.

Works [10] and [11] reveal that during his study Jackett uses information about accidents, traffic volume data from the environment and geometric data taken for 523 urban roads to calculate average accident levels in order to take timely measures.

Law on Road Traffic and the Regulations for its implementation [12] governs the rules of the road, open to the public, the requirements for vehicles, the requirements for driver qualification, the rights and obligations of participants in the movement and the relevant departments and officials, as well as coercive measures to be applied, and the penalties for violating the contents of this law and the issued hereunder regulations. The purpose of this law is to protect the life and health of the participants in traffic, to facilitate their movement to protect the assets of companies and individuals, and the environment from pollution by motor vehicles.

Labor [7] informs about urban intersections with four lanes in one direction, the most common form of roads in the UK. Accidents at intersections are 1772 over the period of 4 years. Accidents involving pedestrians are more than 28.8% of all accidents.

Labor [16] examines 300 road links between major junctions in the United Kingdom. During the 5-year study 1590 accidents occurred on the territory of these road links. Some of the more important discoveries of the study are that the models predict more than the average number of accidents with links connecting pedestrian crossings than segments without pedestrians in any stock vehicle and pedestrian density; some of the physical variables in the model appear to be related to speed. For example, increased visibility in the opposite direction of travel affects the general increase in accidents, accidents with motor vehicles and accidents with pedestrians.

In labor [2] a deterministic model is developed for accidents with pedestrians and vehicles. According to the study accidents have a random character. The Davis model is designed to allow comparison of the possible accident (reducing effects through a variety of techniques) to 'calm' traffic. It focuses on the volume and speed of traffic, borrowing default values for the other variables: distance from the pedestrian lane before the collision; the speed of a pedestrian moving towards the road; time perception and reaction; reducing speed after brake (braking distance).

Study [14] addresses the measurement of risk, based on the theory that each type of activity is related to exposure to a certain degree of risk. Risk measurement, by distance only, offers a broad risk assessment of accidents. Drivers are exposed to different types of risk while traveling in different sections of a road. Risk and Shaoul (1982) pay attention to the classification of the intersections along the way with different levels of risk based on the number of side roads, expected maneuvers in the intersection and the number of expected points of conflict. They believe that a better level of risk assessment can be achieved if assumptions about the number of movements of pedestrians and traffic on the road segment are made. The models show that the risk to pedestrians increases with the traffic flow, but decreases with increasing number of pedestrians. This effect is called 'safety in numbers'.

In study [3] the safety of pedestrians using crosswalks and signalized intersections is investigated and compared to crossing the street without signaling elements. Labor [4] places a table of studied intersections that is used as a basis for counting the number of transport vehicles and pedestrians. It was found that the data is typical for the selected study area of Sofia, Bulgaria.

It is essential to mention it is advisable that the chosen accident prediction model should be a consequence of expert opinion. This is where the expert evaluation method and its feasibility for analysis

of safety management system can take place. The basic objectives of safety strategy are:

- clear definition of the analyzed problem;

- creation of a certain questionnaire connected to the problem;

- implementation of a poll;

- analysis of poll results.

The method of expert evaluation has been used in a study of Safety Management Systems functioning of a Bulgarian railway carrier. This type of model is proposed in study [6], and it is not applied in road transport in Bulgaria yet. By weighing the expert assessments, calculation of parameters and determining the statistical significance of evaluations, it would be possible to determine the degree of influence of respective factor on operating safety not only in rail, but also in road transport .

3. Accident Prediction Models for vehicles and pedestrians

This paper uses the aforementioned model of work [17], statistical data on volumes of flows of vehicles and pedestrians, taken from the Bulgarian Ministry of Interior and Sofia Municipality and data on the characteristics of the accidents. It was considered that this data is relatively old or less complete, and counting was performed in volumes of flow of vehicles or pedestrians according to the method shown in [18].

Models for predicting accidents (APM) can be implemented by transportation engineers and transport planners to predict the rate of accidents, and to assess the effects of changes in safety at various travel modes.

Accident prediction models can be used to determine the possibility of change in the number of accidents involving a motor vehicle, a pedestrian, also the level of accidents for each street and to change the organization of the movement.

One of the most important reasons for accident modeling is the prediction of the number of accidents. For this reason the task of selecting the most appropriate methodology and feasibility study for implementation in Bulgaria was given.

When it comes to modeling small samples, the Poisson-gamma model (low mean problem) is usually the choice of transportation safety modelers. Other modeling techniques are related to the non-linear models and geographically weighted regressions but according to the works in the field of transport modeling the best model is the basic, which is a regression. That is because of the fact that each of the approaches has its own strengths and weaknesses. Difficulties arise from the collection of extensive statistical database if it does not exist so far.

An examination of the literature and research in the field of models for predicting the number of accidents (Accident Prediction Models) shows that the most widely used model is of the following form [17,18]:

(1) $A = b_0 x_1^{b_1} x_2^{b_2}$,

Where:

A - accidents (number of accidents per year);

x_1, x_2 – traffic flows (total number of vehicles or pedestrians per day);

b_n – parameters of the model.

It could be used with other variables characterizing the influence of other traffic safety factors (width of the roadway, crosswalk width, etc.). This further complicates the model and it will not be used in this article. The coefficients b_0, b_1 and b_2 can be determined by the use of relevant statistical data. Due to incomplete statistics for some accidents involving pedestrians the article checks only the relevance of the above-described model in Bulgaria (using coefficients is proposed in the works [17,18]).

4. Application of accident prediction models for Bulgarian conditions

Accident prediction models can be used to determine the possibility of change in the number of accidents involving a motor vehicle, pedestrians, also the level of accidents for each street and to change the organization of the movement. It could be used for variables characterizing the influence of other factors on traffic safety too.

This paper examines two variants of accident prediction models. For each of the models coefficients proposed by New Zealand authors were selected to check their adequacy for Bulgarian conditions.

Based on the volume data streams of vehicles, pedestrians, and data on the characteristics of the accident the adequacy of the above-described model was examined (expression 1) for the conditions in the country. The daily volume of the traffic flows of vehicles and pedestrians were taken from the Sofia Municipality and enriched by observations (counts) and use of the method described in works [17, 18]. Due to the limited volume of statistical data on the investigated types of accidents (complete data, but only for the years 2009-2012) it was decided coefficients obtained in [17, 18] to be used. The applicability (the relevance) of the models was reviewed and verified for the following types of accidents: Model 1: An accident between a road vehicle that is making right turn and pedestrian crossing the intersection (Fig. 1). The type of the model for this type of collision is as follows:

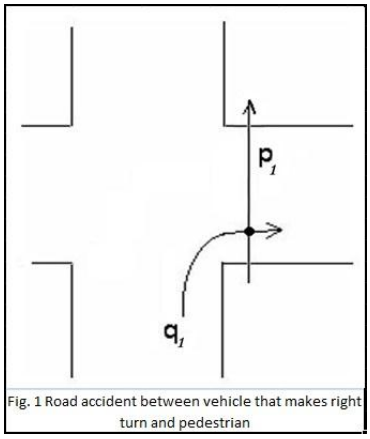

Fig. 1 Road accident between vehicle that makes right turn and pedestrian

(2) $A_1 = 0.000054 q_1^{0.4343} p_1^{0.5127}$,

Where:

q_1 - daily flow of right cornering vehicles for one direction;

p_1 - daily flow of pedestrians in the same direction.

The number of actually admitted and registered by the Police and the State Automobile Inspection (SAI) estimated number of accidents and incidents, obtained by the expression 2, distributed in intervals in accordance with the daily flow of pedestrians are compared in Figure 2.

Correlation between actual and estimated number of accidents in model 1 is shown in Figure 2.

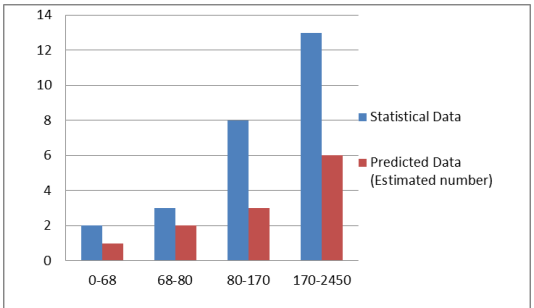

Fig. 2 Accident Prediction Model 1

Model 2: An accident with a transport vehicle and a pedestrian on a walkway (Fig. 3): The type of the model for this type of collision is as follows:

(3) $A_2 = 0.0000306 q_2^{0.6584} p_2^{0.2041}$,

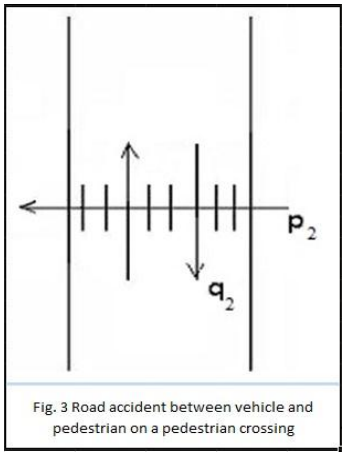

Fig. 3 Road accident between vehicle and pedestrian on a pedestrian crossing

Where:

q_2 - daily flow from motor vehicles;

p_2 - crossing pedestrians.

Figure 4 compares the number of actually admitted and registered by the Police and the SAI accidents and the estimated number of accidents (obtained by the expression 3) distributed in intervals in accordance with the daily flow of pedestrians.

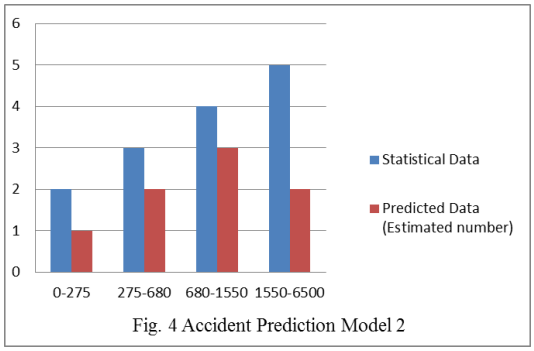

Fig. 4 Accident Prediction Model 2

Studies show that both models work well and can be used to solve practical problems of safety in Bulgarian conditions. The exception is the prediction of the number of accidents involving large volumes of vehicle and pedestrian flows. This fact suggests further research and determination of the coefficients of the models based on more complete statistical data on the number and characteristics of the admitted accidents.

Based on the analysis the following main conclusions can be formulated. First - the analysis of the models found that they generally work well and can be used to predict the safety of vehicles and pedestrians in Bulgaria. Taking into account the safety of this type of road users the following recommendations can be given: development of guidelines to assist local governments in the successful planning and implementation of programs for traffic safety; updating the regulatory framework regarding the terms and conditions of the road; development of programs with concrete measures to improve the organization of the movement. Models for predicting accidents could be used as a basis for helping to reduce accidents involving pedestrians by providing data at what traffic density a number of incidents will occur and how they should be avoided or sufficiently reduced.

5. Conclusion

The forms and types of accident models vary considerably. Individual types of models (e.g. different types of models for each intersection) are of great interest but do not lead to the production of significantly improved model for each accident than the so called 'all accidents model' (basic model). Furthermore, the basic model has proven its stability over the years and enjoys the confidence to predict future levels of safety. The experience in the studies of road accidents shows that they are due to a combination of the following factors: highway geometry, driver and vehicle characteristics and the environment. Accidents are typically caused by an interaction of more than two of these factors. The proposed models can be successfully used in decision making to improve traffic safety in the cities of Bulgaria where it is necessary to estimate the potential number of accidents that could be expected at a given workload of the respective intersection.

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ROAD INFRASTRUCTURE AND TRAFFIC PARAMETERS - MAIN FACTORS AFFECTING TRAFFIC SAFETY

Nikolay Georgiev, Violina Velyova, Mileta Dimitrova
University of Transport 'Todor Kableshkov', 1574 Sofia, 158 Geo Milev str., Bulgaria

safetyniky@mail.com, vili_tuk@abv.bg, m_mimetoo@abv.bg

Abstract: *Within the transport process there is continuous interaction between the three main factors: behaviour of road users, infrastructure conditions and characteristics and vehicles. As a matter of fact, the aforementioned factors are key sources of causes for traffic accidents.*

The purpose of the present article is to propose such a road traffic organization that would reduce congestions, minimize the number of road accidents and the risk to health and life and would enhance safety. In this context certain characteristics of a specific road section in Bulgaria will be examined. Furthermore measures for improving traffic conditions and safety will be defined.

Keywords: TRAFFIC ACCIDENTS, ROAD TRANSPORT SAFETY, VEHICLE, TRAFFIC

1. Introduction

Road accidents lead to huge social and economic losses for society. They are becoming a serious problem for the Bulgarian health, since they have a direct impact on mortality and morbidity.

The traffic process is a continuous interaction between the three main factors: behavior of road users, safety of road infrastructure conditions and characteristics and vehicles. An important indicator also participates in the interaction - pre-medical and specialized medical care. Equal attention should be paid to the improvement of each of these factors by developing goals and programs related to a higher level of safety.

Because of the mentioned above, the following study is related to measures that would help to: reduce congestion in a chosen area, minimize the number of road accidents, reduce the risk, prevent traffic accidents and enhance safety. For the purposes of the study and monitoring of infrastructure impact on traffic safety, the following are selected: an intersection and a road area with a high concentration of accidents. The activities that form the safe behavior of road users, better construction and maintenance of road infrastructure, lower traffic conflicts and ensure participants' protection are of a particular concern.

2. Key factors affecting road traffic safety and the choice of road section

2.1 Overview of the main factors affecting traffic safety

Traffic safety depends on the failure-free operation of all the elements in the 'Driver - Vehicle - Road – Environment' System, hereinafter DVR system. The system's reliability depends on the perfection of its individual elements, which can be represented by the equation of the reliable operation of the system (1):

(1) $P_{DVR} = P_D \cdot P_V \cdot P_R$,

Where:

P_D - probability of a reliable operation of the driver;

P_V - probability of a reliable operation of the vehicle;

P_R - probability of a reliable operation of the road.

One of the main objectives is to study the influence of typical factors related to traffic safety. The most important and responsible element of the DVR system is the driver. His psycho-physiological capabilities are insufficiently studied and hard to maintain. Therefore the reliability of the driver can be assessed indicatively and this element appears to be the weakest in the system. According to formula (1), reducing the probability of a reliable operation of one of the three elements of the DVR system, safety deteriorates sharply and causes traffic safety problems, i.e. it leads to emergency situations that most often end with accidents.

The solution to the traffic safety problems, based on the systematic approach that takes into account the interactions and relationships of all elements in the DVR system, is shown in formula (2). The probability of an accident is presented as a function of factors, depending on the driver - D, vehicle condition - V, road conditions - R, traffic movement - TM and random factors - RF:

(2) $P_{RA} = f(D,V,R,TM,RF)$

The results of various studies on the factors above associated with accidents in several European countries are shown in papers [1, 6]. According to the data provided in these studies, it appears that the human factor is decisive in 68% of the accidents. When taking into account accidents in which the human factor is combined with other factors that are considered to have contributed for the accident, this rate reaches 91.5%. The human factor becomes even more important for reliable operation of the DVR system, if it is subjected to alcohol and drug influence. Research in Norway [3] shows the relative risk of a participation in an accident when drivers are with different levels of alcohol in their blood (grade of intoxication). The relative risk of participation into an accident increases in non-linear relationship with an increase in alcohol intoxication.

Different studies show that the biggest accident rate is in the highway and after that on secondary and tertiary roads. The traffic condition is presented by the characteristics intensity and speed. Accidents increase to about 80%, when the traffic intensity is increased from 10 to 100%. The proportion of people killed also increases by approximately 25 %, which means that an increase in intensity (especially when it gets close to the throughput of the road) raises driver's discipline, reduces the speed and hence leads to lighter consequences of accidents. Furthermore, streets with greater intensity are with better driving conditions. The rate of accidents in highways is the highest due to the high intensity and dissipation speed. Variance of speed has the most significant impact on traffic safety compared to the average velocity of the flow. Deviation from the average speed for the section leads to more interaction between vehicles and a greater likelihood of accidents. Drivers who move at a speed considerably lower or higher than the average speed of the traffic flow participate more often in accidents than those who stick to the average speed. Data for a tolerance of 50% of the average velocity of the flow (50 km/h) is given in [2, 7]. Surprisingly, the results show that the deviations from the average speed is the main reason for the accidents, not the level of speed. The highest velocity (speed limit) to pass through the turn without sideslip, provided that the driver did not slow down and/or accelerate the vehicle can be calculated by the expression:

(3) $V = \sqrt{gR(\varphi + tg\alpha)/(1 - \varphi tg\alpha)}, km/h$

Where:

R - turning radius;

α – transverse slope of the road;

g – acceleration of gravity;

φ - coefficient of adhesion in the transverse direction.

Taking into account all the factors that influence the number of road accidents, it can be said that they are the same for Bulgarian conditions, but it is necessary to pay attention to the statistics in terms of the specific conditions of the chosen road section.

With regard to Bulgarian conditions as a result of road accidents 601 people were killed and 8193 were injured on Bulgarian roads in 2012. There is a decrease of 56 killed and 108 injured compared to 2011. The reduction of the victims for the two years (2012 and 2011) compared to 2010, which is the base - 156 (20.6%), shows a significantly faster rate of decrement of the number of victims compared to the national strategy objectives for improving road safety in Bulgaria [5]. The implementation of targets for the reduction of road casualties in Bulgaria by 50% until 2020 [4] continues, paying close attention to the priorities set in the national and regional strategies and action programs related to active and passive safety.

2.2 Characteristics of the chosen road section

The causes of road accidents can be divided into two groups: subjective - related to human behavior, as a participant in the movement; objective - related to the imperfection of the traffic conditions and vehicles. The aim of this article is to analyze accidents in a chosen road section and to identify the most common reasons for their occurrence. The following main tasks are settled: identifying the object and scope of the study on various indicators of registered accidents; collection and processing of data from the records of accidents; identifying the methodology for processing data; statistical treatment of the data; analysis of the results obtained; conclusions and recommendations for improving traffic conditions and traffic safety.

The 'Pernik - Vladaia' road section is selected for the study, because it is part of the national road network in Bulgaria. The importance of the road section is defined by its affiliation to class road I-1, which is part of the national road network and important thoroughfare in the country. It is also a key link between the two neighboring countries: Romania and Greece. National Road I-1 is the westernmost of first class roads and connects the city of Vidin with the border checkpoint Kulata - Promachon, passing through Sofia. Its total length is 453.8 km. The road is part of the European route E79 - Oradea - Craiova – Vidin - Sofia - Thessaloniki. The concerned section starts from the 'Dragichevo' junction and ends up in the 'Vladaia' checkpoint. The section has a total length of 8.3 km. Daily thousands of cars, buses and trucks pass through it. The road surface is worn and not in a good condition. There are many bumps and holes that hinder the movement of vehicles and are a prerequisite for serious accidents. The number of accidents is extremely high and most likely the road is one of the busiest and most dangerous in the country. Traffic jams that occur because of the two-lane road pass 'Vladaia' are a routine.

According to the Bulgarian Road Infrastructure Agency the condition of the road surface of the section at the end of 2012 is acceptable. Cosmetic repairs associated with partial adjustments do not lead to a qualitative improvement of the road surface condition, as in the most cases increase roughness. There is a presence of longitudinal and mesh cracks, local subsidence and damages. The objective economic conditions in the country, the economic crisis, the closure of almost all industries in Pernik, led to rising unemployment in the city. The capital - Sofia, is a good alternative for searching and finding a job for many people living close to it. A significant part of the workforce in Sofia uses railways but there is also significant travel by private cars or public transport, using this road section. Travelers to Sofia are around 30 000 to 40 000 people. The movement is as follows: workers - 67 %, employees - 21 %, unemployed - 2 %, entrepreneurs – 6 % and others - 4%.

In this sense, the 'Pernik - Vladaia' road section is not only a part of the transport artery of the country and a mean for improvement of the functioning of the transport links, but also the impetus for socio-economic development of the region. The commissioning of the 'Lyulin' highway significantly relieved the traffic intensity (Tab. 1), but the section still remains extremely busy. One reason is the steady increase in the number of vehicles.

Years	2008	2009	2010	2011	2012
Traffic intensity vehicles/day	28000	29000	29000	18000	18000

Tab. 1 Traffic intensity per year in the chosen section

According to the 'traffic police', traffic over the years has doubled. The 'Lyulin' highway takes at least half of the potential traffic at the 'Pernik - Vladaia' section and almost 100 % of that of heavy vehicles. Traffic load reaches 90 % of the throughput of the road section and a pronounced unevenness in the morning and evening hours of the day. The flow is directed to the capital - in the morning and to Pernik – in the evening. Results obtained from the traffic counts show that the highest load is in the intervals 6:30 a.m. to 8:30 am and 4:30 to 6:30 pm, which is why they are defined as peak. An average daily traffic volume of 18 000 vehicles shows that 3 000 cars have passed through the terminal from which the observation was made during the peak hours. In some parts of the road section, where the traffic is one-way, separation of traffic flows is made in two-way traffic through road cones, which facilitates the movement.

An essential traffic characteristic is speed. Speed is limited primarily in conflict points between vehicles or between vehicles and pedestrians, as well as in areas with minimum turning radius according to weather conditions (respectively the coefficient of adhesion).

Parameters of the road that affect the speed driving mode are horizontal curves with their characteristic radii and the condition of the road surface (dry, wet and icy where the adhesion coefficients are 0.7, 0.2 and 0.4).

Drainage facilities in the greater part of the region are missing. Due to roadside vegetation, which varies seasonally, the visibility is limited. There is discrepancy between the actual road markings and visibility when cornering at the observed section. Some parts of the section are narrower than others. Speed limitation is made through road signs and artificial obstacles.

In the present road section there are three pedestrian crossings. Two of them are well signalized and marked with road signs. It should be noted that the third, except lane markings, does not have any other indicators. There are two well signalized intersections in the chosen section. Speed is limited to 40 km/h at the intersections. Speed limitation is 50 km/h in areas with high risk. Almost all of the remaining parts of the section have a limit of 60 km/h. These restrictions are aimed at reducing the number and severity of accidents, but they also reduce effectiveness of the transportation process, due to the lower average speed for the whole section, which is about 50 km/h. This leads to the formation of traffic jams in rush hours throughout the day. Continuous prohibitions for overtaking with the help of road signs lead to a strong variation in speed compared to the average speed of the site or the limited one. There are significant variations in velocity - from under 30% to over 110% at the section. The critical radiuses of the road curve are 2 and they cover about 800 meters of the road section or about 9.6 % of it. Longitudinal slopes uphill and downhill are negligible (less than 3%) and they do not affect significantly the speed mode. The

vertical signalization is acceptable - there are about 70 signs. Limits are signposted by road signs B26 and B24.

3. Analysis of traffic safety

Relative objective indicators to assess the status of road safety are weight factor of the consequences (severity coefficient) and mortality rate of the accident (fatality coefficient).

The weight factor is determined by the expression:

$$(3)\ K_S = \frac{n_f + n_i}{n};$$

The mortality rate is determined by the expression:

$$(4)\ K_f = \frac{n_f}{n_f + n_i},$$

Where:

n_f - number of casualties (fatal) in a road accident;

n_i - number of casualties (injured) in road accidents;

n - number of the registered serious road accidents.

3.1 Road conditions in the 'Pernik - Vladaia' section

A summarized data for accidents in the 'Pernik - Vladaia' section is given in tab. 2 for the 2008 - 2012 period. Coefficients K_s and K_f have the highest values in 2011:

Year	Traffic Accidents	Killed	Injured	K_s	K_f
2008	64	0	5	1,25	0
2009	48	0	3	1	0
2010	40	1	2	1,5	0,3
2011	36	2	3	1,67	0,4
2012	20	0	2	0,67	0
Total	**208**	**3**	**15**	**1,22**	**0,14**

Tab. 2 Accidents in the section "Pernik - Vladaia" (Aggregated data)

The distributions and estimations of road accidents are presented in tables 3, 4, 5 and 6, depending on the weather conditions, the condition of the road surface, the brightness of the place of accident and visibility of the road and its infrastructure.

Year	Clear	Cloudy	Rain	Drench	Snowfall
2008	31	15	6	8	4
2009	23	16	6	–	3
2010	25	10	5	–	–
2011	19	9	–	4	4
2012	15	–	5	–	–

Tab. 3 Distribution of accidents according to the weather condition

Year	Dry	Wet	Snowfall (taken measures)	Mud
2008	35	27	1	1
2009	33	14	1	–
2010	30	10	–	–
2011	28	8	–	–
2012	15	5	–	–

Tab. 4 Distribution of accidents depending on the road surface condition

Year	Daylight	Twilight	Artificial lighting	Dark
2008	42	6	13	3
2009	39	5	3	1
2010	27	6	6	1
2011	21	4	6	5
2012	10	5	2	3

Tab. 5 Distribution of accidents according to the brightness of the place of accident

Year	Excellent	Good	Poor	Unsatisf actory
2008	5	37	18	4
2009	1	31	15	1
2010	–	27	12	1
2011	15	13	4	4
2012	7	9	2	2

Tab. 6. Distribution of accidents according to the visibility of the road and its infrastructure

Most accidents occur in normal weather conditions: in clear weather - 113 or 54% (Tab. 3), dry roads - 141 or 68% (Tab. 4) and good visibility - 117 or 56% (Tab. 5). For the period between 2008 and 2012, there is no data for the passing vehicles and their distribution along the entire length of the road.

It can be assumed with sufficient accuracy that along the road traffic volume was not large and in the variable range. Under these conditions, the density of accidents for the mentioned period for the individual sections can be calculated using the equation:

$$(4)\ K_{da_i} = \frac{N_i}{L_i}, \text{ number of road accidents per km.}$$

From Tab. 2 the density of accidents for the period was 25 accidents/km.

3.2 Analysis of traffic conditions and safety of road section with a high concentration of accidents - I-1B

Terms and criteria for identifying and securing areas with a concentration of road traffic accidents (RTA) and categorizing the safety of roads (road infrastructure), open to the public, are regulated by Ordinance № 5 of the Ministry of Interior of the Republic of Bulgaria from 2003.

In the present 'Pernik - Vladaia' road section there is an area with high concentration of accidents (black spot), which is the intersection of Rudartsi. The identification number of the section is I-1B, with length of 300 m. The relative indicator of accident rate U_r (column 5 of tab. 7), according to the ordinance is given by:

$$(5)\ U_r = \frac{Z \cdot 10^6}{T \cdot Q \cdot L}, \text{ number of road accidents/ 1 mln. vehicle km,}$$

Where:

Z - number of accidents, occurring in researched road section for one period;

Q – average daily traffic volume for the same period of time (vehicles per day);

L – length of the road section (km);

T – number of days in which Z number of accidents have occurred, i.e. T = 365.

The severity of accidents occurring in the Rudartsi intersection (column 6, tab. 7) is defined as the ratio between the number of those who have been killed and/or injured and the total number of accidents.

Year	*Traffic accidents*	*Killed*	*Injured*	*Ur*	*Severity of accidents*
2008	34	0	3	11,089	0,059
2009	27	0	2	4,251	0,074
2010	29	1	0	6,621	0,034
2011	22	0	1	4,18	0,04
2012	11	0	1	3,15	0,09
Total	**123**	**1**	**7**	**5,86**	**0,06**

Tab.7 Aggregated data on accidents in site I-1B

The distributions and estimations of accidents in site I-B are presented in tab. 8, 9, 10 and 11, depending on the weather and road

surface conditions, the brightness of the place of accidents and visibility of the road and its accessories.

Year	Clear	Cloudy	Rain	Drench	Snowfall
2008	34	7	4	2	2
2009	13	11	1	–	2
2010	19	7	3	–	–
2011	13	7	–	1	1
2012	9	–	2	–	–

Tab. 8 Distribution of accidents according to the weather condition

Year	Dry	Wet	Snowfall (taken measures)	Mud
2008	23	9	1	1
2009	18	8	1	–
2010	24	5	–	–
2011	16	6	–	–
2012	9	2	–	–

Tab. 9 Distribution of accidents depending on the road surface condition

Year	Daylight	Twilight	Artificial lighting	Dark
2008	23	3	7	1
2009	25	1	1	–
2010	23	1	5	–
2011	16	1	4	1
2012	6	3	2	–

Tab. 10 Distribution of accidents according to the brightness of the place of accident

Year	Excellent	Good	Poor	Unsatisfactory
2008	–	26	8	–
2009	–	21	6	–
2010	–	23	6	–
2011	11	9	–	2
2012	5	5	–	1

Tab. 11 Distribution of accidents according to the visibility of the road and its infrastructure

Most accidents occur in clear weather - 88 or 72% (Tab. 8), on dry roads - 90 or 73% (Tab. 9) and good visibility - 84 or 68% (Tab. 11).

The most of the accidents occur during the periods of most active movement during the day, i.e. with the highest traffic volume. There is a rise in accidents due to poor perception of the movement and the road from drivers in the darkest part of the day. Drivers underestimate the situation and risk more than in conditions of poor visibility. The same applies to traffic movement on dry roads. Drivers are more careful and cautious on wet and snow-covered roads. Approximately 90 % of the accidents occur on straight horizontal sections. The obvious reason here is the absence of fast lane.

The most common accidents in the area are a consequence of driver's fault and are 'crashes with a moving vehicle ahead' and 'collisions between vehicles'. There is no practice in indicating poor road and weather conditions in 'Traffic Police' reports as a reason for an accident, although one of the accident causes is loss of control due to attempt of the driver to avoid bumps and holes in the lane. Most often the main reason related to road accidents is speeding, which does not allow the driver to avoid the collision. Other reasons include failure to comply with the necessary distance, which is a prerequisite for avoiding accidents or withdrawal of advantage. A small percentage of accidents are caused by inexperienced drivers or due to technical fault in the vehicle. Information processing allows a pooled analysis of the road section characteristics, contributing to the accident realization, to be made.

4. Activities for improvement of road conditions and safety

Based on the analysis, carried out in surveys and taking into account the objective and subjective factors the following measures can be identified to improve road conditions and safety in Bulgaria:

- by the supervisory authorities of 'Traffic Police': making arrangements for the exercise of active control, use of new tools for operational monitoring of traffic and the behavior of road users; increased control over compliance with the speed; zero tolerance for drivers engaged in serious violations of the Law of Road Traffic;

- by road users: learning the techniques and skills to control vehicles in complex traffic conditions, introduction to the benefits of timely information on the state of the road and the traffic conditions; targeted set of measures for younger and older drivers (over 65), introduction to the benefits of active and passive safety;

- from the bodies of administrative management (municipal and regional governments): to draw attention to the maintenance of markings and lanes; strict control over companies concerned with the excavation of roadways for maintenance and quality control of pavement reconstruction, continuous information on the Internet about the current status of road conditions and traffic in the area, construction of information equipment for speed registration and visualization of violations for places with high concentration of accidents. It is necessary that the road sections meet modern requirements for quality infrastructure.

5. Conclusion

The serious deficiencies in the training and qualification of drivers lead to increased number of accidents due to speeding and inability to respond quickly and adequately in distressed situations. The low road culture of the majority of road users violating traffic rules, poor state control and unsatisfactory road infrastructure conditions lead to the occurrence of accidents, which are enormous material and personal loss for society. It is necessary to identify priority areas in which traffic safety organizations to work. An interaction between state institutions is necessary to improve road safety at national, regional and municipal level.

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ANALYSIS OF HAZARDS OF SEA ENVIRONMENT FROM WEST POMERANIAN SEA FISHING FLEET

ph. d. eng Marcin Szczepanek
Maritime University of Szczecin, Faculty of Maritime Engineering Institute of Marine Power Plants Operation, Waly Chrobrego1/2, 70-500, Szczecin, Poland

m.szczepanek@am.szczecin.pl

Abstract: *The paper presents analysis of hazards of sea environmental pollution by lubricating and hydraulic oils based on the west Pomeranian Sea fishing fleet. The analysis of hazards of environmental pollution has been presented here while on lubricating and hydraulic oils are used. The purpose of the Paper is to provide additional controls mitigate potential hazards.*

Keywords*:* ENVIRONMENT, POLLUTION, OIL, FISHING FLEET

1. Introduction

Factors influencing sea environment could be formally divided into 2 groups:
influencing sea waters and influencing atmosphere.

All the wastes from fishing crafts sent to sea waters directly or indirectly, intentionally or unintentionally can be included in group 1. The quantity and type of these wastes depend on many factors, such as:

- technical equipment,
- size of the craft,
- craft equipment with fishing devices,
- craft equipment with accommodation equipment,
- crew members number,
- pro-ecological education of the crew

Following the subject of the paper the hazards analysis for the environment as a result of oils disposal on cutters and fishing boats has been presented.

2. Hazards associated with lubricating oils

Engine lubricating oils pollute the environment while being produced and on every level of their usage: being transported to the users, being stored, during engine operation and during their disposal and recycling after their time of operation. Each of the mentioned levels presents different type of hazard and depends on the following factors:

- possibility of the recycling of oil wastes or the used oil,
- working conditions of the device in the diesel engine,
- chemical compound of the oil,
- possibility of the oil biodegradation,
- way of using the oils

Working conditions of the engine oil determine its consumption and quality (temperature influences the intensity of physic-chemical processes mainly, e.g. oxidation.)

Chemical compound of oil is a decisive factor for the environment and it also determines the most ecological and economical way of oil recycling.

The level of toxicity is different and it depends on the components structure, yet they are generally hazardous to soil and water.

There are installed engines of total power 31827 kW [7,8] on cutters and fishing boats on the west Pomeranian Sea fishing fleet.

It is estimated that the quantity of the required lubricating oil during normal operation of engines amounts from 0,3- 0,5 kg of oil/engine power in kW.

Considering the fact that there are old generation engines on cutters and fishing boats, their operating consumption should be estimated for 5g of oil/kWh. For new generation engines the consumption of oil is about 3g/kWh.

The consumption of oil in the fishing float can be calculated according to the algorithm:

$$\mathbf{C = (3 \text{ or } 5) \cdot P \cdot UP \cdot FD \cdot 24 \cdot 10^{-6}\ [ton]}$$

Where :

C – Consumption of lubricating oils in fishing fleet
P – Total power of the installed engines on fishing crafts
UP –Simultaneity coefficient of the used power for the installed engines
UP = ∑ used power during fishing days /total installed power
FD – Number of fishing days

3. Hazards associated with emission to atmosphere.

Quality, composition and physic-chemical properties of the engine oil are an important operating factor of the engine which may influence highly the composition and level of toxic emissions being created during the engine operation process. Oil influence on the m/a factors is a complex phenomena and not totally known. The research was done by Manni, Flori and Gommellini [4,5].

Toxic components emission is connected strictly with oil consumption by the engine. The relation of cause and effect between the intensity of oil consumption and the level of toxic compounds emission has been described in publications [2,3]. It refers mainly to hydrocarbons (PAH as well) and diesel particulate filters.

The increased consumption of the engine oil is connected with many processes inside the cylinder and their effects, such as: [1]

- Scraping oil by a set of rings to the combustion chamber.
- Increased and thicker oil layer remaining on the cylinder after piston movement and average temperature rise of this layer.
- Absorption and desorption processes of fuel vapours and oil.
- Adsorption by soot (or other particles) of fuel vapours.
- The increase of vaporized oil because of cavitation

The main influence on the harmful factors emission coming from lubricating oils to atmosphere is caused by technical equipment such as:

- Type of the oil used,
- Engine construction
- Technical condition of the engine

From 50 % to 70 % of the used oil is emitted to the atmosphere. Having in mind the m/a data it is possible to calculate the quantity of toxic substances emitted to atmosphere (E) from lubricating oils of fishing boats engines, applying the given below algorithms.

$$E = (3 \text{ or } 5) \cdot 0.5\ P \cdot UP \cdot FD \cdot 24 \cdot 10^{-6}\ [ton]$$

Where :

E – quantity of harmful substances emitted to atmosphere from lubricating oils
P – Total power of the installed engines on fishing crafts
UP – Simultaneity coefficient of the used power for the installed engines
UP = ∑ used power during fishing days /total installed power
FD – Number of fishing days

Taking into consideration the received calculated values of toxic substances emissions from lubricated oils used by fishing fleet to atmosphere, it should be noted that the quantities are frighteningly huge, despite the fact that they are calculated as minimal ones and they can be higher practically. The errors in real calculations come from difficulties of coefficients practical determination for calculated algorithms and that is why the received calculated coefficients could be regarded quite optimistic. Due to their peculiar toxicity, atmosphere pollution coming from this source is extremely high. The quantity of emission depends strictly on annual average number of engines working hours.

It is worth-noticing that for new generation engines calculated average toxic substances emission from lubricating oils is more than twice lower in comparison with the old engines emission.

Oils coming from kerosene or esters which lost their operating properties and cannot be applied for their primary purposes any longer are considered the used ones, as well as oil – water mixtures.

According to Polish ecological law, the used oils are recognized as hazardous.

Fishing boats engine operation is the source of the used oil "production". The used oil can enter sea waters because there aren't any recycling devices for the used oils on fishing boats and there isn't any system for their disposal/collection in ports or fishing berths. Due to outdated engine construction and their sealing systems, we may say that the used oil as leakages enters bilges and it is next pumped out to sea waters. There are no oil separators because of the size and complexity of their installations. It is estimated that leakages amount up to 10% of the used oil. Fishing boats leakages could be regarded as simple drop to sea waters.

"The drop" with reference to toxic substances or outflows containing such substances means any, without any reason, discharge, removal, spillage, leakage, pumping out, emission or emptying.

The quantity of used oils coming to bilges as leakages is the function of engine working hours and their technical condition. The quantity of used oils coming to bilges as leakages on boats (B) can be determined according to the algorithm:

$$B = (3 \text{ or } 5) \cdot 0.1\ P \cdot UP \cdot DP \cdot 24 \cdot 10^{-3}\ [ton]$$

Where:

B – Quantity of lubricating oils leakages
P – Total power of the installed engines on fishing crafts
UP –Simultaneity coefficient of the used power for the installed engines
UP = ∑ used power during fishing days /total installed power
FD – Number of fishing days

It can be noticed that hundreds tons of oils coming from engines operation on fishing boats and cutters can enter sea waters. Such quantity of harmful substances coming into sea waters influences biological life development there very badly - because:

- It limits light access for the development of zoo and phytoplankton due to creation of oil film on the water surface.
- Living organisms, fish and zooplankton absorb harmful substances from lubricating oils (PAH).
- The quality of fish food gets worse (zoo and phytoplankton) with toxic chemical substances and leads to limited reproduction of fishes.
- Seaside areas get less attractive for tourists.

4. Hazards associated with hydraulic devices

West Pomeranian Sea fishing fleet crafts use hydraulic fishing devices –hydraulic winches. Hydraulic oils used in their hydraulic systems are a potential pollutant for the Baltic Sea. Hydraulic oil high working pressure, lots of load and often overload of hydraulic winches, outdated construction and the age of the devices are the reason of frequent pipeline, hydraulic joints or seals breaks leading to hydraulic oils leakages to bilges in the boats. The oil is a potential "drop", similarly as the used oil or the oil from operating engine leakages.

Having in mind the specific hydraulic systems described above, probability of the hydraulic system breakdown resulting in oil leakage can be estimated as 0.25. There is about 150 l of hydraulic oil on average in hydraulic systems of fishing boats and cutters. The average oil leakage quantity from the system due to a breakdown amounts to about 10% of the used oil volume in the hydraulic system. The quantity of the hydraulic oil used on fishing boats can be determined according to the algorithm:

$$CHO = 0.25 \cdot 0.1 \cdot N \cdot C \cdot HW \cdot FD/365\ [\text{litres}]$$

Where:

CHO – consumption of hydraulic oil by west Pomeranian Sea fishing fleet
HW – simultaneity coefficient of the hydraulic winches used
HW = ∑ crafts using hydraulic winches during fishing days/ total number of crafts with hydraulic winches (205 crafts)
FD – Number of fishing days
C – Average capacity of the hydraulic system (150 L)
N – Number of crafts with hydraulic winches

Summary

In order to improve the situation and reduce the risk of marine environment pollution, active and reactive policy of risk management should be introduced:

- Introduction of pro –ecological education for fishing crews.
- To modernize the fishing craft to match the eco-friendly standard.
- Effective introduction of the best accessible technology and the best ecological procedure.
- To modernize or exchange the propulsion engines to meet the requirements of emissions ecological criteria. It is extremely important to use proper constructions and materials for different sealing in engines, in order to limit the negative influence of lubricating oil on natural environment. The choice of elastomers used for sealing has to be exceptionally careful - having the working temperature in mind and the chemical composition of the used oils. At present, up-to-date elastomers provide proper interaction with basic mineral oils.

- Introduction of the disposal for used oils, bilges polluted with lubricating or hydraulic oils and the improvement of fishing ports and berths to match the standards determined by conventions.
- Introduction of understandable to fishing crews, ecological procedures for each operation and emergency procedures as well.
- Introduction of clear and effective control procedures for wastes and their disposal management by state administration
- The use of lubricating oils following EKO and Energy Conserving criteria, biodegradable.
- To exchange or modernize the existing hydraulic systems on the crafts - if applicable.

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PROECOLOGICAL ENERGETIC SYSTEMS FOR FISHING CUTTERS

ph.d. eng. assoc. prof. Cezary Behrendt
Maritime University of Szczecin, Faculty of Maritime Engineering Institute of Marine Power Plants Operation, Waly Chrobrego1/2, 70-500, Szczecin, Poland

c.behrendt@am.szczecin.pl

Abstract: *In view of the hazards to the environment resulting from operating fishing cutters, a proposal for energy saving and proecological energetic systems for these vessels is presented in this paper. It also demonstrates the significance of the proecological energetic systems, includes a review of the impact of fuel type, renewable energy sources and energy conversion methods on the degree of the hazards to the environment. The proposed solutions regarding the energetic systems refer to the fishing cutters of the length from 15 to 30 m. The solutions are divided into two groups according to currently available technologies and future technologies allowing for alternative energy sources to be applied.*

Keywords: FISHING CUTTERS, ENERGETIC SYSTEMS STRUCTURE, ECOLOGY

1. Introduction

The marine fishing industry constitute a major food supplier. This task is performed by fishing fleets belonging to the particular countries. The Polish fishing fleet operating at the Baltic Sea, in 2013, comprised of 142 of the fishing cutters the length of which equaled from 15 to 26 meters, while in 2004 there was 411 fishing cutters operated [3]. Such a considerable decrease results mainly from the catch limits, compensations granted to fishermen for vessels' scrapping and from the age of the operating fishing cutters, most of which is over 30 years old [2,3]. The energetic systems of the Polish fishing fleet, due to the old generations and the long operation periods of machines and devices, are characterized by high energy consumption and considerable environmental load [2]. Grants from the European Fisheries Fund allow for obtaining financing only for the replacement of engines for the main propulsion system with the engines of newer generation with less fuel consumption, which very frequently, does not provide an expected improvement of the operational properties of the propulsion system [2].

The reduction of the energy consumption of the energetic system may be obtained by a comprehensive approach to the issue by: a development of concepts and system design, the selection of energy saving and proecological machines and devices, drawing up and the implementation of energy management procedures.

When designing prospective energetic systems for the fishing cutters, an option of using alternative fuels and renewable energy sources should be considered, too.

Such an approach during a design process is furthermore in compliance with the sustainable development principle, strongly promoted in the European Union states, which consists in the integration of ecological, economical and social goals, the IMO requirements regarding the environmental protection and the Code of Conduct for Responsible Fisheries developed by FAO [5].

Aspiration to the sustainable development, in practice, requires:

- closing material cycle: raw materials – production processes – product use – waste and impurities – after utility raw materials,
- the reduction of energy consumption by increasing energy efficiency [7], the use of the renewable energy sources and the alternative fuels,
- quality promotion including, but not limited to, in terms of product durability, the minimization of waste and the environment protection.

This paper presents the developed conceptions of the energetic systems for the fishing cutters of the length up to 30m, divided into projects in which modern technologies were applied and prospective projects including future technologies.

2. Significance of proecological energetic systems

The most beneficial impact on the environment protection may be achieved when certain actions, involving mainly the improvement of the existing technologies and the development of new ones, are undertaken at a design stage. The proecological designing will, inter alia, contribute to the reduction of generated waste and impurities, the limitation of materials' and energy resources' consumption. Above all, a product, which in the particular case is a fishing cutter, should have higher energy efficiency and its operation should have the least effect on the environment.

The processes of generating mechanical energy, electricity and heat for the fishing cutters include the opportunities for actions directed at the improvement of energy and environmental indicators. The most significant are:

- further development of internal combustion engines, boilers, electric generators and auxiliary devices and control systems leading to the improvement of ship energetic system efficiency and the reduction of the burden on the environment,
- the wider use of alternative liquid and gas fuels, in particular hydrogen,
- the implementation of fuel cells in connection with hydrogen application
- the use of hybrid systems based on fuel cells and heat engines
- the use of energy from renewable sources,
- energy use rationalization.

Certain abovementioned actions require a comment. The use of energy from the renewable sources is strongly promoted in the European Union member states. Not all onshore technologies, using renewable energy sources, may be efficiently applied at ships. One of the physical properties of the renewable energy is its low density when compared with the conventional energy. For instance, solar radiation is characterized by a density <1,33 kW/m2, wind by a density <3 kW/m^2, while e.g. coal combustion in a boiler is a value of 500 kW/m^2 [4,6,12]. This property of the renewable energy causes that it is hard to use it at ships, in particular at small vessels, where the space is limited. Nonetheless, in case of bigger cutters it is worth to consider to use photovoltaic panels installed at the roof of the superstructure. Return to sail supporting main propulsion system may also be intentional. The actions aiming at using the energy from the renewable sources refer also to biofuels.

Hydrogen, the wider use of which is also postulated in shipbuilding, is a perfect fuel in terms of the environment since water is a product of the combustion process. In nature, hydrogen in a free form occurs in a small amount as it combines easily with other chemical elements. Its resources are considered to be an infinite supply as it is a water component and together with it circulate in a closed cycle in the nature. However, in order to

produce hydrogen, energy is necessary. That causes that at the current conventional fuel price level hydrogen is less attractive. Nowadays the most of hydrogen is obtained from the decomposition of hydrogen-rich compounds, including hydrocarbon fossil fuels, which also involves CO_2 emission. If hydrogen is intended to replace hydrocarbon fuels then its production should be related with the use of the renewable energy. Only with such a production method hydrogen is a clean fuel.

Figure 1 presents a scheme showing how fuel type selection or the renewable energy sources and the solutions regarding the propulsion in an energetic system for a fishing cutter affect the environment load.

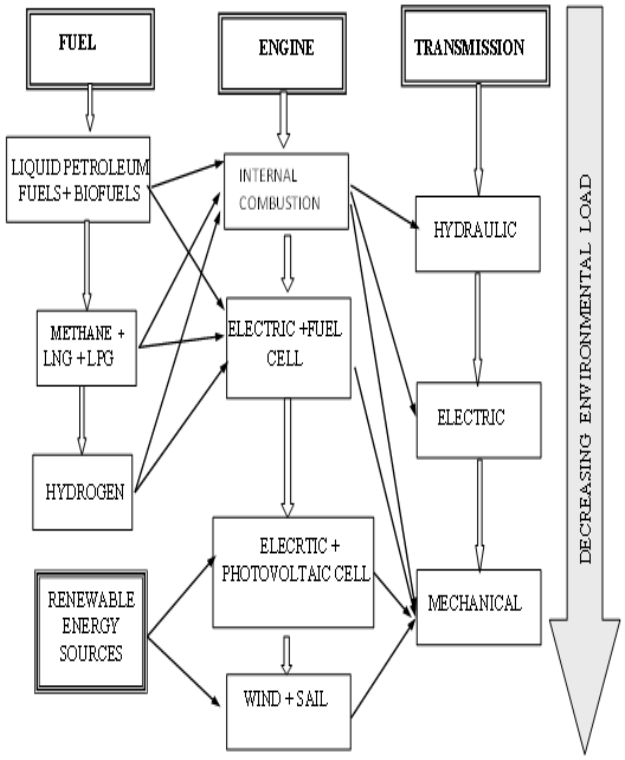

Fig.1. *Impact of energy source and propulsion system configuration on environmental load*

Figure 1 contains liquid and gas fuels which may be used at the ships. The renewable energy sources, as an alternative to the fuels, are included given the fact that their use has the minimum impact on the environment. In that case they are solar energy and wind energy. The proposal to install wind engine as the least burdensome environment may be also debatable, because in effect its impact on the environment is comparable with a photovoltaic cell supplying an electric motor.

Summing up, using the components listed in figure 1 leads to the development of a propulsion system that is more environmental friendly and energy saving, and thereby the entire energetic system for a fishing cutter.

3. Proposed energetic system

Complex energetic systems are at the fishing cutters in question. They consist of more technological devices of the higher total energy demand. Therefore, a proper solution regarding the energetic system is of particular relevance. In that group of the energetic systems many opportunities providing high efficiency occur. The selection of an appropriate energetic system will depend on the specific balances of mechanical energy, electricity and heat.

For instance, the systems with two engines for the main propulsion system may be considered. Such a system, presented in figure 2, is characterized by the high power availability of the wide range of variable operational conditions. An open issue is a power share of each engine i.e. whether to adopt two identical engines or of diversified power. Such solutions also increase propulsion system redundancy. An alternative to the above may be, presented in figure 3, an energetic system occupying less space in the engine room with the use of a shaft generator, which may work also as an electric motor supplied by an auxiliary power generator set. Due to that an auxiliary or emergency propulsion system is provided. Such system's efficiency is slightly lower comparing to a system with two internal combustion engines driving the propeller by a mechanical gear. The final selection may be determined by an engine room size and operational issues. The said systems also include a boiler for heat generation. It should be also mentioned about recommended waste energy use contained mainly in the engine cooling water.

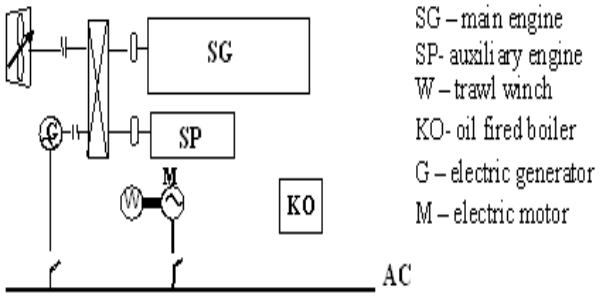

Fig.2. *Energetic system scheme for a fishing cutter with two internal combustion engines*

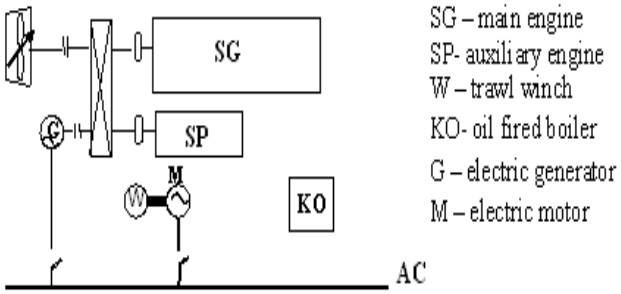

Fig.3. *Energetic system scheme for a fishing cutter with internal combustion engine and shaft generator operating as engine*

Particularly recommended solution regarding the energetic system is a system corresponding to a concept of all electric ships [1]. The proposed solution of such a system is presented in figure 4.

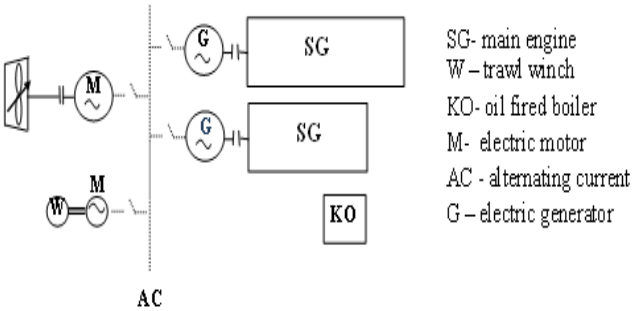

Fig.4. *All electric ship energetic system scheme*

As presented in the figures 2-4 it is possible to use hydraulic drive for winches instead of the suggested electric propulsion, however, the electric system is subsequently less effective.

4. Prospective energetic systems

It is essential that the decreasing resources of petroleum were taken into consideration upon developing solutions regarding prospective energetic systems for the fishing cutters and basing their work on unconventional fuels. In the short term it will also be possible to use natural gas since its resources are bigger than petroleum. Whereas, in the long term, only unconventional fuels as biofuels or hydrogen are remaining. Temporarily, it may also be intentional to use hybrid propulsion systems based on the

conventional energetic systems in relation with the unconventional energetic systems.

The use of hydrogen as the fuel is usually associated with storage problems due to its specific volume which results in the fact that its supplies require a large volume. In case of the fishing cutters with very limited autonomy usually to 72 hours, the issue virtually does not exist. The use of hydrogen as the fuel is possible not only in piston internal combustion engines but also in fuel cells constituting an electricity source.

For small vessels such as fishing cutters, low-temperature fuel cells may be particularly useful, especially PEMFC (Proton Exchange Membrane Fuel Cell) deemed as the most prospective [9,11]. They are characterized by low work temperature not exceeding 100˚C, high density of generated current, short, measured in seconds, start-up period and the possibility of fast load changes. The efficiency of such systems is at the level of around 40%-50% and is higher than the efficiency of internal combustion engines of low power installed on the fishing cutters. The difference is even more noticeable in the partial loads on which internal combustion engines operate less economically than on the nominal load. However, the efficiency of the cells in that case is considerably higher. Such cells are promised to be used extensively in the automotive industry. Apart from the undoubted advantages presented above quite long durability should also be mentioned for this type of cells as well as the lack of competition for them in the ecology field.

The energetic system based on the fuel cell comprises of, except the cell as an electricity source, an inverter converting direct current generated in the cell into alternating current, batteries and electric motors.

One of the advantages of the fuel cells is that water is a byproduct of the reaction of so called hydrogen cold combustion in the cell and therefore due to that there is no need to ensure water supplies. Such a solution eliminates the necessity to dedicate separate room for technical water tanks and reduces the vessel weight. There is also an opportunity to use waste heat from the cell cooling system.

Nevertheless, it appears to be the most realistic in the near future to use the cells as emergency electricity source or to supply the propulsion system during sailing at low speed in ports or at water areas covered by restrictive regulations on exhaust gases toxic components or noise emission. The fuel cells may be also a very good alternative for diesel engine generator sets. Their use in that case comes down to produce electricity only in a limited period e.g. during maneuvers or stay at a port. They may also be used as a local energy source for individual receivers at a vessel.

The energetic system for the fishing cutter with the fuel cell as an auxiliary power source is presented in figure 5 below. While figure 6 shows the energetic system entirely based on the fuel cell, which shall be treated as the furthest prospect for execution.

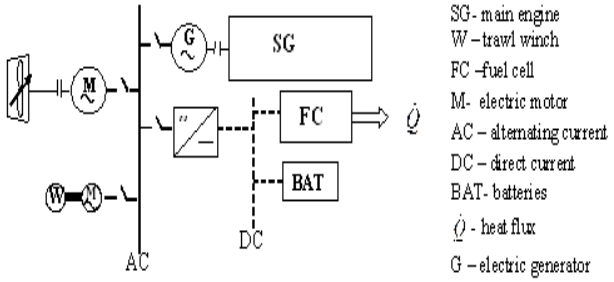

***Fig.5**. Energetic system scheme for fishing cutter with fuel cell as auxiliary power source*

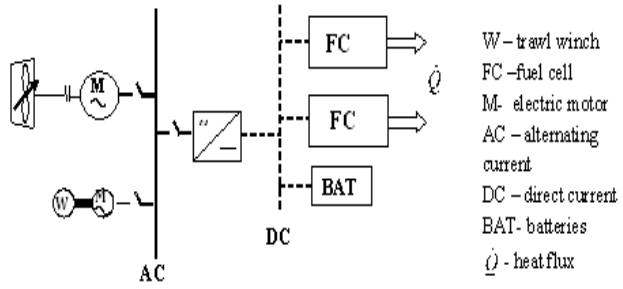

***Fig.6.** Energetic system scheme entirely based on fuel cell*

Although costs regarding the energetic system solutions based on the fuel cells are still significantly higher than the cost of the energetic system solutions with internal combustion engines, their development potential should be borne in mind. Further price reduction should be expected upon cell volume production is commenced for vehicles.

Another prospective energetic system that may be applied, in particular at small fishing vessels using passive fishing gear, may be the hybrid system [4], which apart from an internal combustion engine, comprises also of the electric motor, supplied by batteries charged from the photovoltaic cell or from the shore.

Figure 7 presents a scheme of the energetic system with a photovoltaic panel.

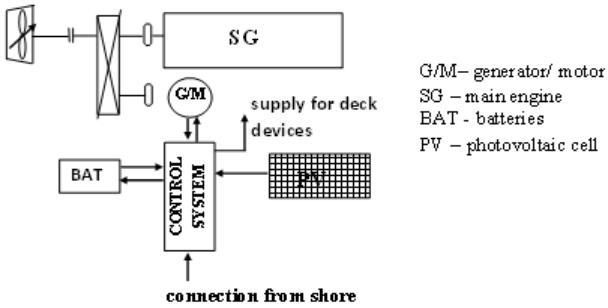

***Fig.7.** Scheme of hybrid system with photovoltaic cell*

It is also possible to charge the batteries by the internal combustion engine when the electric machine operates as a generator. The propeller may be propelled by the internal combustion engine itself, by the electric motor itself or by both engines simultaneously. Sailing using only the electric motor, beyond the emission limitation of harmful exhaust gas components, has also an advantage that the energetic system does not emit noise.

Summary

The energetic system proposals for the fishing cutters presented in the paper are the concepts with regards to the modern and future technologies which may be applied in the shipbuilding, providing the reduction of energy consumption and impact degree on the environment. In order to select the solution for a specific vessel, the system efficiency should be determined, demand for mechanical energy, electricity and thermal energy should be specified on the grounds of an energy audit as well as machines and devices should be fitted.

The energies' demand is significantly affected by the hull resistance which depends on it shape, by catch type and the fishing gear related thereto. These issues are not presented in the paper as they have no decisive impact on the energetic system configuration. The employees of the Marine Engineering Faculty of the Maritime University of Szczecin have conducted research on marine energy issue for many years. An energy audit methodology has been developed [10], energy research has been carried out [2,3] as well as an energy audit of a number of the fishing cutters. The possibility to use LNG as the fuel has also been considered [8]. The research are implemented in close cooperation with fishermen, scientific and research institutions in

Poland and abroad and with the financial support from the European Union within the granted projects.

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A ROLE OF INTERNATIONAL TOURIZM IN REGIONAL DEVELOPMENT OF GEORGIA

РОЛЬ МЕЖДУНАРОДНОГО ТУРИЗМА В РАЗВИТИИ РЕГИОНОВ ГРУЗИИ

Assoc.Prof. Dangadze i., Assoc.Prof. Chogovadze J.
Akaki Tsereteli State University, Kutaisi, Georgia
dangadze55@mail.ru jumberi54@gmail.com

Abstract: *The role of international tourism in economic development of Georgia and its regions is very large, which involves such significant tourism objects as customer-travel agents-tour operators- tourist transport services providers. With account for interests and demands of customers, the key things here are correct planning and operative management of such complex material-information processes, as tour formation and realization. International Tourism is a highly effective basis for foreign currency inflows to the country. An advantageous form of tourism export is capable of solving a number of social and economic problems for those countries, which actively develop tourism sector*

KEY WORDS : *International tourism**;** transport services.*

1. Introduction

Tourism came into everyday life of hundreds of millions of people, and became an integral part of modern life. Due to the rapid pace of development of tourism it is often called a phenomenon of 20^{th} and 21^{st} centuries. In 2012, about 1 billion of international tourist arrivals were recorded by World Tourism Organization (WTO) that exceeds a similar indicator for 1950 by 40 times. International tourism in many countries became one of the leading sectors of the economy and the reliable source of incomes to the budget. International Tourism is a highly effective basis for foreign currency inflows to the country. An advantageous form of tourism export is capable of solving a number of social and economic problems for those countries, which actively develop tourism sector. The share of tourist servicing in total revenues of international trade is about 7%, and they remain behind just such sectors as oil products and motor-cars export. According to international data the revenues of international tourism are expected to be doubled during the period of 2008-2014.

About 5 thousand companies are registered on the World Travel Market in London. Practice shows, that the strengthening of the role of international tourism concerns with Georgia as well, where the development of international tourism gathers the rapid paces.

2. Preconditions and means for resolving the problem

of 20th century, the international tourism acquired universal nature that resulted in formation of the world tourism market, in which all the countries are involved. On average 65% of international tourist travels is made to the European countries, 20% - to USA, 15% - to other regions. According to the World Tourism Organization, 21st century will be a tourism century. The influence of of international tourism on the development of the country and its regions as well, (Fig At the beginning.1)

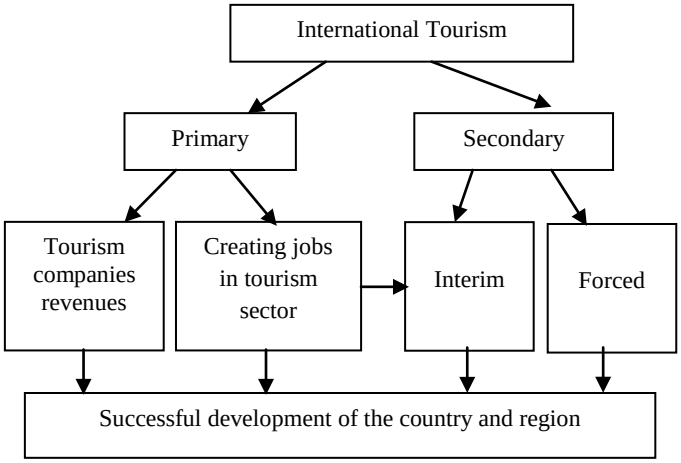

Fig. 1. The influence of international tourism on the development of the country and its regions

By tourist service cost per capita the countries are subdivided into three groups: over $500, $150-500 and $150 and lower (Table 1).

Average annual tourism costs per capita ($)

Table 1

Over 500	150-500	150 and lower
Kuwait	Great Britain	Korea
Austria	Finland	Iceland
Norway	Canada	Hungary
Switzerland	Australia	Ukraine
Singapore	Italy	Argentina
Belgium-Luxemburg	France	Rusia
Denmark	Japan	Romania
Netherlands	Czech Republik	Thailand
Israel	USA	Turkey
Ireland	Poland	China
Germany	Georgia	

The complex factors influencing the development of tourism industry subdivided into two groups as follows:

1.Political, economic, socio-demographic and cultural

2.Factors influencing tourism development and they are often used by tourism organizations in their activities (construction of new tourism infrastructure, personnel development, technical modernization of tourism facilities, and rational use of material resources, objects and tours).

The paces of development of international tourism over the recent 60 years, its prospective development by 2020, as well as revenues generated from international tourism (USD) are shown in Table 2.

The paces of development of international tourism

Table 2

Years	Number of Tourists	Foreign currency inflows (USD)
1950	25 mil	2100000000
1960	69 mil	6900000000
1970	159 mil	17900000000
1980	284 mil	97 bin
1990	415 mil	230 bin
2000	698 mil	476 bin
2010	1 bil	1100 bin
2020 (fore cast)	1,6 bil	2 trillion

With its economic-geographical location, Georgia is one of the most distinguished countries. Despite smallness of territory, there are combined both plain and mountainous areas, sea and the land. Georgian resorts and tourist destinations long ago had gained international acceptance.

Due to beautiful nature, famous Caucasus Mountains and unique view of the Black Sea Coast, the number of people wishing to receive treatment in Georgian seaside and mountain resorts grows rapidly.

Millions of people have relaxed in Georgia for many years, and over 500 resort-tourism establishments rendered services to them. It should be noted that simultaneously over 120 thousand people were able to receive treatment in our sanatoriums, boarding houses, rest homes, holiday camps and other recreation-purpose establishments. At present, tourism industry in Georgia is redeveloping, so tourism is one again one of the main source of economic revival of Georgia.

Georgia is known with resorts of universal important in both plain and mountainous areas. There are more than 100 well-known resorts in Georgia, some of which have international importance, such as: Bakuriani, Borjomi, Kobuleti, Bichvinta, Akhali Atoni, Mtsvane Kontskhi, etc. Georgia is especially distinguished by existence of balneotherapeutic health resorts such as Tskhaltubo, Abastumani, Nabeglavi, Utsera, Sairme, etc.

According to recent data of National Statistics Office of Georgia, the number of international travelers and volume of revenues generated from them have increased threefold in recent four years. The main goal of the development of international tourism in Georgia is to create a product and promote it in Asian and European countries. In recent five years, the number of international tourists inflowing into the country and revenues from international tourism has been increased considerably (Table 3).

The number of international tourists in Georgia and revenues from international tourism

Table 3

Years	The number of international tourists	The volume foreign currency inflows (USD)
2009	1 500 049	470 285
2010	2 031 717	659 245
2011	2 822 363	938 297
2012	4 389 256	1 800 550
2013	5 000 000	2 500 000

Statistical analysis of international tourists in Georgia in 2013 has shown that the total number of arrivals is as follows:

a) Tourists - 1 935 767 arrivals (39% of total number, growth in comparison with similar indicator of previous year is 17,3%);

b) Transit - 1 094 159 arrivals (22% of total number, growth in comparison with similar indicator of previous year is 55,6%);

c) Other - 1 943 706 arrivals (39% of total number, growth in comparison with similar indicator of previous year is 14,2%).

International tourism industry grows considerably in the regions of Georgia.

In 2013, especially large number of tourist flows was registered at Bagrati Temple. The total number of tourists was 120 795, including foreign travelers – 15 066. With the number of visitors, the first quintuple consists of the following countries: Ukraine – 3120; Israel – 2803; Poland – 1914; Russia – 1233; Japan – 1135.

The marked interest in the Imereti region is observed in the recent period in tourist routes as follows:

1.Kutaisi – Chiatura – Sachkhere;
2.Kutaisi – Tkibuli – Shaori;
3.Kutaisi – Tskhaltubo – Tsageri;
4.Kutaisi – Bagdati – Sairme;
5.Kutaisi – Khoni – Gordi;
6.Kutaisi – Kharagauli – Nunisi;
7.Kutaisi – Gelati;
8.Kutaisi – Sataplia Nature Reserve;
9.Kutaisi - Kumistavi Cave;
10.Bagrati Temple.

At present, under support of Shota Rustaveli National Science Foundation, there are carried out studies of mentioned routes and destinations, on the basis of which there will be created the transport-visitor passports, which will be widely available and they will undoubtedly

increase the capacities of both individual and tourist groups to access these tourist destinations.

The Georgian Tourism Assiciation (GTA) was founded in 2006. It represents the private tourism companies, hotels and guest houses organization, which is aimed to develop such significant aspects in tourism sector, as follows:

- Successful cooperation between the tourism companies in Georgia;
- Cooperation between private and public sector;
- Quality management in tourism industry;
- Accessibility of tourism information;
- Sustainable tourism development in Georgia.

The major business lines of the association are incoming, domestic and outgoing tourism, conduction of educational seminars and trainings, training of professional guides. GTA assists to join to international hotel booking system, dissemination of tourism information, and lobbying, as well offers web-site consultancy, preparing video-materials, marketing support, seminars and trainings.

The Georgian Tourism Assiciation carries out different projects, which assist to tourism development in Georgia. Within these projects, GTA cooperates closely with Department of Tourism and Resorts of Georgia, Agency of Protected Areas, International Donor Organizations (EPF: USAID/SME; GTZ; SDC), local partners (Elkana, GeoLand) and its member companies.

3. Conclusion

It is supposed that for the next fifty years, tourism industry will be one of the real sources for generation of new jobs in number regions of the world, including Georgia. The humanitarian importance of international tourism is increasing that is one of the means for improving the living conditions for population.

4. Literature

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ИНФОРМАЦИОННЫЕ ТЕХНОЛОГИИ В ЛОГИСТИКЕ, ПРИНЦИПЫ ИХ ПОСТРОЕНИЯ И АВТОМАТИЗИРОВАННАЯ ИДЕНТИФИКАЦИЯ

INFORMACION TECHNOLOGY IN LOGISTICS, PRINCIPLES OF THEIR CONSTRUCTION AND AUTOMATED IDENTIFICATION

Академический доктор Русадзе Н.Э.
Государственный университет Акакия Церетели, Инженерно-технический факультет – Кутаиси, Грузия
E-mail:nunukarus@mail.ru

Abstract: *Information systems ensure comprehensive integration of all components of management of material flows, their operative and reliable control. Information and technical support of logistical systems is characterized not only by a combination of technical means and character of information, but by those methods and principles, which are used for construction of them. The problems to be solved are as follows: creation and optimization of the logistics chain links; the semi-constant ones, i.e. management of relatively constant data; production planning; general management of resources; reserves management.*
KEYWORDS: LOGISTICS, CARGO, FLOW, MODEL, INFORMATION, BAR CODE, SUPPLIER, CUSTOMER.

1. Введение

Среди элементов логистических систем важную роль играет «информация». Однако «информация» рассматривается в качестве элемента только на уровне логистической системы. При более детальном подходе, «информация» как элемент, сама по себе преобразуется в сложную информационную систему, состоящую из различных подсистем. Так же как и любая другая подсистема, информационная система должна состоять из упорядоченных взаимосвязанных элементов, а также должна обладать неким единством интегрированных свойств.

Декомпозицию информационных систем на составляющие элементы возможно осуществить по-разному. Чаще всего информационные системы делят на две подсистемы: функциональную и обеспечивающую. Функциональная подсистема состоит из совокупности решаемых задач, которые сгруппированы по признаку общности цели. В свою очередь, обеспечивающая подсистема состоит из следующих элементов: техническое обеспечение, т.е. совокупность технических средств, осуществляющих обработку и передачу информационных потоков; информационное обеспечение, включающее различные справочники, классификаторы, кодификаторы, средства формализованного описания данных; математическое обеспечение, т.е совокупность методов решения функциональных задач.

2. Результаты и дискуссия

Логистические информационные системы, как правило, являются автоматизированными системами управления логистическими процессами. В логистических информационных системах математическое обеспечение представляет собой совокупность программ и средств программирования, которое обеспечивает решение задач по управлению материальными потоками, разработку текстов, получение справочной информации, а также функционирование технических средств.

Организация связи между элементами в логистических информационных системах может значительно отличаться от организации традиционных информационных систем. Это обусловлено тем, что информационные системы в логистике призваны обеспечивать всестороннюю интеграцию всех элементов управления материальным потоком, их оперативное и надежное взаимодействие.

Особо нужно отметить то, что информационно-техническое обеспечение логистических систем отличается не совокупностью технических средств и характером информации, которая используется для их обработки, а теми методами и принципами, которые используют для их построения.

Логистические информационные системы подразделяют на три группы: плановые; диспозитивные (диспетчерские); исполнительные (оперативные).

Логистические информационные системы, существующие в различных группах отличаются как функциональными, так и обеспечивающими подсистемами. Функциональные подсистемы отличаются составом решаемых задач. Обеспечивающие подсистемы могут отличаться всеми своими элементами, т.е. техническим, информационным и математическим обеспечением.

Плановые информационные системы создаются на административном уровне управления и используются для получения долгосрочных решений стратегического характера. Решению подлежат следующие задачи: создание и оптимизация звеньев логистической цепи; условно-постоянные, т.е. управление сравнительно постоянными данными; планирование производства; общее управление ресурсами; управление резервами, и другие задачи.

Диспозитивные информационные системы создаются на уровне управления складом или цехом и используются для обеспечения отлаженной работы логистических систем. Здесь могут решапться следующие задачи: детальное управление запасами (по местам складирования); распоряжение внутрискладским (или внутризаводским) транспортом; отбор грузов по заказам и их комплектация; учет отправляемых грузов и другие задачи.

Исполнительные информационные системы создаются на уровне административного или оперативного управления. Обработка информации в этих системах осуществляется в темпе, что обусловлено современными информационными технологиями. Такой режим работы в масштабах реального времени позволяет получать необходимую информацию о передвижении груза в текущий момент времени, чтобы своевременно обеспечить соответствующее административное или управленческое воздействие на объект управления. С помощью этих систем можно решать различные задачи, связанные с контролем материальных потоков, оперативным управлением обслуживанием предприятия, управлением перемещениями и т.д.

Создание многоуровневых автоматизированных систем управления материальными потоками связано с значительными затратами, главным образам в сфере разработки программного обеспечения, которая, с одной стороны должна обеспечивать многофункциональность системы, а с другой стороны, высокую степень ее интеграции. В этой связи, при создании автоматизированных систем управления в сфере логистики, мы должны исследовать возможность применения относительно недорогого стандартного программного обеспечения с его адаптацией к местным условиям. На сегодняшний день создаются макеты достаточно совершенных программ, однако их можно применять не во всех видах информационных

систем. Это зависит от уровня решаемых задач при управлении материальными потоками.

В соответствии с принципами системного подхода, любую систему мы должны исследовать сначала во взаимодействии с внешней средой, а затем – внутри собственной структуры. Этот принцип – принцип последовательного хода на этапе создания системы – мы должны соблюдать также при проектировании логистических информационных систем.

Уровни в логистических системах с позиции системного подхода:

Первый уровень - рабочее место, где осуществляется логистическая операция по материальному потоку, т.е. перемещается, выгружается, упаковывается и т.д. грузовая единица, деталь или любой другой элемент материального потока.

Второй уровень – в участке, цехе или складе, где происходит процесс транспортировки груза, располагаются рабочие места.

Третий уровень – в целом, система транспортировки и перемещения, которая включает цепь событий, началом которого можно считать момент выгрузки сырья поставщиком. Эта цепь завершается при доставке готовых изделий на место потребления.

В плановой информационной системе решаются задачи, связывающие логистическую систему с совокупным материальным потоком. При этом осуществляется сквозное планирование в цепи «сбыт-производство-снабжение», что позволяет создание ориентированной на потребности рынка эффективной системы организации производства с выдачей необходимых требований в систему материально-технического обеспечения предприятия. Этим плановые системы как бы «подключаются» к внешней среде в логистической системе, в совокупный материальный поток.

В соответствии с концепцией логистики, информационные системы, которые относятся к различным группам, интегрируются в единую информационную систему. Различают вертикальную и горизонтальную интеграцию: вертикальной интеграцией считается связь между плановой, диспозитивной и исполнительной системами с помощью вертикальных информационных потоков; горизонтальной интеграцией считается между отдельными комплексами задач в диспозитивной и исполнительной системах с помощью горизонтальных информационных потоков. В целом, преимущество интегрированных информационных систем заключается в следующем: повышается скорость обмена информацией; снижается количество погрешностей в учете; сокращается объем непроизводительной «бумажной» работы; приходят в соответствие друг с другом разделенные ранее информационные блоки.

Через каждое звено логистической цепи проходит большое количество товарных единиц. При этом, внутри каждого звена товар многократно перемещается в местах хранения и обработки. Вся система перемещения товара – это непрерывно пульсирующие дискретные потоки, скорость которых зависит как от производственного потенциала, так и от ритмичности заказов, размеров существующих запасов, а также от скорости реализации и потребления. Для того, что иметь возможность эффективно управлять этой динамичной логистической системой, необходимо в любой момент времени обладать информацией о детальном ассортименте входящих и выходящих материальных потоков, а также о материальных потоках перемещающихся внутри их. Как свидетельствует зарубежный и отечественный опыт, эта проблема решается при осуществлении логистических операций путем применения к материальному потоку микропроцессорной техники, которая способна идентифицировать отдельные грузовые единицы. Речь идет об устройстве, способном сканировать различного рода штрих-коды. Это устройство позволяет получать информацию о логистиеских операциях в момент их осуществления и на местах – на сладах промышленных предприятий, оптовых баз и магазинов, и на транспорте. Полученная информация обрабатывается в масштабе реального времени, что позволяет управляющей системе реагировать на нее в оптимальные сроки.

Автоматизированная совокупность информации основана на различных штриховых кодах, каждый из которых имеет свои технические преимущества. Существуют различные технологии печатания штриховых кодов, в том числе мастерфильмы, офсетная литография, точечно-матричная печать и др. Если существует электронная связь между информационными технологиями поставщика и получателя товара, тогда информация о товарных кодах, которая составляет партию, об их количестве, а также о базе данных передается автоматически. В случае необходимости, электронная технология передачи информации может быть дополнена раскрытием приложенных документов. При поступлении товара на склад получателя сканируется штриховой код с помощью специального приспособления. Это может быть контактный сканнер-карандаш, портативный лазерный сканнер или стационарное сканирующее устройство. Количество товара в разрезе товарных кодов запоминают с помощью устройства для передачи сбора данных. Затем эта информация загружается в базу данных, где сравнивается с данными по партиям товара, полученных по сети электронной связи. При продаже товара в магазине, кассир считает штрих-код из изделия, отобранного покупателем. Приблизительно 2 секунды требуется для сканирования товара и идентификацию его товарного кода. После этого, касса-компьютер находя в памяти его цену и другие необходимые реквизиты, выносит их на монитор и печатает чек. В момент выдачи чека кассой-компьютером, главный компьютер секции получает информацию о том, что этот товар продан. Получение товара со склада и его реализация осуществляется также с помощью этого компьютера.

Таким образом, система перманентно обеспечивает не только суммарный учет товара, но его количественный учет, организация которого невозможна без кодирования товара. Количественный учет при реализации товара применяется для своевременного пополнения торгового ассортимента. Заказ на ввоз товара в магазин или его доставки в торговый зал, автоматически составленный и переданный электронной сетью, предусматривается запросом, сформулированным на каждой торговой позиции.

Технология применения автоматизированной идентификации штриховых кодов в логистике позволяет значительно улучшить управление материальными потоками на всех этапах логистических процессов. Отметим ее главные преимущества. В производстве: создание системы единого учета и контроля перемещения изделий и комплектующих частей на каждом участке, а также для общего состояния логистического процесса; сокращение количества вспомогательного персонала и учетной документации, исключение погрешностей. В складском хозяйстве: автоматизация учета и контроля перемещения материальных потоков; автоматизация процессов инвентаризации материальных запасов; сокращение логистических времени операций по материальным и информационным потокам. В торговле: создание единой системы учета материальных потоков; автоматизация заказов и инвентаризации товаров; сокращение времени обслуживания покупателей.

Развитие торговых отношений с помощью Интернета способствовало формированию качественно новой логистики, а также внесению целого ряда корректив в традиционную бизнес-логистику. Бизнес-логистика в режиме Интернета построена на общем взаимодействии логистики и компьютера или других автоматизированных средств связи. Такая форма организации логистики называют «Интернет-бизнес-логистикой», или сокращенно «Интернет-логистикой».

Компьютеризация информационных потоков в сфере производства и дистрибуции продукции способствовала развитию новых логистических технологий.

Логистическая информационно-компьютерная технология представляет собой совокупность операций по получению и

обработке информации в реальном режиме времени по показателям и запасам внутренних материальных потоков-ресурсов, незавершенному производству, готовой продукции, грузоперевозкам, параметрам заказов в единой логистической системе. Каждому хозяйственному объекту необходима коммуникация с торговыми посредниками в логистике, банками, страховыми компаниями и непосредственно с конечным потребителем готовой продукции. В развитых странах действует глобальная система спутниковой связи по мониторингу и диспетчеризации транспортировки (Inmarsat).

Глобальная система спутниковой связи «Inmarsat» обеспечивает двухстороннюю передачу текстов и данных с любой точки Земли. Взаимосвязь осуществляется с помощью специальных станций.

Количество сделок, заключенных по Интернету за последние три-четыре года выросло приблизительно в 20 раз. Несмотря на это, владельцам Интернет-магазинов все еще приходится прилагать немало усилий для доставки товаров потребителям. С учетом географического расположения торговых точек, наряду с классической логистикой, ориентированной на потребителя, всесторонне развивается Интернет-логистика сбыта. Она предполагает не только ускоренную доставку товара, а также строгий контроль целой цепи продвижения вперед.

Транспортные компании с определенной осторожностью относятся к перспективам роста электронной торговли. Она больше способствует обострению конкуренции со стороны почтовых и курьерских служб, чем обеспечению роста объема перевозок и прибыли.

Электронная идентификация и электронный паспорт позволяют обеспечивать мониторинг перемещения груза и передавать информацию в онлайн режиме. Использование виртуальных расчетов и систем идентификации позволяет не только сократить время транспортировки, но и оперативно обладать информацией о местоположении определенной партии товара. Эти обстоятельства обуславливают оптимизацию планирования товарных потоков и финансов компании.

Если раньше для успешной реализации проекта решающим фактором был правильный выбор транспортной компании и установление с ней выгодных отношений, то теперь, цены на транспортное обслуживание у всех компаний почти одинаковы. Поэтому для успешной деятельности фирмы важно обладать информацией о транспортном средстве и грузе на определенной территории в определенный момент времени.

3. Заключение

Таким образом, Интернет-логистика сделала еще один к сокращению поиска и заказчиков и накладных расходов. Нужно отметить, что даже в условиях существования различных расчетных систем и порталов в области перевозок, по банальной причине, из-за отсутствия необходимой информации о товаре, а также из-за недостатка рабочего времени, теряется приблизительно 5-10% рентабельных сделок. Менеджеру, работающему в данном рыночном сегменте, в течение дня приходится делать большое количество расчетов потенциальных сделок. Необходимо контролировать все подготовительные процессы, связанные СС сделками по купле-продаже. Необходимо в максимально сжатые сроки найти необходимую информацию, рассчитать стоимость сделки, согласовать условия и проанализировать каждый возможный вариант. На эти процедуры уходит 80% всего рабочего времени.

Огромное значение имеет использование такой логистики в сельском хозяйстве. В отдельных странах, около 30% сельскохозяйственной продукции терялось из-за отсутствия там достаточно развитой инфраструктуры.

Таким образом, решена следующая задача программистов, в случае достижения соглашения с крупными транспортными компаниями, осуществление визуализации карты автомобильных маршрутов с указанием точек перемещения и видов транспортных средств. А это, в свою очередь, позволит существенно сократить количество «пустых» пробегов, увеличить прибыль транспортных компаний и сократить тарафы грузоперевозок. Будет также возможно найти наиболее оптимальные компании для комбинированных перевозок морским, железнодорожным и автомобильным транспортом.

4. Литература

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