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Green Transport

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8. Međunarodno znanstveno savjetovanje - Luke i plovni putovi
8th International scientific conference - Ports and Waterways

ZELENI PROMET
GREEN TRANSPORT



ZBORNIK RADOVA
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Zagreb, 03. listopada 2013.
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PREFACE

Faculty of Transport and Traffic Sciences of University of Zagreb in co-organisation with Design, Operations and Productions Systems Lab of Department of Financial and Management Engineering of University of the Aegean, Croatian Chamber of Economy, Department of Civil, Environmental, Building Engineering, and Chemistry of Politecnico di Bari and Intermodal Transport Cluster under the auspices of Ministry of Science, Education and Sports of the Republic of Croatia and International Sava River Basin Commission organised the eight International scientific conference on Ports and Waterways (POWA 2013), entitled “Green transport”, which took place on 3rd of October 2013 at Croatian Chamber of Economy, Rooseveltov trg 2, Zagreb, Croatia.

Aim of this year conference was to present and analyse research activities and to examine technical and technological innovations within the field of water transport. The papers, posters and presentations, were focused on analysis and development of awareness of green transport, transport safety and security, intermodality and transport market liberalization, legal issues, education and training and transport strategies related to water transport and port planning and management, with emphasis on the Republic of Croatia and the Adriatic sea.

Papers were presented at the conference within presentation session and poster session. Special part of this year conference was GIFT Session, dedicated to the presentation of EU funded research within project GIFT. Other novelty of this year conference was Student Section, organised for presentation of best graduate student papers.

The conference provided a forum for discussion and exchange of ideas, methods, and knowledge between managers, operators, designers and the scientific and academic communities involved in this field.

POWA 2013 is largely supported by the Croatian academic community, economic sector and port communities. The authors of contributions are experts and practitioners, as well as students, from public and private companies and institutions: faculties, polytechnics and schools of professional higher education, research institutes, transport and traffic authorities, port authorities, transport organisations and logistics operators.

We are grateful to all authors for their contributions and to the members of the International scientific committee and members of the Organising committee for their help and great effort invested in activities contributed to the success of the conference and the publishing of this Conference proceeding.

Editors

Zagreb, October 2013

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ANALYSIS OF FACTS OF HUMAN ERRORS

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ABSTRACT

Human error in maritime traffic can be defined as error which is caused by human act. According statistic of maritime accidents it is considered as important cause of maritime accidents.

It is caused mostly because of lack of important information or influence of external and internal inputs which have negative influence at human perception. Wrong perception often leads to wrong conclusions and wrong actions. In this paper authors analyse human error, reasons and consequences of same.

KEY WORDS

Human errors, Maritime accidents, Maritime risks, Technology, Safety

1. DEFINITION OF HUMAN ERROR

It is according to [10] to observe human error directly. It is only possible to observe human error indirectly by observation of human behaviour. Therefore a definition of human error includes three parts:

- Evaluation of human behaviour against performance standard or criterion
- Event which results in a measurable performance shortfall such that the expected level is not met by the acting agent.
- A degree of volition such that the actor has the opportunity to act in a way that will not be considered erroneous.

According to that, the behaviour must be initiated by and be a response to an event or a situation. Otherwise it is meaningless to interpret the behaviour as an error. According to [21] human error is the result of behaviour originated from psychological processes on different levels:

- Perception
- Attention
- Memory
- Thinking
- Problem solving
- Decision making.

From that it can be defined that human error is a result of observable behaviour originated from psychological processes on different levels, evaluated against some performance standards, initiated by an event in a situation where it was possible to act in another way considered to be right. It can be relevant to distinguish between safety critical errors – errors that affect (is a threat to) safety in one way

2. WHY DO HUMAN ERRORS OCCUR?

Even when there has been a mechanical failure, human error can play a role either by way of a lack of maintenance or monitoring (failing to pick up a potential problem), a lack of suitable equipment or protective devices, or a breakdown in communication or procedures (Figure 1).

Crew fatigue and complacency can often be a major factor in incidents. The prudent ship-owners or managers will ensure that these are addressed by way of additional manning or rotating the ship staff more regularly if the ship is employed on a demanding trade route. There are, however, owners and managers who are unable to do this, which could in part be due to a shortage of available trained seafarers, but is more often attributed to commercial or operational considerations.

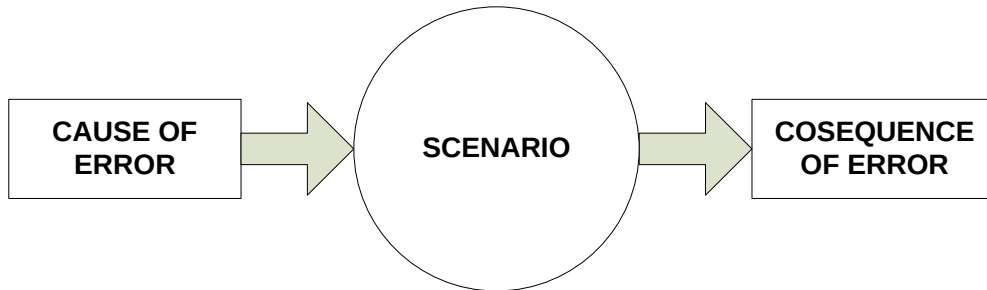


Figure 1. Scheme view of cause and consequence of error

Good equipment can cost more, but safety should be accorded a higher priority, because a ship cannot be operated safely without the seafarer. Crew fatigue might be consequences of company pressure. Estimated Time of Arrival (ETA), port schedule etc. might be often reasons of wrong procedure. Fatigue is often on most of ships because of reducing of crew. Unbalanced workload can be very dangerous because of fatigue. Human Errors are very common because of lack of skills or knowledge (Figure 2). Modern equipment is facilities which are not perfect. Task of seaman is not to reduce those errors than to learn that they exist.

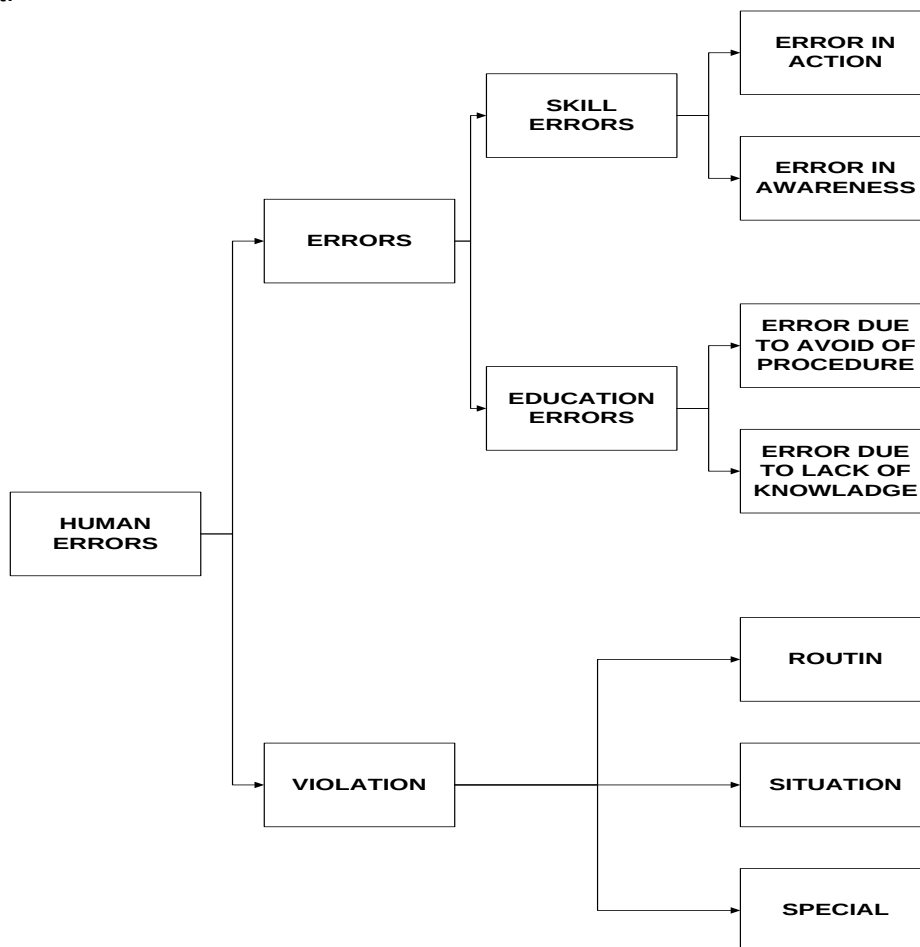


Figure 2. Scheme of cause of human errors

Source: [2]

Because of different way of design of ship's hull and superstructures, *Safety of Life at Sea Convention* –SOLAS in chapter V, Regulation 15 describes permission able bridge ships design. However, SOLAS hasn't proposed yet requirements for ships equipment such as navigation, engine control equipment, cargo control equipment etc. These facts are good for shipbuilders innovative solutions and competition in technology but exceeds time for seaman's familiarization.

3. POSSIBILITY OF HUMAN ERROR

Some study shows that human error was the cause of maritime accidents in 96% of cases. According to the same study, in 93% of cases the cause is human error two or more people [2]. Emphasizes the connection between more events and more people that are necessary prerequisites accident occurring. From the same study shows that for the case of the absence of one of the events, a chain of events resulting in termination. Therefore it can be concluded that it is necessary to find ways of preventing "bad" event because it will be the only way to reduce the likelihood of maritime accidents and increase safety [19].

4. CONSEQUENCES OF HUMAN ERRORS

Consequences of Human Errors Major causes of maritime accidents keep the system of people and human error. Estimated that the approximately 75-96% of marine casualties caused, at least in part by some form of human error. Studies have shown that human error contributes to:

- 84-88% of accidents tankers
- 79% of towing and stranding
- 89-96% collisions
- 75% of fires and explosions[14]

Human error can lead to unwanted behavior. One of the unwanted appearances is stress.

Stress is an adverse psychological condition that occurs as a result of greater discrepancy between the current state and the desired state. Loss of control over the situation leads to tunnel vision and to focus on the currently irrelevant information. Stress causes the human body to the two heavier flat: panic and *cognitive hysteria*.

The panic caused by the inability to cope with the situation. It occurs due to stress and defense of the human organism to the current situation.

Cognitive hysteria is response of the human body in a stressful situation where the same organism defends off the situation. A man who has a cognitive hysteria usually not aware of the current activities, giving priority to small things, you do not want to accept the new situation and sl. Influence of *cognitive hysteria* in crisis situation could be observed in the behavior of the commander of the *Costa Concordia* during the evacuation of crew and passengers.

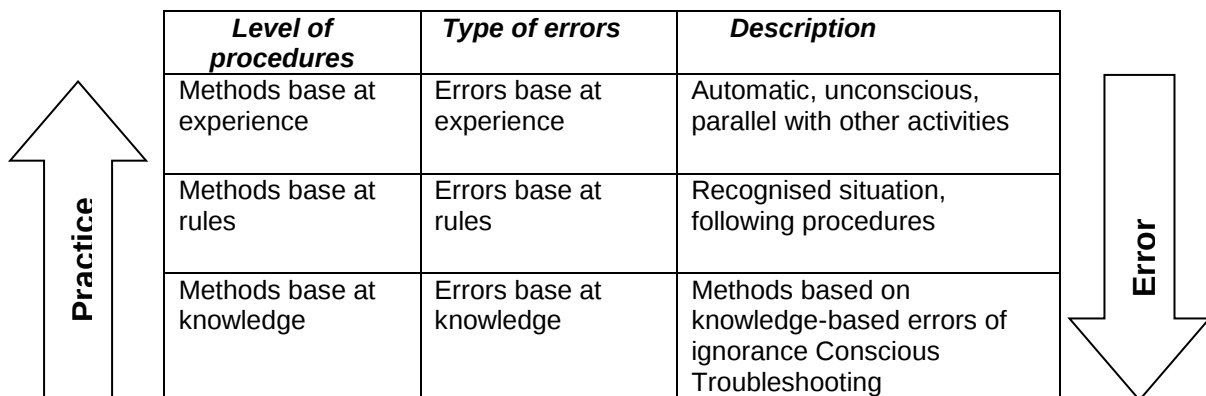
5. WAYS TO REDUCE HUMAN ERROR AS THE CAUSE OF MARITIME ACCIDENTS

The success of the maritime profession is dependent on many factors, such as innate and acquired knowledge and experience. People have certain capabilities and limitations. Human knowledge is necessary for the interpretation of individual situations, the selection decision, the application of knowledge, etc. On the other hand, man is limited by the speed of learning and memory size. There are leading machines. On the human capacity greatly affects knowledge and experience. Design technology can have a huge impact on human capabilities and work. Environment held an important factor for the performance of work and performance. It includes the time and physical size (light, noise, temperature), but also politics, economic impacts, etc. Environment directly affects the ability of physical labor. For example, the human body has a fairly limited range of temperatures that allow you to work.

Crossing the boundaries of the same will have a negative impact on the work. More and ship vibration can adversely affect a man which in these conditions can reduce dexterity, increase fatigue, stress, etc. Human errors are kept complex problem in the overall maritime system. Are mainly caused by new technology, the environment, and organizations that are relatively difficult consistent with optimal human features. Their incompatibility affects operator error. In order to solve this problem management of English maritime companies have attempted to influence the increase in motivation. Performance had to reduce the incidence of human error. International Code of Safety Management (*International Safety Management Code - ISM Code*) requires shippers to determine policy in terms of safety and environmental protection. Safety management must be communicated to all employees on land and on ships. You must determine the allocation of responsibilities and modes of communication between the staff and the shipping master or crew members. Shipping company must appoint a person with special powers (designated person). Their task is to enable direct connections between people on the board and top management in the shipping company for the purpose of safety and protection of the marine environment. Avoiding mistakes can be achieved through two strategies:

- Prevention
- Error in handling.

Table 1. The formation processes and errors



Level of procedures	Type of errors	Description
Methods base at experience	Errors base at experience	Automatic, unconscious, parallel with other activities
Methods base at rules	Errors base at rules	Recognised situation, following procedures
Methods base at knowledge	Errors base at knowledge	Methods based on knowledge-based errors of ignorance Conscious Troubleshooting

Source: [15]

Prevention may be the result of the election or operator training. Error handling is sometimes called error correction or error control, a feature of her that must be supported in interactive systems. Human error usually occurs when the user interface is designed in such a way Prevention. Designers should follow the strategy of prevention is not the case in practice. Some of the ways the emergence of errors are shown in Table 1.

6. CONCLUSION

In relation to the ergonomic point of view, the only element of control on the feedback level justifies the application of automation, and for those processes that help and support provider. Human error can be greatly reduced appropriate performance devices (equipment), working environment and appropriate organization within which the equipment and the work environment to be configured with the basic assumption that support operators and adapt to its capabilities and limitations - human-centered design. At the same time, we noticed passivation man on board requires its continuous improvement, and the equivalent simulation devices on the land on which they will work out all foreseeable circumstances it can handle. Imperative to create common standards for the use-specific segments of equipment and devices imposed itself. In addition to the training of simulation technology officers should continuously improve the existing knowledge about the devices that handle.

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EVALUATION OF OPERATING SPEED FOR TWO-LANE RURAL ROADS: AN ITALIAN CASE STUDY

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ABSTRACT

The operating speed is an essential information for planning and implementing interventions aimed to increasing road safety. In the literature, there are already numerous studies that have as their objective the evaluation of the operating speed especially on tangent elements, but each of them has been developed by analyzing data from various environmental conditions: due to these differences, in practice, a general large application of these models to environmental conditions different from the one for which they have been calibrated is unreliable. In this paper we present a first solution to the problem of evaluation of operating speed on rural two-lane roads of the Province of Pisa. In the following, an overview is presented on the state of the art and on the existing models; in the second part is then presented the methodology followed for selection, data collection, calibration and validation of the model for the evaluation of operating speed on tangent elements, relating only to two-lane rural roads.

KEYWORDS

Environmental speed, operating speed, two-lane rural roads, model calibration, model validation

STIMA DELLA VELOCITA' OPERATIVA PER STRADE EXTRAURBANE A DUE CORSIE: UN CASO DI STUDIO ITALIANO

ABSTRACT

La velocità operativa di un tracciato stradale costituisce un dato essenziale per la pianificazione e la messa in atto di interventi volti all'incremento della sicurezza stradale. In letteratura esistono già numerosi studi che hanno come obiettivo la valutazione della velocità operativa soprattutto sui rettifili, tuttavia ciascuno dei modelli esistenti è stato sviluppato analizzando i dati provenienti da realtà sostanzialmente diverse: a causa di queste differenze, la generica applicazione di questi modelli a condizioni anche molto diverse da quelle per cui sono stati sviluppati non è attendibile. Nel presente lavoro viene presentata una prima soluzione al problema della velocità operativa valutata per le condizioni tipiche delle strade extraurbane a due corsie della Provincia di Pisa. Nel seguito, preliminarmente viene presentata una rassegna sullo stato dell'arte e sui modelli esistenti; nella seconda parte viene invece presentata la metodologia seguita per la scelta, la raccolta dati, la calibrazione e la validazione del modello per il calcolo della velocità operativa sui rettifili, relativamente alle sole strade extraurbane a carreggiata unica e a singola corsia per senso di marcia.

KEYWORDS

Velocità ambientale, velocità operativa, strade extraurbane a due corsie, calibrazione del modello, validazione del modello

1. INTRODUCTION

In Italy, with the enactment of the DM 2367/2004 about "Technical Instructions for the design, approval and use of safety devices in road construction", and with Circ. 62032/2010 "Uniform application of the rules relating to the design, approval, and use of safety devices in road construction", Public Administrations have to provide the installation of safety devices on roads with a design speed (or equivalent to design speed) higher than 70km/h.

This type of activity is part of a policy aimed to the improvement of quality of service and traffic safety for the existing road network. This policy requires to take in account some

actions about adjustment of existing roads according to guidelines and criteria defined in the draft “Standard about upgrading of existing roads” (21/03/2006).

The design speed, fixed a priori in the definition of any new design, is difficultly evaluable when needed for existing infrastructures, since no indication or procedure is given by current regulations or standards. This gap raises the problem, for Public Administrations, to find a way to evaluate this parameter. Moreover, a further issue requires attention: since actions on existing infrastructures necessarily affect a pre-existing situation, many studies show that in these cases it would be more appropriate to take as a reference the operating speed rather than the theoretical design speed, because the operating speed reflects the real conditions of an infrastructure and the real behavior of users using that infrastructure. In fact, in the evaluation of the dangerousness of a site, is the speed effectively reached by users that constitutes the exposure to the danger of the site, as well as the TGM represents the probability. Moreover, the choice of using the operating speed instead the design speed is supported by many international standards, where it could be found explicit reference, for example regarding how to carry on the test of consistency for a path.

During years 2012 and 2013 was developed a procedure for the estimation of the design speed for rural roads. In the first instance, we used a methodology that took into account only the radius of the planimetric curvilinear elements, as suggested by Italian DM 2367/2004. This methodology, however, has pointed out the need for further integration: one of the possible and desirable integration is to take in account the speed on tangent elements in the calculation.

There are already numerous studies that have as their objective the evaluation of the operating speed on tangent elements for two-lane rural roads. In this paper we present a first solution to the problem of evaluation of the operating speed for two-lane rural roads in the Province of Pisa.

In the following, an overview is presented about the state of the art and about existing models; in the second part is then presented the methodology followed for selection, data collection, calibration and validation of the model for the evaluation of the operating speed on tangent elements, relating only to two-lane rural roads in the Province of Pisa. The choice to focus, at the moment, our attention on this category of roads is mainly due to two reasons: the first concerns the importance of this category of road infrastructure plays within the environmental tissue, and the second concerns the fact that, on these roads, the improvement of traffic safety necessarily needs structural actions on the network, that directly involve the speed required by users.

2. STATE OF THE ART

Currently within a lot of international standards there are different formulations of the regression equations used to estimate the operating speed, defined as “the 85th percentile of the speed held by drivers in free-flow condition”. These equations for operating speed are different for each of these standards, however all of them take the moves from experimental studies carried out on a sufficient number of observations on roads similar in structural and functional characteristics.

Each formulation cannot be considered universally valid, due to substantial differences between different national realities (and sometimes even between different local realities within the same country) in terms of the orography of terrain, of the weather conditions, of the vehicles fleet and, most importantly, of the users habits. In Italy was recently introduced the concept of operating speed. This concept appears in the previously cited draft “Standard for action about adjustment of existing roads”, where are defined criteria to plan improvements in functionality and safety of homogeneous sections: operating speed is defined as “the speed maintained by vehicles in free flow conditions, exceeded only by 15% of users”.

In Table 1 are shown the regression models obtained from the most important worldwide studies on the estimation of an operating speed for existing roads. As you can see, all these models use geometric elements as independent variables. Someone of them uses also a

behavioral variable, such as the approach speed, measured in site close to the starting point of the curve element.

The parameters used in these different models are:

CCR	curvature change rate ($^{\circ}/\text{km}$)
DC	curvature degree ($^{\circ}/100\text{m}$)
DF	deviation angle ($^{\circ}$)
L_C	length of the curve element (m)
L_T	length of the tangent element (m)
L_{T1}	length of the preceding tangent element (m)
L_{T2}	length of the following tangent element (m)
85MSR	85 th percentile of the speed differences distribution between the tangent and the central point of the curve (km/h)
R	curvature radius (m)
R_a	curvature radius of the preceding curve element (m)
V_a	curve approach speed (km/h)
V_d	desired speed (km/h)
V_F	approach speed on tangent element (km/h)
V_P	administrative speed limit (km/h)
V_{85T}	85 th percentile of approach speed on tangent element (km/h)
V_{85}	85 th percentile of speed (km/h)
$\Delta 85V$	85 th percentile of the speed differences distribution on two contiguous elements (km/h)
ΔV_{85}	difference between V_{85} between two contiguous elements (km/h)

Table 1. Estimator models for V_{85}

Author	Country	Model	p^2
McLean (1979)	Australia	$V_{85} = 53.80 + 0.464 \cdot V_F - 3260/R + 85000/R^2$	0.920
Kerman et al. (1982)	U.K.	$V_{85} = (V_a - V_a^3)/(398 \cdot R)$	0.910
<i>Guidelines for the design of roads (RAS-L-1)</i>	Germany	$V_{85} = 60 + 39.70 \cdot e^{-3.58 \cdot 10^{-3} \cdot CCR}$	0.790
Glennon et al. (1986)	USA	$V_{85} = 103.96 - (4524.94/R)$	0.840
Lamm, Choueiri (1987)	USA	$V_{85} = 95.77 - 0.076 \cdot CCR$	0.836
Kanellaidis et al. (1990)	Greece	$V_{85} = 32.20 + 0.839 \cdot V_d + 2226.9/R - 533.6/\sqrt{R}$	0.925
Lamm (1993)	Germany	$V_{85} = 10^6/8270 + 7.20 \cdot CCR$	0.730
Ottesen, Krammes (1994)	USA	$V_{85} = 103.04 - 0.0477 \cdot CCR$	0.800
Morrall, Talarico (1994)	Canada	$V_{85} = e^{4.561 - 5.86 \cdot 10^{-3} \cdot DC}$	0.631
Islam, Seneviratne (1994)	USA	$V_{85} = 103.30 - 2.41 \cdot DC - 0.029 \cdot DC^2$	0.980
Krammes et al. (1995)	USA	$V_{85} = 103.66 - 1.95 \cdot DC$	0.800
Lamm et al. (1995)	Greece	$V_{85} = 10^6/10150.1 + 7.676 \cdot CCR$	0.810
Choueiri et al. (1995)	Lebanon	$V_{85} = 91.03 - 0.050 \cdot CCR$	0.810
Al-Massaeid et al. (1995)	Jordan	$\Delta V_{85} = 3.64 + 1.78 \cdot DC$	0.510
Voigt (1996)	USA	$V_{85} = 99.61 - 2951.37/R$	0.840
Abdelwahab et al. (1998)	Jordan	$\Delta V_{85} = 0.9433 \cdot DC + 0.0847 \cdot DF$	0.920
Pasetti, Fambro (1999)	USA	$V_{85} = 103.90 - 3020.50/R$	0.680
Fitzpatrick et al. (2000)	USA	$V_{85} = 106.30 - 3595.29/R$	0.920
Ottesen, Krammes (2000)	USA	$V_{85} = 102.44 - 1.57 \cdot DC - 0.012 \cdot LC - 0.01 \cdot DC \cdot LC$	0.810
Andueza (2000)	Venezuela	Curves:	

		$V_{85} = 98.25 - 2795/R - 894/R_a + 7.486 \cdot DC + 9.308 \cdot L_T$	0.810
		Tangents: $V_{85} = 100.69 - 3032/R + 27.819 \cdot L_T$	0.720
McFadden, Elefteriadou (2000)	USA	$85MSR = 14.90 + 0.144 \cdot V_{85T} - 954.55/R + 0.0153 \cdot L_T$	0.712

3. MODEL DEVELOPING FOR TWO-LANE RURAL ROADS IN PROVINCE OF PISA

The need to calculate, in some way, a speed equivalent to design speed for each homogenous section has been addressed, in first instance, using an empirical procedure based on the evaluation of the design speed of the curves (as suggested by the DM 2367/2004), calculated by the following formulation (as reported in DM 05/11/2001):

$$\frac{V_C^2}{R \cdot 127} = q + f_T$$

q transversal gradient of the curve

f_T part of the usable transversal adherence coefficient on that curve, inversely proportional to the speed

R radius of curvature (m)

V_C design speed (km/h)

The radius of curve elements preceding and following the tangent section, and the length of the tangent section, were measured on photogrammetric maps (scale 1:10000), by reconstructing the road axis in the section of interest. Regards other parameters present in the formula, the transversal gradient was evaluated directly in the site, and the f_T parameter was evaluated by reference to the DM 05/11/2001, which determines values based on the V_C :

$$V_C = 100 \text{ km/h} \quad f_T \leq 0.11$$

$$V_C = 40 \text{ km/h} \quad f_T \leq 0.21$$

In this case, because it isn't available a values of V_C , f_T was estimated as a function of the radius R of the curve, since it is the reference parameter for the calculation of V_C . In particular, we have adopted these values:

Table 2. Estimated values for f_T parameter

Radius R (m)	f_T
$R \leq 50m$	0.21
$50m < R \leq 75m$	0.20
$75m < R \leq 100m$	0.19
$100m < R \leq 125m$	0.18
$125m < R \leq 150m$	0.17
$150m < R \leq 175m$	0.16
$175m < R \leq 200m$	0.15
$200m < R \leq 225m$	0.14
$225m < R \leq 250m$	0.13
$250m < R \leq 350m$	0.12
$R > 350m$	0.11

Therefore, it was possible to evaluate V_C for the i -th curve according to the following formulation:

$$V_{C,i} = \sqrt{(q + f_T) \cdot R \cdot 127}$$

This methodology allowed the calculation of V_C of each curve, but this is only a punctual parameter. To obtain a speed parameter representative of an entire homogenous section (where we can find a large number of curves and tangent elements) the procedure provides to calculate the design speed V_T as a weighted average of the $V_{C,i}$, using the lengths L_i of each of the n curve element as weights, according to the following formulation:

$$V_T = \frac{\sum_{i=1}^n (V_{C,i} \cdot L_i)}{\sum_{i=1}^n L_i}$$

The results of this empirical procedure are really encouraging. A further advantage of this procedure is that it allows an assessment of the homogeneity of the homogenous section by the simple analysis of variance of the $V_{C,i}$ belonging to the homogenous section analyzed. The procedure has, however, some limits: the first is that V_T cannot be considered as representative when this procedure is applied to section characterized by few curves and long tangent elements; the second is that $V_{C,i}$ (and therefore V_T) evaluated as above is essentially a theoretical parameter.

It is perfectly understandable the need to integrate (and therefore, as final objective, to replace this procedure by including the speed on tangent elements, with the intent to obtain a speed parameter representative of the real operating conditions on infrastructures: this parameter is the operating speed.

Then, as a first step, a model for the estimation of the environmental speed on tangent section was developed: this was possible because during the 2012 and 2013 numerous instrumental measurements on the road network of the Province of Pisa were carried out, and a large volume of data is available for analysis. These measurements (used for many applications: acoustic plans, updating of the network, plans for safety devices), performed by automatic counter equipment based on radar technology, were carried out on tangent elements with following characteristics:

- sufficient distance from intersections and obstacles;
- about at halfway of the tangent element;
- mostly flat environmental condition;

For each vehicle, were recorded these data: time of transit, direction, lane, speed (km/h), vehicle length (cm), gap (s) and headway (s) between two vehicles.

For this first phase of calibration of the model, we analyzed data collected on 14 stations, for a total of 25 different sections (considering the two directions, when available). Afterwards, for the validation phase of the model we used data collected on 9 different stations, for a total of 17 sections.

The first step was to select the structure of the model. The choice fell on a model with three independent variables, which are considered sufficiently binding and representative of the speed held by users on tangent sections: V_{CP} (design speed of the preceding curve in the traveling direction, in km/h), V_{CS} (design speed of the following curve in the traveling direction, in km/h) and L_{rett} (tangent section length, in m). The choice fell on the speed of the curves, rather than on the radius, because it can be evaluated as a function of two geometric and one kinematic parameters related to the curve itself: the radius R , the transversal gradient q , and the proportion of maximum transverse adhesion f_T . The latter is evaluable as a function of speed and therefore again as a function of the radius of the curve. Since at this stage is not yet available a speed model for curve elements, it was necessary to use the previously evaluated values for $V_{C,i}$, as shown above.

For the selection and calibration of the model, we used the open-source software *Gretl* 1.9.12. This software allows you to write and to analyze linear and non-linear regression models. In this first phase of the research, several models of both categories have been tested.

Before proceeding with the calibration was first necessary to focalize the attention on some basic hypothesis:

- the 85th percentile of the speed of vehicles actually recorded in the site was considered as representative of the operating speed, as indicated by the Italian standard cited above;
- heavy vehicles were excluded from analysis: a vehicle is classified as heavy when its detected length is greater than 6m;
- not all light vehicles registered were included in the calculation of 85th percentile, but only those that could be considered traveling in free flow conditions: we considered those for which the measured gap from the preceding vehicle is greater than 5s;
- for tangents with lengths greater than 800m, the value of L_{rett} was limited to this value. This value is representative of a distance sufficient for users to reach the desired speed and to travel at this constant speed on tangent elements, until the point where they will start the deceleration before entering the following curve. The evaluation of this value is really hard, due to need to evaluate also the acceleration and deceleration rates, so we can retain this length as sufficient;
- we also analyzed some stations located on tangent elements characterized by intersections or roundabouts at one or both edges: in this case we set as crossing speed of the intersection $V_C = 30\text{km/h}$, independently from the radius of the trajectory used by users, as it was considered representative of the actual traveling speed in the intersection area.

The following Table 3 shows the data used for model calibration.

Table 3. Calibration Data

	V_{85} (km/h)	V_{CP} (km/h)	V_{CS} (km/h)	L_{rett} (m)
SP2 – km 17+200 – dir. 0	59	38	55	227
SP2 – km 17+200 – dir. 1	61	55	38	227
SP43 – km 7+200 – dir. 0	91	77	60	556
SP43 – km 7+200 – dir. 1	89	60	77	556
SP35 – km 15+800 – dir. 0	82	71	99	232
SP35 – km 15+800 – dir. 1	78	99	71	232
SP13 – km 0+700 – dir. 0	80	72	50	541
SP13 – km 0+700 – dir. 1	78	50	72	541
SP66 – km 9+000 – dir. 0	80	38	39	778
SP66 – km 9+000 – dir. 1	76	39	38	778
SP69 – km 3+500 – dir. 0	84	43	30 ⁽¹⁾	792
SP69 – km 3+500 – dir. 1	89	30 ⁽¹⁾	43	792
SP10 – km 5+350 – dir. 0	73	75	56	404
SP10 – km 5+350 – dir. 1	75	56	75	404
SP31 – km 3+500 – dir. 0	99	90	89	423
SP31 – km 3+500 – dir. 1	91	89	90	423
SP11 – km 4+000 – dir. 1	78	30 ⁽¹⁾	91	444
SP12 – km 7+200 – dir. 0	82	76	82	445
SP12 – km 7+200 – dir. 1	89	82	76	445
SR68 – km 23+400 – dir. 0	86	83	52	435
SR68 – km 23+400 – dir. 1	84	52	83	435
SR439 – km 55+670 – dir. 0	67	30 ⁽¹⁾	62	628
SP1 – km 0+550 – dir. 0	63	55	51	249
SP1 – km 0+550 – dir. 1	66	51	55	249
SP5 – km 1+100 – dir. 0	80	86	72	263
SP5 – km 1+100 – dir. 1	76	72	86	263

⁽¹⁾ speed set to 30km/h, according to previous hypothesis

The comparison between the different models tested was carried out on the basis of two methods: the analysis of the adjusted coefficient of determination R^2 and the Akaike Information Criterion.

Indeed, in the field of regression analysis, simple R^2 is used as the main index of the goodness of the regression curve. For the analysis of simple linear regression, it is used to measure the fraction of deviance explained, i.e. the proportion of the variability of Y explained by the explanatory variable X. In the context of multiple linear regression is used instead the adjusted R^2 coefficient: in fact, as the number of explanatory variables (or predictors) increases, it also increases the value of simple R^2 . In this case the adjusted R^2 correctly measure the fraction of the variance explained. It can be negative and it is always lower than the simple R^2 . When the value of the adjusted R^2 approaches unity, greater is the fraction of variance explained by the model, greater is the ability of the latter to describe real data: the rule to follow is therefore to prefer models with higher values of adjusted R^2 .

Unlike in the case of linear regression, doesn't exists a general method in determining the values of the parameters that provide the best data fitting in the case of non-linear regression. In this case, we can use classes of numerical iterative algorithms for optimization, which starting from initial values, set by random procedure or by a preliminary analysis (e.g. linear regression model), to come to points considered optimal. We could have a local maximum of the goodness of fitting, in contrast with the case of linear regression, where the maximum is always a global maximum. The software used allows the automatic calculation of several evaluation criteria, among which the one known as the Akaike Information Criterion was used. In this case, the rule to follow is to prefer models with the lowest AIC value.

As said above, on the basis of these two parameters we carried out a comparison between different models: among all, the more representative result was the one obtained with the following linear model:

$$V_{85} = a + d \cdot (V_{CP} + V_{CS}) + c \cdot L_{rett}$$

For each parameter, the software also evaluates the p-value, which allows an assessment of significance. We can retain the value of a parameter as significant when its p-value was lower than 5%, or when it is significant to the 95% of cases.

The value of the three parameters, obtained using linear regression techniques, are the following:

Table 4. Model Parameters

Parameter	Evaluation	Std. Error	p-value
a	22.1991	5.03095	0.00022
c	0.05012	0.0049	<0.00001
d	0.27382	0.02714	<0.00001

We can see, from the low p-value obtained, that they are perfectly significant. With these parameter values, the model gives the following value for the coefficient of determination:

$$R_{adjusted}^2 = 0.847805$$

This shows really good fitting with real data, and it is similar to the values of the same coefficient obtained from existing models.

Finally, the model thus calibrated is:

$$V_{85} = 22.1991 + 0.27382 \cdot (V_{CP} + V_{CS}) + 0.05012 \cdot L_{rett}$$

4. MODEL VALIDATION

With the same hypothesis, we proceeded to the validation of the model based on the following data:

Table 5. Validation data

	V_{CP} (km/h)	V_{CS} (km/h)	L_{rett} (m)
SP9 – km 2+800 – dir 0	40	100	216
SP9 – km 2+800 – dir 1	100	40	216
SR436 – km 25+800 – dir 0	30 ⁽²⁾	65	382
SR436 – km 25+800 – dir 1	65	30	382
SP65 – km 2+000 – dir 0	99	30 ⁽²⁾	216
SP66 – km 4+000 – dir 0	30 ⁽²⁾	100	800 ⁽³⁾
SP66 – km 4+000 – dir 1	100	30 ⁽²⁾	800 ⁽³⁾
SP26 – km 0+400 – dir 0	30 ⁽²⁾	62	609
SP26 – km 0+400 – dir 1	62	30 ⁽²⁾	609
SP21 – km 0+600 – dir 0	60	89	219
SP21 – km 0+600 – dir 1	89	60	219
SR439 – km 95+900 – dir. 0	96	78	151
SR439 – km 95+900 – dir. 1	78	96	151
SP3 – km 0+400 – dir 0	35	73	725
SP3 – km 0+400 – dir 1	73	35	725
SP3 – km 1+700 – dir 0	73	66	96
SP3 – km 1+700 – dir 1	66	73	96

⁽²⁾ speed set to 30km/h according to previous hypothesis⁽³⁾ lenght set to 800m according to previous hypothesis

The application of the calibrated model, as shown in Chapter 3, has allowed us to obtain the results reported in following Table 6, where we also report the differences between measured and calculated ΔV_{85} :

Table 6. Comparison between calculated V_{85} e measured V_{85}

	$V_{85,rl}$ (km/h)	$V_{85,mod}$ (km/h)	ΔV_{85} (km/h)
SP9 – km 2+800 – dir 0	80	71.36	-8.64
SP9 – km 2+800 – dir 1	80	71.36	-8.64
SR436 – km 25+800 – dir 0	70	67.36	-2.64
SR436 – km 25+800 – dir 1	70	67.36	-2.64
SP65 – km 2+000 – dir 0	76	68.35	-7.65
SP66 – km 4+000 – dir 0	102	97.89	-4.11
SP66 – km 4+000 – dir 1	102	97.89	-4.11
SP26 – km 0+400 – dir 0	78	77.92	-0.08
SP26 – km 0+400 – dir 1	82	77.92	-4.08
SP21 – km 0+600 – dir 0	76	73.98	-2.02
SP21 – km 0+600 – dir 1	82	73.98	-8.02
SR439 – km 95+900 – dir. 0	84	77.41	-6.59
SR439 – km 95+900 – dir. 1	89	77.41	-11.59
SP3 – km 0+400 – dir 0	89	88.11	-0.89
SP3 – km 0+400 – dir 1	86	88.11	2.11
SP3 – km 1+700 – dir 0	69	65.07	-3.93
SP3 – km 1+700 – dir 1	72	65.07	-6.93

There is a good correspondence between the observed values of V_{85} and the calculated values obtained by the model. This good correspondence is even more evident if we look at the following picture:

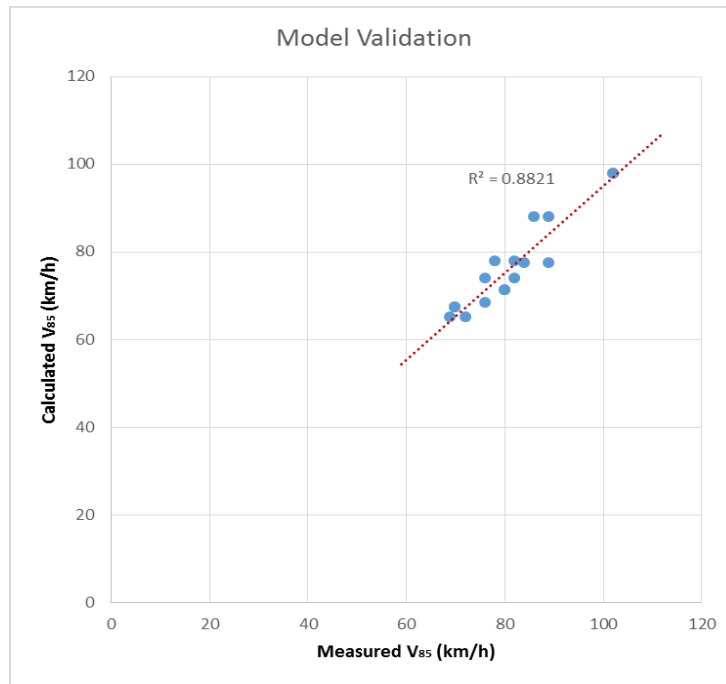


Figure 1. Measured V₈₅ vs. Calculated V₈₅

The value of R^2 of 0.8821, confirms the good correspondence between measured and calculated values, and therefore the goodness of the model.

5. CONCLUSIONS AND FURTHER DEVELOPMENTS

An evaluation of a speed equivalent to the design speed for homogeneous sections is the basis of many planning tools. However, for a higher level of significance, it is more useful to consider a speed representative for the real operating conditions of a homogeneous section. In the literature there are a high number of models, each one developed for substantially different environmental conditions: due to these differences, in practice, a general large application of these models to environmental conditions different from the one for which they are calibrated is unreliable.

With the present work, foundations were laid for a first model calibrated on data collected on single carriageway two-lane roads in Province of Pisa. The availability of such a tool (or a methodology for its implementation) means, the possibility to assess the operating speeds of entire paths starting from just geometric data, easily measurable. Maintaining the current evaluation of $V_{C,i}$, the model here developed allows the calculation of a speed parameter taking into account also the speed on tangent sections. It is therefore possible to obtain a diagram of the operating speeds, from which by integral procedure (in this case it reduces to a weighted average that take into account also tangent sections), we can obtain a speed value that will be representative of the actual behavior of the users.

The good reliability of the model here developed allows its application to two-lane rural roads similar to those in Province of Pisa for geometric parameters, roads functionality and terrain orography.

At the actual status, only the model for tangent section has been developed. Anyway, other steps of development are already provided: the first will be about the development of a model for evaluation of speed parameter for curve elements; the second will be about the development of a model for evaluation of speed parameter exiting and entering in intersection areas; the third will be about the verification and a new calibration of the current model for tangent sections on the basis of the speed values obtained these two new models.

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COMPATIBILITY AND COMPETITION BETWEEN TRANSPORT SYSTEMS

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ABSTRACT

The paper investigates questions of compatibility, complementarity and competition between different transportation systems within the traffic system as a whole. The traffic system is a collection of different transportation systems which function within a certain space and time. An important determinant of a certain transportation system is the space within which the existing transportation systems meet the daily demand for passenger and cargo transport. Between these transportation systems, there is, at the same time, a requirement of compatibility because of necessary complementarity in providing transport services, and on the other hand there is unavoidable mutual competition in acquiring the highest number of customers because of the need for profitability, especially if they function on a commercial level.

KEYWORDS

compatibility, complementarity and competition, transportation systems

KOMPATIBILNOST I KONKURENCIJA TRANSPORTNIH SUSTAVA

SAŽETAK

Radom se obrađuju pitanja kompatibilnosti, komplementarnosti i konkurencije između transportnih sustava unutar prometnog sustava. Prometni sustav je skup transportnih sustava koji funkcioniraju na određenom prostoru i određenom vremenu. Bitna odrednica nekog prometnog sustava jeste prostor unutar kojega postojeći transportni sustavi svakodnevno podmiruju transportnu postojeću potražnju u putničkom i teretnom prometu. Između tih transportnih sustava postoji istodobno s jedne strane zahtjev kompatibilnosti zbog potrebne komplementarnosti u pružanju transportnih usluga, a s druge se strane neizostavno pojavljuje međusobna uzajamna konkurencija u pridobivanju što većeg broja korisnika usluga zbog potrebne ekonomičnosti svakog od sustava, posebice ako funkcioniraju na komercijalnoj osnovi.

KLJUČNE RIJEČI

kompatibilnost, komplementarnost i konkurencija, transportni sustavi

1. TRAFFIC SYSTEM

The technology of traffic and transportation is a scientific field within technical sciences, which has its own expert and scientific dimension that is content of studying. The expert dimension of technology of traffic and transportation relates primarily to management of the transportation process and the scientific dimension is studying and determining the laws of the transportation process. In determining the expert content of technology of traffic and transportation, considering the well known definition of management, it can be concluded that the expert content of technology of traffic and transportation relates to planning, organizing, human resources management, leadership and control of the traffic, that is transportation process.

The function of traffic (flow of traffic lines) that is transportation (passenger and cargo) is the primary function of the traffic system. The traffic system is observed and studied through the flow of passenger and cargo lines in the traffic system in a certain space and time. For example, the road transportation system enables transportation processes (including all of its phases, form the preparation phase, execution phase and ending phase) whether in passenger or cargo road traffic.

The traffic system consists of all the traffic sub-systems, that is transportation systems which are in function in a certain space and time. The purpose of the traffic system is to enable the functioning of the people's community, as in its normal functioning and also its undisturbed and as quick as possible total social development.

2. COMPATIBILITY OF THE TRANSPORTATION SYSTEMS IN THE TRAFFIC SYSTEM

The goal of the traffic system is to facilitate the demand for transportation with adequate traffic supply. For this reason the primary goal of a traffic engineer is optimization of passenger and cargo transport (transport processes) in the traffic system.

Considering the requests of users and the interest of the community as a whole, an important factor of optimization of the traffic system is economy, so in that sense it is important to achieve a minimum of average total cost per unit of transportation work or the quantity of transported cargo. The cost of the service, that is the economy of functioning of a certain transportation system is a result of applied technique that is its technical sub-system (within which the system is for example the traffic infrastructure, transportation means, transport devices, manipulation means, information system) which considering the level of technical equipment (used infrastructure and suprastructure) determines the technological possibilities or options which the traffic engineer has in its disposal at a given moment. Further on, each of these technological options or possibilities demands a certain organization and human resources with appropriate skills, know-how and experience. The total result of that kind of technique and chosen technology (it is often possible that the same technique enables multiple technological solutions) in the appropriate organization is shown in total expenses of a certain transportation system, for example the price of a transport service in cargo or passenger traffic.

The compatibility of transportation systems of a certain traffic system is enabled throughout all of its sub-systems, first of all its technical, technological, organizational, economic, legal and ecologic subsystems between the transportation systems in a certain space and time. In the passenger traffic, compatibility is enabled through, for example, joined terminals (at one point a direct transfer or a link to multiple transportation system is enabled), The information regarding traffic schedule and the coherence of arrivals and departures of transport vehicles which enable traveling without waiting, coherence of tariffs or possibly prices of tickets, that is one ticket in which the joined transport service of multiple transportation systems is formed. In the cargo traffic the request for compatibility mainly relates to standardization of transport devices (packages, palettes, containers) considering the use of carrying capacity, possibility of cargo placement, a simple and secure logistic unit manipulation, accurate identification and protection of cargo, joined infrastructure (for example warehouse, cargo terminals which link together multiple transport systems), standardization of manipulation means (before, during and after the transportation process) and so forth.

The compatibility of transportation systems is the basic prerequisite of optimal contribution of the traffic system in the functioning of economy and is accordingly of special interest to society.

3. THE COMPETITION OF TRANSPORTATION SYSTEMS WITHIN THE TRAFFIC SYSTEM

The competition of transportation systems within the traffic system is linked to quality of the transport service according to demands of customers, type of cargo, and travel destination. These are the exact criteria upon which the distribution of transport demand by individual transport systems within a certain traffic system depends. Standard elements of quality of a transport service are, first of all, safety (equally important in passenger and cargo transportation), regularity, punctuality, comfort, frequency, speed and price. Depending on the type of transportation in question (cargo or passenger) according to the demand of

customers, the order of significance of individual elements within the expected quality of transport service changes.

The city traffic system can often be compared to (especially in metropolitan areas with multi-million inhabitants) a “global” traffic system in its own right, so it is necessary to observe its functioning and development from the position of the whole integral traffic system which consists of present transportation systems in a certain space and time.

The efficiency of the transport process (shown by number of transported passengers or by quantity of cargo or by executed passenger and cargo transport work in a unit of time) and the realized business efficiency (as a financial result of the relation between total income and total expenses) must be observed and analyzed within any transportation system, but one must not forget the importance of the effect of the whole traffic system which functions in a certain space and meets the demand in a certain time by utilizing all its transportation systems.

The necessity of an integral approach to the functioning of a city traffic system comes from the complementarity of transportation systems which function within the system, because of their different technical-technological attributes and accordingly different transportation capabilities, environment impact and the concept of sustainable development of each individual transportation system. On the other hand this exact necessity of an integral approach to analysis, functioning and contribution of the traffic system, considering its purpose of meeting the transportation demand requires compatibility between transportation systems which exist in a city traffic system of a certain town, region or a national traffic system.

4. CONCLUSION

A complete approach in modelling and managing development and the functioning of a certain traffic system comes from complementarity of existing transportation systems, because of their different technical-technological attributes and accordingly different transportation capabilities. In which, an important factor is environment impact, that is the application of the concept of sustainable development of each individual transportation system. If the necessity of an integral approach to analysis, functioning and contribution of a traffic system considering its purpose of meeting the demand for transportation, then the request for compatibility between transportation systems which exist in a certain traffic system becomes significant. The basic factor in the process of modelling, managing and developing a traffic system is the current and forecasted transportation demand, which is met by utilizing certain transportation systems. An important criteria of dimensioning a certain transportation system is the desirable level of quality of the transport service. Practice shows that each transportation system has its place and role in the functioning of the whole traffic system, so except for the competition between them (which is always present), their complementarity is most important for the system to fulfill its role of meeting the transportation demand with minimal average total cost per transported passenger in the passenger traffic or transported unit of cargo in the cargo traffic. The optimisation of the traffic system vertically (technical, technological, organizational, economical, ecological, and legal sub-system) and horizontally (transportation systems) is a permanent duty of traffic engineers.

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MASTERPLAN FOR SISAK NEW PORT - PRELIMINARY DESIGN SOLUTION

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ABSTRACT

In this paper authors will discuss the New Sisak Port as a multifunctional economic infrastructure with the following functions; Wet Port for the Sisak – Moslavina region and the Greater Zagreb area which gives access to cost-effective inland waterway transport; Logistics centre for the City of Sisak and the region; Industrial development site of the region. As a consequence, high emphasis will be given to the analysis of the situation and the potentials of economic development and the identification of prospective areas for port and industry zone related investment. Data for different statistical sources will be assessed and matched in order to obtain a harmonized transport flow data basis. The transport prognosis provided transshipment volumes for Sisak New Port by commodities and by three development scenarios (low, main and high scenario). In the framework of the transport research and supporting the development of the scenarios a regional (economy) analysis of the Sisak region was completed, which evaluated the development of industrial activities in relation to Sisak New Port. Authors performed an analysis of three port layout variants and sub-variants. As a result of port layout variants evaluation, variant B was proposed as most preferable layout solution for Sisak New Port. According to agreed methodological approach, authors have started to produce a template for each type of the data inputs, CAPEX, OPEX, REVIN and economic benefits needed for elaboration of the Financial and Economic analysis of the New Port Sisak Investment.

KEYWORDS

Sisak new port, development, data collection, port layout, economic analysis

PRIJEDLOG IDEJNIH RJEŠENJA ZA IZGRADNJU LUČKE INFRASTRUKTURE NOVE LUKE SISAK

SAŽETAK

U radu autori će predstaviti infrastrukturni projekt nove luke Sisak u funkciji višenamjenske "suhe" luke za područje Sisačko-moslavačke županije i šireg područja grada Zagreba, logističkog centra grada Siska te razvojno industrijskog područja sisačke regije. Analizirati će se postojeće stanje i potencijali za gospodarski razvoj te identifikaciju potencijalnih novih investicija za razvoj industrija unutar lučkog područja. Statistički podaci će se uskladiti kako bi se utvrdile osnovne podloge za kreiranje baze podataka o protoku tereta. Prognoza prometa odredila je tri razvojna scenarija (pesimističan, umjeren i optimističan). U okviru istraživanja prometne potražnje, a pritom uvažavajući razvojne scenarije izvršena je ekonomska analiza sisačke regije koja je ocjenila razvoj industrijskih aktivnosti u kontekstu izgradnje lučke infrastrukture Nove luke Sisak. Autori su izradili tri varijantna rješenja i podrješenja za izgradnju lučke infrastrukture. Evaluacijom navedenih rješenja autori su predložili varijantno rješenje "B" za izgradnju infrastrukture. Sukladno dogovorenom metodološkom pristupu, autori su kreirali predloške za pojedinu vrstu ulaznih podataka, CAPEX, OPEX, REVIN i ostale ekonomske koristi potrebne za elaboraciju financijske i ekonomske analize ulaganja u Novu luku Sisak.

KLJUČNE RIJEČI

Nova luka Sisak, razvoj, prikupljanje podataka, idejno rješenje lučke infrastrukture, ekonomska analiza

1. INTRODUCTION

The overall objective of the project is the development of river transport on the Sava River waterway, while the purpose is to provide the following elements:

- Master plan of the New Sisak Port, with its complementary elements:
 - preliminary transport study,
 - preliminary solution for port infrastructure,
 - Feasibility study with Cost-Benefit Analysis (CBA) and financial and economic analysis;

Main difficulties for the project that can be foreseen at this moment focus mostly on the following aspects:

- Availability of detailed and reliable statistical data on the transport flows in Croatia and neighbouring countries;
- The dramatic decline of the cargo throughput on the Sava River waterway and the consequent modal change of the traffic patterns; it will take significant efforts to restore the confidence of transport users in a reliable and cost-effective inland waterway transport; guaranteed minimum standards for the fairway will be essential for attracting cargo;
- Serious deterioration of the existing waterway and port infrastructure due to war conflicts and lack of adequate maintenance since the beginning of 1990-ies; There are high efforts in restoring navigability on river Sava with good progress under the responsibility of the Sava River Commission; nevertheless not all financial needs are already settled; in particular it is not yet decided how short term upgrade measures (dredging and river training) will be financed in order to bridge the gap until the full rehabilitation of river Sava is achieved;
- Current poor state of technology of fleet and lack of state-aid schemes for its modernization;
- Lack of state-aid schemes similar to Western Europe to stimulate private investment in ports and terminals;
- Need to integrate New Port Sisak into the forthcoming programming of the Transport Operational Program for (TOP) the new financial period of the European Union;
- Need to integrate New Port Sisak as project under the new TOP with the new OP Regional Development in order to trigger industrial development in the region with the New Port Sisak as major business development infrastructure;
- Need to set-up an organisational instrument to perform industrial site development as part of the new port administration or in addition to the new port administration.

The Consortium considers the New Sisak port as a multifunctional economic infrastructure with following functions:

1. “Wet port” for the Sisak – Moslavina region and the Greater Zagreb area which gives access to cost-effective inland waterway transport;
2. Logistics centre for the City of Sisak and the region;
3. Industrial development site of the region.

The development concept of the port will comprise a reasonable number of development stages following the development strategy for the New port. This development strategy must be based on the economic strongholds of the city and the region as well as on the future state and county strategies for regional development. Some potential industry sectors have been discussed in the inception meetings like steel, agriculture, renewable energy, chemical industry as well as waste collection and treatment.

The aspect to use the New Port of Sisak as a catalyst for regional development, also in the sense to start a re-industrialisation process is considered essential for achieving a successful project.

As a consequence, high emphasizes will be given to the analysis of the situation and the potentials of economic development and the identification of prospective areas for port and industry zone related investment.

The development of Sisak New port and its further extensions will require strong financial support from the national government as well as the European Union. Therefore, the project must become a priority project in the forthcoming program period of the Transport Operational Program for (TOP) the new financial period of the European Union. In addition, the project must be reflected with its requirements as well in the forthcoming Operational Program of Regional Development. This requires a strong national co-ordination of the Croatian Authorities and the support of the relevant EU services. The project implementation also must be accompanied by state-aid funding schemes for private sector port investment and fleet modernization. These state-aid schemes shall follow the best practices on relevant state aid in Western Europe. Both state-aid schemes should be back financed by the Structural Funds under the new financial perspective for Croatia as EU member.

2. ANALYSIS OF EXISTING PORT INFRASTRUCTURE

The Port of Sisak is situated on the right bank of the Sava River, inside the Crnac settlement, and due to the pipeline connection with the Sisak oil refinery it is an industrial port (primary oil). The port consists of three loading and unloading pontoons for crude oil, petroleum products and pumping stations for freight handling. The current port capacity is approximately 1.5 million tons of freight per year and it cannot be increased due to the location of the port near the urban area of the city. Thus, the current activities of the port are limited to the crude oil transshipment.

In terms of throughput, the port of Sisak including the oil terminal at Crnac was the second largest river port in the former Socialist Federal Republic of Yugoslavia (SFRY) with an annual throughput varying between 0.8 and 1.0 million tonnes. In that period oil products from the Sisak refinery were transported via the terminal at Crnac to Pančevo on the Danube in Serbia.

There has been no recent activity as Sisak old Port other than sand and gravel operations. The crude oil unloading facility at Crnac receives crude oil from Slavonski Brod (originating from Croatian oil fields) by IWT.

The Sisak New port would involve the provision of additional land transport infrastructure (implementation of plans for extending the motorway system south from Zagreb to Sisak has been almost finished) and port facilities; these are apparently being planned with the purpose of positioning Sisak port as the Sava river facility serving the Zagreb hinterland and beyond.

The port of Sisak does not have a Master plan for future developments at the present site. This is logical in view of the encountered bottlenecks (water depth restrictions, bridge restrictions, poor sailing conditions on the Kupa river, limited terminal dimensions). The location of the existing port simply does not allow new port developments.

Medium-term Development Plan for Inland Ports and Inland Waterways (2008-2016) envisages the following activities for the Sisak New Port:

- Development of Master plan Sisak New Port
- Development of concept of the Sisak New Port
- Preparation of Feasibility study including Cost-Benefit analysis (CBA)

The construction of the Sisak new port is planned on the Sava river waterway (E-80-12) international mark according to European Agreement on main inland waterways of international importance (AGN) near Sisak, downstream of the existing Port. Its construction is anticipated south of the Crnac settlement in the area which is, by the existing spatial-planning documentation, intended for that purpose. The area is encircled by the Sava river on the north, the Blinja brook on the east, the Zagreb - Volinja railway tracks on the south and the Komarevo settlement on the west. The route of the new highway runs alongside the route of the planned New port of Sisak. The pipeline is located 2 km west of the envisaged location of the Sisak New Port. Specified area also includes the Donje Komarevo settlement.

The planned port area is to be situated on 400 hectares (4 square kilometers), depending on the traffic demand to be indicated by the feasibility study. The scope of the above area is 9.6 km. The size of area is approximately 3 km x 1,8 km. The width of the fairway near the future Sisak New Port is 70-72 meters and depth is 3-5 meters. Sisak New Port refers to 584 + 500 to 586 + 500 rkm. The expected traffic in the port is anticipated by 0.5 – 1 million tons in the first year.

In order to create the preconditions for the development of logistic centre in the area of Crnac and achieve functional connection of Zagreb industrial-economic area with the inland transport at the Sava River, the Sisak New port development must be observed also in the context of construction of Zagreb-Sisak motorway which construction is in progress.

The initiative for the construction of the Sisak new port has been indicated by the following bodies: Ministry of the Sea, Transport and Infrastructure, Sisak - Moslavina County, City of Sisak, Port Authority Sisak, City of Zagreb, International Commission for the Sava River Basin and other bodies within the inland transport sector in following documents: Croatian Transport Development Strategy, Inland Navigation Development Strategy (2008-2018) and Medium-term Development Plan for Inland Ports and Inland Waterways (2009 – 2016).

The analysis of the Sisak New port area in accordance with a spatial plan of the town of Sisak has been performed. Also, the alignments of the roads and rails and their connections with other routes and the Sisak New port have been determined.

Sisak New port area is scheduled by planning documentation:

- Spatial Plan of the Sisak-Moslavina County,
- Spatial Plan of the City of Sisak.

It is envisaged to have the following facilities and to enable the following activities in the port area of Sisak New port:

- container terminal,
- containers storage facility,
- customs terminal
- freight forwarding offices,
- ro-ro facility (roll-on /roll-off),
- administration building and terminal shunting station,
- parking center for cars and heavy goods vehicles,
- enclosed storage (various applications),
- logistics center,
- workshops for maintenance and repairs,
- auto logistics,
- terminal for raw materials and recycling,
- gas stations,
- ferry loading ramp for freight and passenger vehicles,
- loading cars and trucks to rail,
- combined cargo transport container handling terminal.

2.1. First findings and status quo of the project

Current port facilities adjacent to the area of the foreseen location of the new port comprise only of three loading and unloading pontoons used to facilitate the transshipment of crude oil and oil products via pumping stations. The immediate proximity of populated areas (City of Sisak and village of Crnac) hinders any further expansion of the port capacities which were estimated in previous studies to 1.5 million tons of freight (oil and oil products only) per year.

In the City of Sisak, there is another transshipment site on river Kupa, presently used only for handling of sand and gravel. According to the information gathered it is not foreseen that

these facilities will be relocated to the new port despite the worsening of navigating conditions on the Kupa River.

Plans of the Croatian Government to construct a new port on the new location in the vicinity of Sisak also involve the provision of additional land transport infrastructure (motorway from Zagreb to Sisak) and new port infrastructure necessary for handling of bulk and break-bulk cargoes. In this view, the present project was envisaged in the Medium-term Development Plan for Inland Ports and Inland Waterways (2009-2016).

2.2. Data collection

The Consortium's team has so far managed to collect most of the data foreseen to be collected in the Inception phase. The data collected so far is summarized in the following paragraphs.

For the purposes of the transport study, a number of issues have been tackled. In order to provide a solid basis for the elaboration of the transport study a proper insight has to be provided in the transport needs of the infrastructure users and the Sisak region. This implies that the demand has to be determined for the current situation and also estimated for the future situation. The future situation can be estimated using different scenarios.

The basis of this information depends upon traffic flows within and between the different Croatian zones and between Croatia/the Sisak region and other countries/regions. Therefore, the first step is to collect the available data. Besides the Croatian national data sources also EUROSTAT data will be used where appropriate. The collection of data will focus on (international) trade data, national transport data by mode with regional detail and if possible with an O/D structure, port/transshipment information, socio-economic data and traffic counts.

3. TRANSPORT STUDY & MARKET RESEARCH

This activity has been completed, evaluating the current status of the inland waterway transportation and transshipment in ports in Croatia as well as in South Eastern Europe. Current flows of national and international cargoes suitable for inland waterway transport responsible for transshipment in river port terminals and its origins, hubs and destinations in South Eastern Europe have been compiled to an origin-destination matrix, which covers all transport flows (road, rail and inland navigation transport) for year 2010 which are relevant for Sava River transport.

The research was supported by fact finding missions in Zagreb and Sisak having interviews with key logistic service providers, as well as regional enterprises stakeholders.

Meetings with following companies took place:

- Logistic Providers / Forwarders:
 - MSan (MSan group, MSan Zagreb, Rijeka – ZG transport) ; Kuehne + Nagel d.o.o; H.U.P. Hrvatska udruga poslodavaca/Banelli; Austrian Railways (ÖBB)/Express Interfracht; Dunavski Lloyd
- Enterprises:
 - Petrokemija; ABS (two meetings); INA; Metaling / CIOS group; SELK and Almos; Applied Ceramics (two meetings); Oberndorfer; Lipovica; Nexa
- Other stakeholders:
 - Forest Administration Sisak; Faculty of Metallurgy Sisak; Planning Department – City of Sisak ;Agency for Investments and Competitiveness ;SIMORA (two meetings) ;Sisak projekti ;Croatian National Railways

Based on the results of previous activities, the forecast of the future development (main scenario) was presented in a consolidated form to the participants of the information meeting on December 14, 2012 which also served as a meeting of an "Industry Reference Group".

The prognosis was detailed in a main scenario covering the years 2015, 2025 and 2035. In the following, based on the main scenario, the transport prognosis has been elaborated for a low and a high scenario to determine the limits of transport.

3.1. Transport study

Data from different statistical sources were assessed and matched in order to obtain a harmonized transport flow data basis. This statistical analysis was accompanied by interviews led with stakeholders of the industry, of transport and logistics companies and of the regional administration. The interviews were held in Zagreb, in Sisak-Moslavina region and in Vienna.

The first phase focused on collection and processing of existing cargo data and documents such as studies, statistics, trends, traffic data including the origin – destination matrices, annual reports of European, national and international organisations and all other relevant data in Croatia and its surroundings in order to provide a sound database for further processes in port master planning. This cargo related database together with information on the potential economic developments and information gather from local enterprises and stakeholders form a good foundation for both demand-driven and economic activity-generated port planning and development.

The second phase comprised compilation and matching of the existing cargo data (trade and transport database) to harmonised matrices (road, rail and inland waterway transport), the transport prognosis, based on the interview with companies and on the general economic development perspectives.

The transport prognosis provides transshipment volumes for Sisak New Port by commodities and by three development scenarios (low, main and high scenario).

In the framework of the transport research and supporting the development of the scenarios a regional (economy) analysis of the Sisak region was completed, which evaluates the development of industrial activities in relation to Sisak New Port.

The data show the expected transshipment potential in Sisak-Moslavina region, i.e. the transport flows in Sava Corridor, which use inland navigation and the other land modes of transport. The results for the Scenarios are given in the following sections.

Table 1. GDP and growth rate estimates

Type of technology	2010-15	2015-25	2025-35
GDP Croatia	+1,5	+2,4	+2,0
Low scenario			
Transport growth downstream	+1,0	+1,0	+0,9
Transport growth upstream	+1,0	+1,0	+0,9
Main scenario			
Transport growth downstream	+2,0	+1,8	+1,6
Transport growth upstream	+2,5	+2,0	+1,7
High scenario			
Transport growth downstream	+3,0	+2,8	+2,6
Transport growth upstream	+3,2	+3,0	+2,6
GDP Croatia	+1,5	+2,4	+2,0

Source: Contributed by author

Additionally, to reflect different growth perspectives of the industrial branches, distinctions were by transport modes with additional growth factors. The factors reflect increasing

competition in slow growing markets, which, in general, improve the positions of more flexible road transport and decrease competitiveness of inland navigation (Table 2):

Table 2. Growth assumptions per transport modes

Type of technology	Road	Rail	IWT
Low scenario	1,10	1,00	0,70
Main scenario	1,00	1,00	1,00
High scenario	0,90	1,00	1,05

Source: Contributed by author

3.1.1. Low scenario

In the Low Scenario the overall transshipment volume amounts to 2.01 million tons upstream, of which inland navigation holds a share of 0.41 million tons equivalent of 20.3%. Downstream the overall volume achieves 1.45 million tons, of which inland navigation has a share of 0.17 million tons equivalent of 11.8%.

3.1.2. Main scenario

In the Main Scenario the overall transshipment volume amounts to 2.41 million tons upstream, of which inland navigation holds a share of 0.64 million tons equivalent of 26.6%. Downstream the overall volume achieves 1.80 million tons, of which inland navigation has a share of 0.29 million tons equivalent of 16.3%.

3.1.3. High scenario

In the Main Scenario the overall transshipment volume amounts to 3.20 million tons upstream, of which inland navigation holds a share of 1.18 million tons equivalent of 36.9%. Downstream the overall volume achieves 2.16 million tons, of which inland navigation has a share of 0.37 million tons equivalent of 16.9%.

In the High Scenario, given a favourable economic framework, certain room for additional industrial development could be available, which could further increase transshipment volumes beyond the given figures. Since such development is highly speculative, it is has not been included in the calculations. Finally, a graphical representation of the transport forecasts is given in Figure 1.

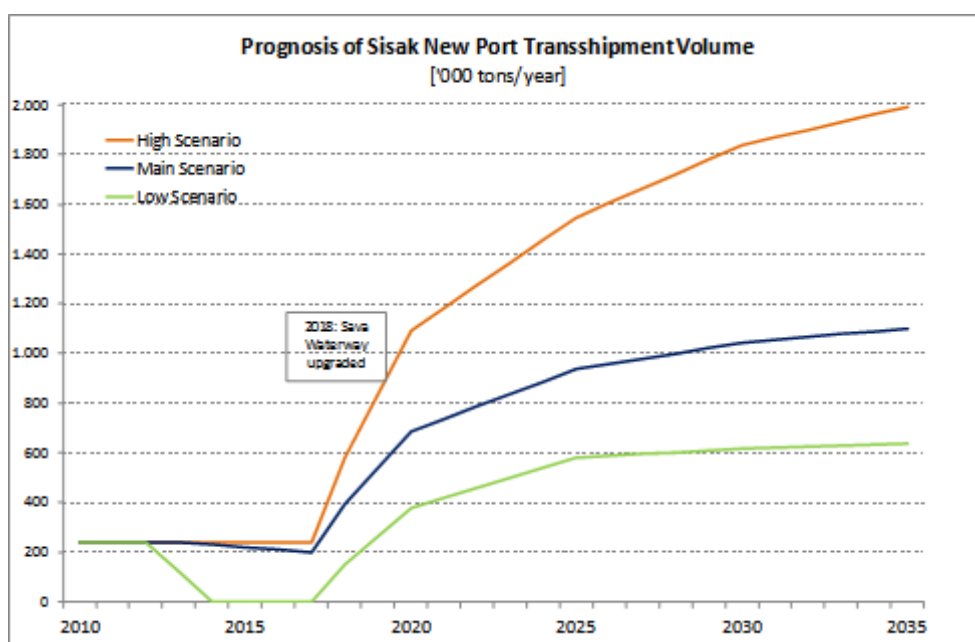


Figure 1. Transport volumes forecasts of the Sisak New Port up to year 2035

Source: Contributed by author

3.1.4. Results

For the estimation of the potential transshipment volumes of Sisak New Port and for the traffic flows along the Sava River Corridor, regionalized data were compiled for all international transport flows with origin or destination in Central Croatia (Zagreb and Sisak-Moslavina regions) and running parallel to Sava River.

For the year 2010, this potential is given with 1.7 million tons upstream and 1.1 million tons downstream, altogether 2.8 million tons. The modal shares show road transport ahead with 1.62 million tons, followed by rail transport with 0.96 million tons and inland navigation with 0.24 million tons (from Slavonski Brod to the Sisak refinery).

The data were used as a basis for the prognosis of transport volumes. Based on these figures the transport volume growth has been derived. In addition transport volumes identified in the bottom-up-analysis have been derived from the individual expectations of the companies interviewed. The companies' expectations were accepted as input for the Main Scenario.

3.2. Port layouts

In this reporting period, the Consultant performed an analysis of three port layout variants and several sub-variants. Given location and its shape offers several possibilities for the port layout. Analysis of possible port types and variants was based on:

- Transport forecast;
- Experience with similar port in the surroundings.

Same concept of port development was applied for each variant and sub-variant. Based on transport forecast for each scenario, three development phases were considered:

- Phase 1 building - two quays;
- Phase 2 building - additional two quays (four in total);
- Phase 3 building - additional two quays (six in total).

Port complex in all analysed layouts consists of port aquatory, port coast and port hinterland. Disposition of the port elements analysis implicated two basic port types: riverside port and basin port type. Variant A (Figure 1) analysed river-side port according the mentioned phases. In the third phase of this port type, building of the small basin for the liquid cargo is predicted.

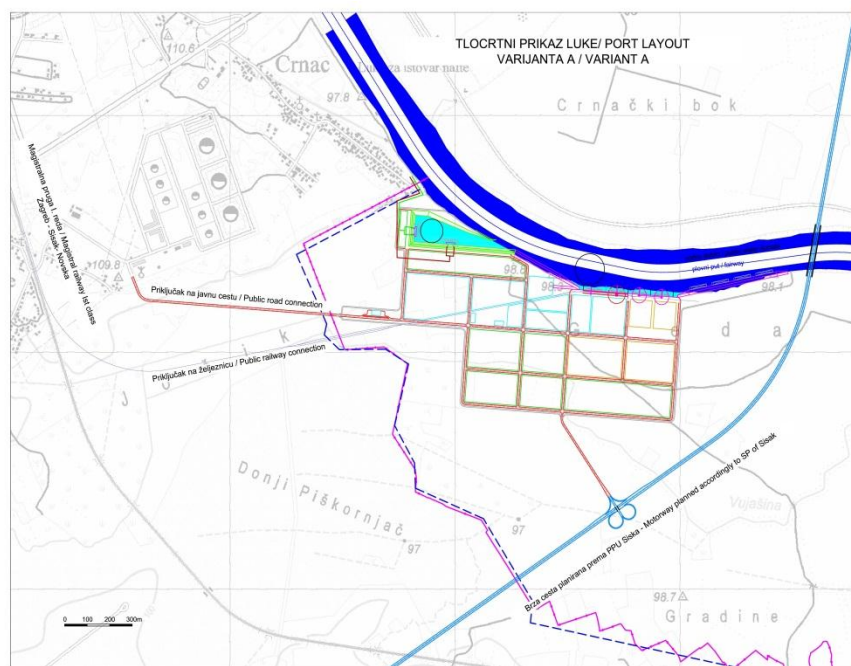


Figure 2. Port layout solution, Variant A – open shore port

Source: Contributed by author

Analysis of the basin port type imposed two basic solutions for this type of the port- basin location in north- south direction (Variant B – Figure 2) and basin location in east- west direction (Variant C- Figure 3).

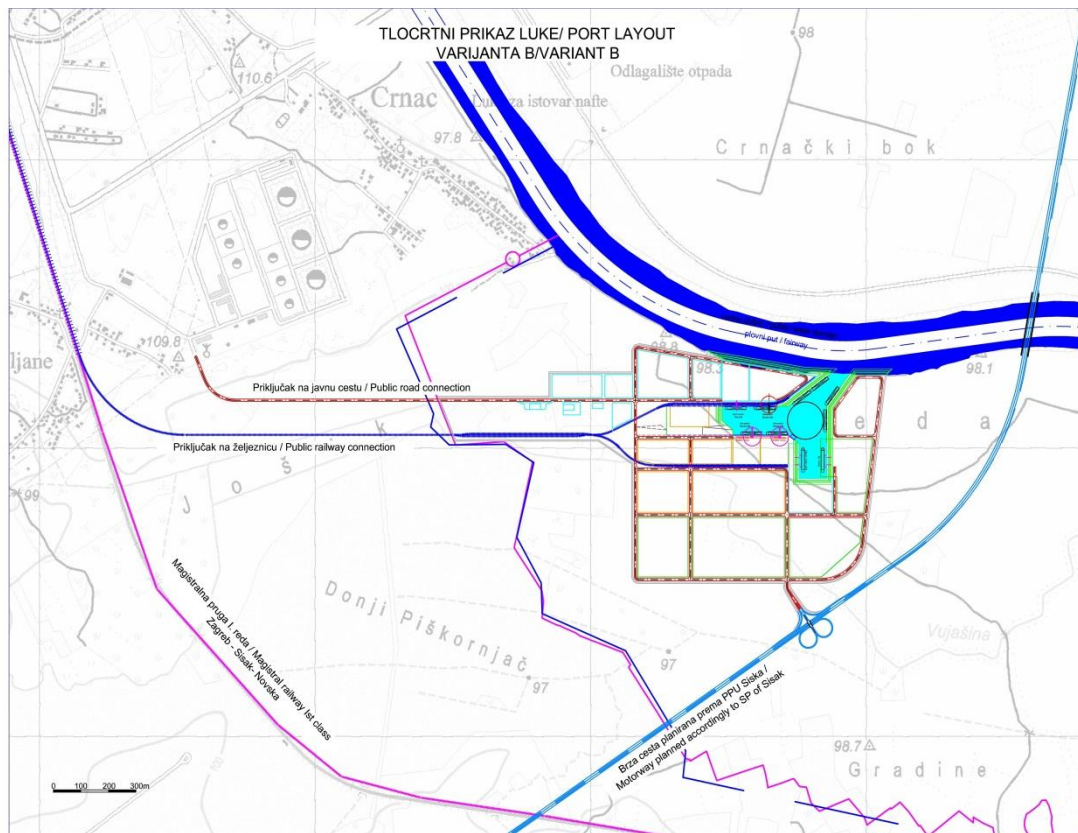


Figure 3. Port layout solution, Variant B – West-East basin

Source: Contributed by author

Hinterland of each port type includes zones for:

- Administration building; Customs; Workshops; Logistic centre; Gasoline station; Economic/industrial zones.

Corridors for further communal and energetic port infrastructure were defined:

- Water supply; Water sewer; Electricity and lighting; Telecommunication; Gas distribution; as well as transport infrastructure, such as internal railways, roads and parking places.

Each variant was evaluated based on hydraulic-hydrological aspects, navigation & traffic aspects, construction & quality aspects, operational aspects, environmental impact, safety & security aspects. As a result of port layout variants evaluation, variant B was proposed as most preferable layout solution for Sisak New Port.

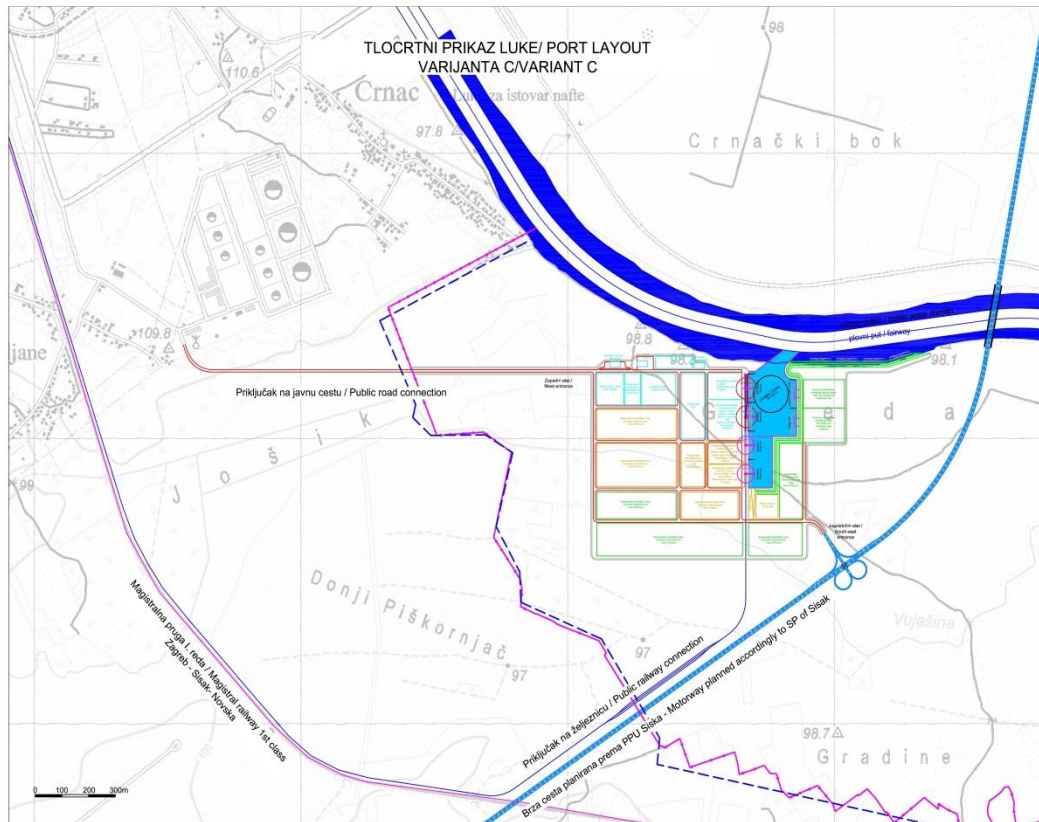


Figure 4. Port layout solution, Variant C – North-South basin

Source: Contributed by author

4. FEASIBILITY STUDY AND COST BENEFIT ANALYSIS

According to the methodological approach agreed, the consultant has started to produce a template for each type of the data inputs (CAPEX-Capital Expenditures, OPEX-Operational Expenditures, REVIN- Revenues, and Economic Benefits) needed for elaboration of the Financial and Economic Analysis of the New Port Sisak Investment as well to the Sensitivity and Risk Analysis ones.

In this respect the progress work for refining of the following templates as well its data collection is presented below.

4.1. Financial Cost-Benefit Analysis

The breakdown of Investment Costs was made for each investment phase as well as for the layout type and the corresponding costs were divided into 4 categories:

1. Costs related to site preparation;
2. Infrastructure Costs (Road, Railway, Waterway, Outdoor Installations);
3. Transshipment facilities and Equipment/Superstructure Costs;
4. Miscellaneous Costs (including service facilities, -buildings, safety and security elements, as well as planning and other contingency expenditures).

Based on data collection organized in the produced template, several variants of costs for different layout variants were calculated and will be taken into account as inputs for the financial performance indicators within Financial Costs Benefits Analysis.

As these data are fully dependable of the port design layout, work regarding CAPEX data inputs is still on-going as the final one needs to be further refined.

According to the template produced the operating expenditures were broken down into four categories:

1. Labour Costs
2. Public Utilities (Electricity, Gas, Water, Drainage, Sewage)
3. Equipment Fuel Consumption
4. Miscellaneous (including the maintenance of infrastructure as well of superstructure)

The data regarding the tariffs as well as the different labour structures was collected from other Croatian Ports –Vukovar Port as well as from other Danube ports in order to provide indication for additional revenues categories.

Based on data collection organized in the produced template, several variants of costs for different layout variants were calculated and will be taken into account as inputs for the financial performance indicators within Financial Costs Benefits Analysis.

As these data are fully dependable on the port design layout, work regarding OPEX data inputs is still ongoing as the final design layout needs to be further refined.

In order to prepare the work for calculating the potential revenues for the Sisak port green field investment, the Consultant has undertaken preparatory work based on inputs of the Traffic and Market study previously deliverable in order to produce:

- Calculations of the traffic forecast for the remaining years between 2020 and 2044;
- Calculations of the ships number which are estimated to call at the port taking into account also the envisaged loading capacity per ship;
- Aggregation of the NST-07 categories into 3 big categories (dry-bulk, liquid, general cargo, heavy cargo);
- Calculation of average Sava river shipping distance indicator.

In parallel with the preparatory work, the Consultant started to collect the necessary input for the calculation of the operating revenues. According to the produced template the following categories of revenues were considered:

- Real estate, Transshipment, Railway utilization , Port Dues, Public Utilities Network Utilization.

Data regarding port dues and tariffs were collected from other Croatian Ports particularly Vukovar Port as well as other Danube ports for other additional revenues categories which do not exist in other Croatian river ports.

Based on data collection organized in the produced template, several variants of revenues for different layout variants were calculated and will be taken into account as inputs for the financial performance indicators within the Financial Costs Benefits Analysis.

As these data are dependable of the final port design layout the work regarding REVIN data inputs is still pending to the final design layout and needs to be further refined and finalised.

All above inputs (CAPEX, OPEX and REVIN) are considered crucially for the calculation of the financial performance indicators (FIRR-Economic Internal Rate of Return and FNPV-Economic Net Present Value) within Economic Cost Benefit Analysis according to the CBA Guide to Cost-Benefit Analysis of Investment Projects, DG REGIO 2008, and the rules displayed in Guidance on the Methodology for Carrying out Cost – Benefit Analysis, Working document No. 4, DG REGIO 2006.

4.2. Economic Cost Benefit Analysis

In order to prepare the work for calculating the potential economic benefits of the green field investment, the consultant has undertaken preparatory work based on inputs of the Traffic and Market Study as well other studies in order to elaborate:

- Extrapolations and calculations of the traffic forecast for the years between 2020 and 2044;
- Calculation of average Sava river shipping distance indicator using the traffic projections;
- External costs for different transport modes particularly for Inland Waterway and Road Transport.

In this respect the consultant used as a reference the Marco Polo Calculator edition issued in 2010.

Regarding transport costs for different transport modes particularly for Inland Waterway and Road Transport, the consultant used studies from the OIR – Austrian Institute for Spatial Planning. Following types of economic benefits for the Croatian economy were considered as a result of Sisak New Port investment:

- External costs savings due to modal shift from road to inland waterway;
- Transport costs savings due to modal shift from road to inland waterway.

These two categories of benefits will form the basis for calculating the economic performance indicators according to the Economic Costs-Benefit Analysis.

The economic benefit spread sheet as well as the economic costs one (dependable of the final designing layout) are considered as crucial inputs for calculation of the economic performance indicators (EIRR-Economic Internal Rate of Return and ENPV-Economic Net Present Value) as well as for the Sensitivity and Risk Analysis within Economic Cost Benefit Analysis according to the CBA Guide to Cost-Benefit Analysis of Investment Projects, DG REGIO 2008, and the rules displayed in Guidance on the Methodology for carrying out Cost – Benefit Analysis, Working document No. 4, DG REGIO 2006.

Taking into account that the final layout of the Sisak New Port has to be approved in its final version by the beneficiary, the consultant elaborated a first set of cost and revenues calculations which will be finalized in the future work process and based on the feedback of the beneficiary as well as the involved stakeholders.

5. CONCLUSION

A successful implementation of the New Port Sisak requires a strong co-ordination of the project with the objectives and the priorities of the forthcoming Operational Programs of Transport and Regional Development of the European Union. Further EU support for the implementation is considered essential as well as accompanying state-aid schemes to trigger parallel private investment in terminals and fleet modernization. By combining the national and EU development strategies, the project has the potential to serve as an important catalyst for the re-industrialization of the Sisak – Moslavina County and to become a best practice project for integrated and sustainable port development. Thus, the project could make an important contribution to trigger economic growth and jobs for the City of Sisak as well as for the entire region.

Transport and market study, which is in its final stage, will be used as an important input for the port planning phase and for the determination of demanded size, purpose and activities of the new port.

The planned civil engineering works result into the need to re-locate the proposed electric power line as well as the planned motorway route. For the electric line a compromise could be elaborated, the issue of the motorway will be discussed with the relevant authorities in the next reporting period.

The activities of the project have entered the most intensive phase from the engineering point of view, as the selected variants of the port layout, based on numerous planning, engineering, hydraulic, organisational and operational analyses, were presented to the defined stakeholders. The Ministry in charge confirmed the draft design solution B as the most preferred one which provided the Consortium with an important feedback and the necessary directions for further work and detailed planning. In parallel, the CBA analysis has been commenced in this reporting period within the foreseen timeline. The CBA will reveal important financial and economic aspects of the selected design solution, thus validating the planning and engineering work done so far and setting the scene for final aspects of the engineering part of the Master Plan.

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PROCEDURE FOR CALCULATION OF STOPPING DISTANCE AND TIME OF PUSHED CONVOYS

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ABSTRACT

Movement of vessel is realized under the influence of the force of propulsion, which is created by a propeller or other types of propelling devices. After the change of the working regime of the propelling engine the speed of the vessel changes according to certain rules, while at the same time vessels obtains irregular movement. Traveled distance and time lapsed of a certain maneuver, which take time during this irregular movement are called inertial characteristics of a vessel. These characteristics mostly depend on the type of maneuver, influence of external conditions, depth of waterway as well as the extent of loaded cargo. In this paper the method for calculation of stopping distance and time will be presented for motor cargo vessels of different capacities which realize their propulsion through so called „Z“ transmission of different types.

KEYWORDS

motor push boat, waterway, inertial characteristics, stopping time, stopping distance

POSTUPAK PRORAČUNA PUTA I VREMENA ZAUSTAVLJANJA POTISKIVANIH SASTAVA

APSTRACT

Kretanje broda ostvaruje se pod dejstvom sile propulzije, koju stvara peopeler ili brodsko kretno sredstvo nekog drugog tipa. Posle promene režima rada pogonskog motora brzina broda se menja po određenom zakonu, dok brod dobija neravnomerno kretanje. Put i vreme nekog manevra, koji se odvijaju po neravnomernom kretanju, nazivaju se inercijalne karakteristike broda. Ove karakteristike, u najvećoj meri, zavise od vrste manevra, delovanja spoljnih uslova, dubine u plovnom putu kao i stepena utovarenosti broda. U radu biće predstavljen postupak proračuna zaustavnog puta i vremena motornih brodova za prevoz tereta različitih nosivosti koji propulziju ostvaruju sistemom tzv. Z prenosa različitih tipova.

KLJUČNE REČI

motorni potiskivač, plovni put, inercijalne karakteristike, zaustavno vreme, put zaustavljanja

1. INERTIAL CHARACTERISTICS OF A VESSEL

Movement of a vessel is realized with the propelling force created by the propeller or other propelling device. After the change of the working regime of vessels engines the speed of navigation changes according to certain law, while the vessel gets irregular movement

Distance and time of a certain maneuver, which is done by irregular movement, is called *inertial characteristics of a vessel*. These characteristics, in great extent, depend on the type of mauve, influence of external forces, depth of waterway as well as the degree of the use of the vessel's carrying capacity.

The most important inertial characteristics are: *acceleration, movement under inertia, active slowing down and loss of speed*.

In this paper the means for calculating the total time and distance for stopping a pushed convoy with the adopted characteristics with the use of active stopping.

Active stopping is characterized by the process of accelerated loss of speed of a vessel by the propelling force which is in opposite direction to the movement. Highest interest in practical work during navigation presents overturning the movement of propelling engines from forward regime to reverse regime.

The movement of vessel in the stated regime is described with system differential equations in the following form:

$$\left. \begin{aligned} (m + \lambda_{11}) \frac{dv}{dt} + R_X + R_P - T + X_A &= 0; \\ (m + \lambda_{22}) \frac{dv}{dt} \cdot \alpha - Y_P - F + R_{Y(B)} + Y_A &= 0; \\ (J + \lambda_{66}) \frac{d\omega}{dt} + M_B - M_P - M_A &= 0 \end{aligned} \right\} \quad (1)$$

where the following are:

- m – mass of a vessel;
- λ_{11} – pulled mass of the water during the movement of vessel in the X axis which is oriented in the symmetry plane of the vessel;
- R_X – force of the resistance of water which influences vessel in the plane of symmetry of vessel and it is opposite to the direction of movement;
- R_P – lengthwise component of the force of water on the rudder which is put out of the plane of symmetry for the angle α ;
- T – propelling force created by the propelling device;
- X_A ; Y_A – corresponding lengthwise (X_A) and transversal (Y_A) components of the force of the wind;
- λ_{22} – pulled mass of the water during the movement of vessel in the Y axis (normal to the symmetry plane);
- α – drift angle of the vessel;
- Y_P – sideways force of the rudder moved from the plane of symmetry for the angle α ;
- F – centrifugal force of inertia;
- $R_{Y(B)}$ – transversal hydrodynamic force which has influence on the vessel's hull during its navigation with the angle α ;
- J – moment of inertia of the vessel to the vertical axis Z;
- λ_{66} – moment of inertia of pulled mass of water to the axis Z;
- M_B – moment of transversal hydrodynamic force $R_{Y(B)}$ in relation to axis Z;
- M_P – moment of lateral force of the rudder Y_P in relation to axis Z;
- M_A – moment of the force of wind Y_A in relation to axis Z;
- ω – angular velocity of vessel.

If the influence of wind is not considered then equation (1) can be written in the following form:

$$m \cdot \frac{dv}{dt} = \pm z \cdot T - K \cdot v^2 \quad (2)$$

where the following are:

- m – mass of the vessel and mass of water being pulled behind it where $m \approx m \cdot (1 + k_{11})$;
- k_{11} – is coefficient of drawn mass of water;
- v – Speed of the vessel in the direction of longitudinal axis of symmetry;
- z – total number of vessels propelling devices (propellers);
- T – Propelling force achieved by one propeller (+ is used for the acceleration regime and – is used when the vessel is stopping);
- K – proportion coefficient.

The given equation (2) doesn't consider the force of resistance of the rudder when it forms an angle with the axis of symmetry of the vessel, since that force for low values of the angle influences inertia characteristics equally low.

Left part of the equation (2) presents the inertia force and it is presented by multiplied mass and acceleration of a vessel while the right part of the equation is the force which increases the speed of navigation to the wanted or it prevents it. Force of the resistance, given as $K \cdot v^n$ is opposite to the direction of movement of the vessel and its real value, mostly, depends on the exponent of the speed (n). Plus sign before the force of resistance is for the case when the vessel is gaining speed (accelerating), while minus sign is for the case when it is stopping.

2. VESSEL'S STOPPING MANOEUVRE

Most important characteristics of the stopping maneuver of a vessel are: *time* (t), *stopping distance* $S(t)$ and *speed of navigation* $v(t)$.

In real navigating conditions most effective way of stopping a vessel is achieved by the work of a propeller. The length of stopping distance and time depend on several basic factors such as: displacement of a vessel, actual speed of navigation, type of the propelling engine and its power, type and characteristics of propulsion unit.

The change in the direction of propeller's rotation is done to change the direction of movement of vessel (forward or backward) and, also for acceleration, or deceleration. There are two in principle different methods for changing the direction of rotation of propeller: 1) the use of specialized mechanism for the change of direction; 2) the use of mechanical, hydraulic or electric transmission that is situated between propelling engine and propeller. During the last years specialized mechanisms for the change of direction is installed only in vessels that are propelled by slow turning diesel engines with high power, while faster turning diesel engines are equipped with couplings with mechanical or electrical transmission. The mechanism for direction change makes whole with fuel supply system, engine starting system and remote control of the engine.

The process of stopping an inland vessel in forward regime, can be conditionally divided into three periods which are:

The first period (characterized by time t_1) – length of this period consists of the following elements: navigator grabs the handle which controls number of rotations of propelling engine when the vessel is in regime „full speed ahead“ and places it into „stop“ position; so, this period lasts from the moment when the engine develops full power to the moment of placing it into „stop“ position, or in other words, until stopping the fuel supply to the engine. During that period vessel continues its movement with the unchanged speed (v_c). The distance that vessel covers in that first period is:

$$S_1 = v_c \cdot t_1 \quad (3)$$

where the following are:

v_c – initial speed of the vessel, m/s;

t_1 – duration of the first period, s.

Duration of the first period (t_1) depends on type of the propelling engine, type of the system for remote control of the engine, as well as the speed of operation of the navigator. Time (t_1) can be determined only experimentally for specific vessel.

The second period (characterized by time t_2) lasts from the moment of stopping of the fuel supply to the engine (measuring from the moment of calming of rotation masses of the engine, transmission and propellers) to the moment when the propeller is rotated for 180° from the starting position. Basically this second period mostly depends on type of the propelling engines, type of the propulsion device and is usually determined statistically.

Movement of a vessel in this second period can be adopted as regime of *slowing down*, or *passive stopping*, which can be defined with the following equation:

$$m \cdot \frac{dv}{dt} + (\varepsilon + \varepsilon_B) \cdot K \cdot v^2 = 0 \quad (4)$$

where the following are:

ε – coefficient which accounts for the influence of depth of waterway;

ε_B – coefficient which accounts for the work of the propellers.

After integration between 0 and t_i and from v_c to v_i following is obtained:

$$t_i = \frac{m}{K \cdot (\varepsilon + \varepsilon_B)} \cdot (v_i^{-1} - v_c^{-1}) \quad (s) \quad (5)$$

from where it follows:

$$v_i = v_c \cdot \left[\frac{K \cdot (\varepsilon + \varepsilon_B) \cdot v_c}{m} \cdot t_i + 1 \right]^{-1} \quad (m/s) \quad (6)$$

Previous expression (6) presents the possibility to calculate the value of the speed for any part of the passive stopping if the values m and K are known. If in the expression (6) $t_1 = t_2$ is adopted calculations will give $v_1 = v_2$.

In order to determine the length of the distance of passive stopping the expression which refers to one of its elementary parts has to be used, or in other words for $dS = v_i \cdot dt$. If in the expression (6) $v_i = \frac{dS}{dt}$ is placed, after the integration the length of the stopping distance for this period can be determined:

$$S_i = \frac{m}{K \cdot (\varepsilon + \varepsilon_B)} \cdot \ln \frac{v_c}{v_i} \quad (m) \quad (7)$$

Analogue to this for $v_i = v_2$ it can be obtained that $S_i = S_2$.

By analyzing the expressions (5) and (7) for the passive stopping regime, in theory the complete stopping of the vessel (when $v_i = 0$) comes only when $t_i = \infty$, where $S \rightarrow \infty$. In real conditions, which has been confirmed with experiments, vessels stop after complete loss of speed.

In practical tasks, however, time and distance can be calculated if it is adopted that at the end of period of stopping the speed has some value which is very small at which the vessel, practically, can be treated as it has completely stopped, for example $v_i = 0,05 \cdot v_0$ or at most $v_i = 0,1 \cdot v_0$.

The third period (characterized by time t_3) presents the active part of stopping of a vessel and it lasts from the moment when the propeller is rotated for 180° from the starting position of forward regime to the moment of placing the handle into the reverse regime with the given number of rotations of the engine. the process of active stopping can be described with a differential equation of the following form:

$$m \cdot \frac{dv}{dt} = -z \cdot T - \varepsilon \cdot v \cdot K \quad (8)$$

The differential equation (8) is only correct if certain assumptions are made and introduced. Research has shown that the propelling force in the backwards regime slightly (neglectably low) changes within certain limits and equally to certain average value (T) which, in final results, is equal to $T(t)$. In that case the integration of the expression (8) is possible. If the starting conditions characteristic for the second period are adopted $t_i=t_2$, $S_i=S_2$ and $v_i=v_2$ the expressions which define the third period can be obtained:

$$t_i = \frac{m}{\varepsilon \cdot K \cdot b_T} \cdot \left(\operatorname{arctg} \frac{v_2}{b_T} - \operatorname{arctg} \frac{v_i}{b_T} \right) \quad (9)$$

$$S_i = \frac{m}{2 \cdot \varepsilon \cdot K} \cdot \ln \frac{b_T^2 + v_2^2}{b_T^2 + v_i^2} \quad (10)$$

$$b_T^2 = z \cdot T \cdot (\varepsilon \cdot K)^{-1} \quad (11)$$

where the following are:

t_i – time of active stopping, s;

v_i – speed that the vessel achieves during the period of active stopping, m/s;

S_i – travelled distance during active stopping, m.

The third period ends when it is achieved that $v_i=0$. Then the following are:

$$t_3 = \frac{m}{\varepsilon \cdot K \cdot b_T} \cdot \operatorname{arctg} \frac{v_2}{b_T} \quad (12)$$

$$S_3 = \frac{m}{2 \cdot \varepsilon \cdot K} \cdot \ln \left(1 + \frac{v_2^2}{b_T^2} \right) \quad (13)$$

The final expressions for total stopping time and distance of a vessel is obtained by adding of the different individual time periods, as:

$$t = t_1 + t_2 + t_3 \quad (14)$$

$$S = S_1 + S_2 + S_3 \quad (15)$$

3. METHODOLOGY FOR CALCULATION OF INERTIAL CHARACTERISTICS OF VESSELS

Solution of the differential equation (1) is applicable for different cases of slowing down (or stopping) and acceleration of vessel and it is directly correlated to the assumptions whose introduction limits the accuracy of the chosen methodology of calculation. Several methods are being used lately, with different degrees of error, which enable the calculation of wanted parameters of the vessel's movement. Results of calculations approximate the results obtained by experimental measurements in real navigating conditions only when the corrective coefficients are introduced into used equations, obtained through experimentations.

In all the expressions for calculation of inertial characteristics the common is relation between *mass* and *coefficient of resistance*. From the theory of the ship it is known that:

$$R(v) = K \cdot v^2 \quad (16)$$

where from it follows:

$$K = \frac{R(v)}{v^2} = 0,5 \cdot \rho \cdot \Omega \cdot \xi \quad (17)$$

where the following are:

R – force of the resistance of water, N;

ρ – density of water, kg/m³;

Ω – wetted surface of the vessel's hull, m²;

ξ – coefficient of total resistance.

Wetted surface of the vessel's hull is determined according to curves from the vessel's drawing or based on the known expressions, such as:

$$\Omega = L \cdot T \cdot \left(1,36 + 1,13 \cdot C_b \cdot \frac{B}{T} \right) \quad (18)$$

where the following are:

L – length of the vessel on actual water plane, m.

C_b – block coefficient;

B/T – relation between width of the vessel and actual draught.

Coefficient of total resistance for the known starting speed of the vessel (v_0) is determined according to the expressions (16), (17), where the value of resistance of the vessel is determined from the graph of the resistance constructed for the observed vessel.

Calculation of the coefficient (K) for other values of vessel's speed can, approximately, be drawn from the expression:

$$\bar{v} = \frac{v_i}{v_0} = \sqrt{\frac{K}{K_H}} \quad (19)$$

where the following are:

v_i – speed of the vessel for which the calculation is being conducted, m/s;

K_H – value of coefficient of resistance for the starting speed v_0 .

Coefficient of influence of waterway depth (ε) and free rotating propeller (ε_B) are determined according to following expressions:

$$\varepsilon = \left[1 + 0,33 \cdot \frac{T}{H_{pp}} + 1,1 \cdot \left(\frac{T}{H_{pp}} \right)^3 \right] \quad (20)$$

$$\varepsilon_B = \frac{R_B}{R} = 100 \cdot \frac{D_B^2}{K_H} \cdot \frac{A}{A_d} \quad (21)$$

where the following are:

T/H_{pp} – relation between draught of the vessel and depth of waterway;

R_B – force of resistance of free rotating propeller, N;

A/A_d – relation between real area of propeller's wings and the area of propeller's circle;

D_b – diameter of propeller, m.

Coefficient of drawn mass of water is calculated according to the methods of theoretical hydrodynamics, while for approximate calculations the following expressions are being used:

$$k_{11} = 0,5 \cdot T \cdot L^{-1} \quad (22)$$

$$k_{22} = (2 \cdot T \cdot B^{-1}) \cdot [1 - B \cdot (2 \cdot L)^{-1}] \quad (23)$$

where k_{11} is coefficient of drawn mass of water during movement of vessel on the axis (x), while k_{22} is coefficient of drawn mass of water during movement of vessel on the axis (y).

To determine characteristics of vessel's slowing down on the backwards regime of the engines it is necessary to calculate force of propulsion of propeller (T), according to the following expression:

$$T = k_T \cdot \rho \cdot n_1^2 \cdot D_B^4 \quad (24)$$

where the following are:

T – force of propulsion of propeller, N;

k_T – coefficient of propeller's propulsion force in its backwards regime,

n_1 – number of rotations of propeller in backwards regime, s^{-1} .

According to notations in the expression (11) it follows that:

$$b_T^2 = \frac{T}{K_1} = \frac{T}{K_H \cdot \left(\frac{v_2}{v_0}\right)^2} \quad (25)$$

where v_2 – is the speed of vessel at the beginning of the third period of vessel stopping process, m/s.

Expression (25) enables the approximation of the parameter (b_T) for the given degree of use of carrying capacity of vessel. In cases of change in draught it is necessary to calculate (b_T) according to expressions (17), (19) and (24).

4. RESULTS OF THE RESEARCH

The research that relate to the use of calculation methods for determination of stopping distance and time have been used for motor push boat of high power of propelling engines ($N=3 \times 1295,36 \text{ kW} = 3886,08 \text{ kW}$). The general plan of such vessel is presented in the figure 1, while its basic characteristics are given in the table 1.

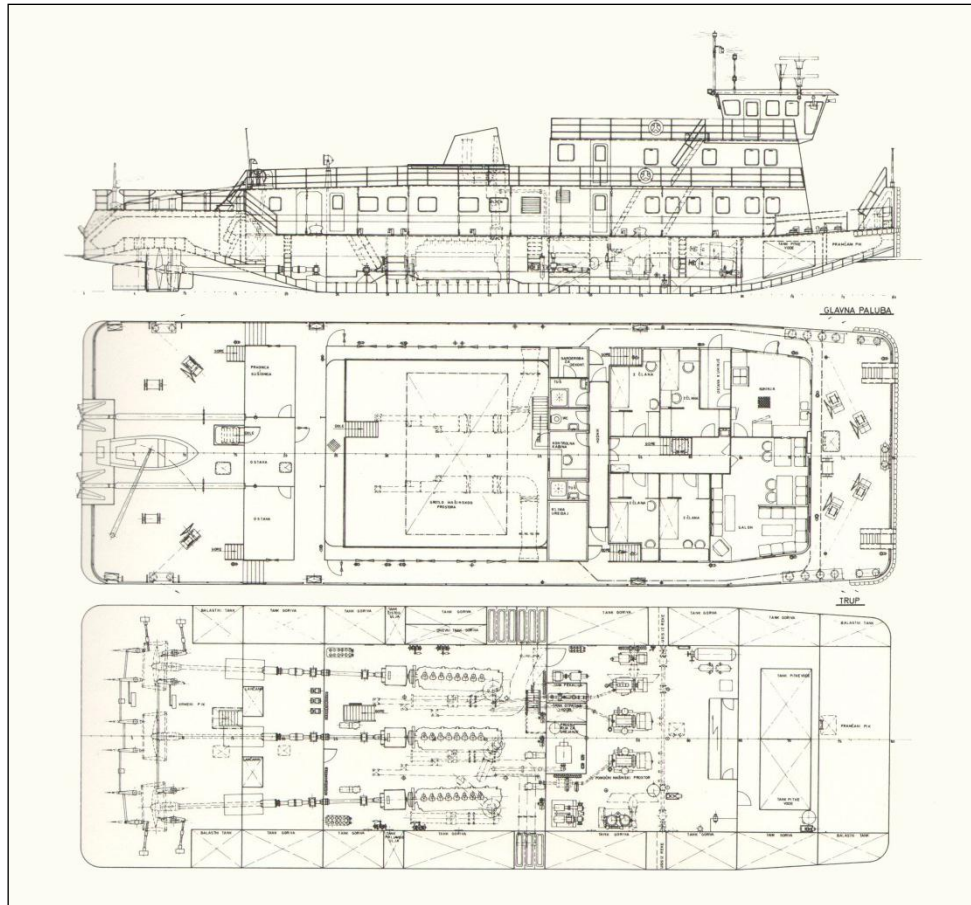


Figure 1. General plan of motor push boat (N=3×1295,36 kW=3886,08 kW)

Source: "Dunavbrod" Beograd, Business association of Yugoslav river shipbuilding, catalogue

Table 1. Basic characteristics of motor push boat (N=3×1295,36 kW=3886,08 kW)

Characteristic	denotation	value
maximal length of the vessel, (m)	L_{oa}	40,45
length at CWL, (m)	L_{CWL}	38,76
width at CWL, (m)	B_{CWL}	13,00
freeboard (m)	H_K	2,80
highest draught, (at CWL) (m)	T_{max}	1,80
displacement at T_{max} (CWL), (m ³)	V_{CWL}	810,00
block coefficient	C_b	0,891
type of the propelling engine	Tvornica Jugoturbina, Karlovac	
number of propelling engines	3	-
power of propelling engines, (kW)	N	1295,36
number of rotations, (r/min)	n_m	750
reduction		2,5:1
number of propellers	3	-
number of rotations of propellers, (r/min)	n_p	300
diameter of propellers (mm)	D	2000

Source: Yugoslav Register of inland vessels, Belgrade 1994

Calculation example of stopping distance and time is applied for pushed convoy which is made of push boat and not symmetric barges whose basic characteristics are presented in table 2, while general plan of those barges is shown in figure 2.

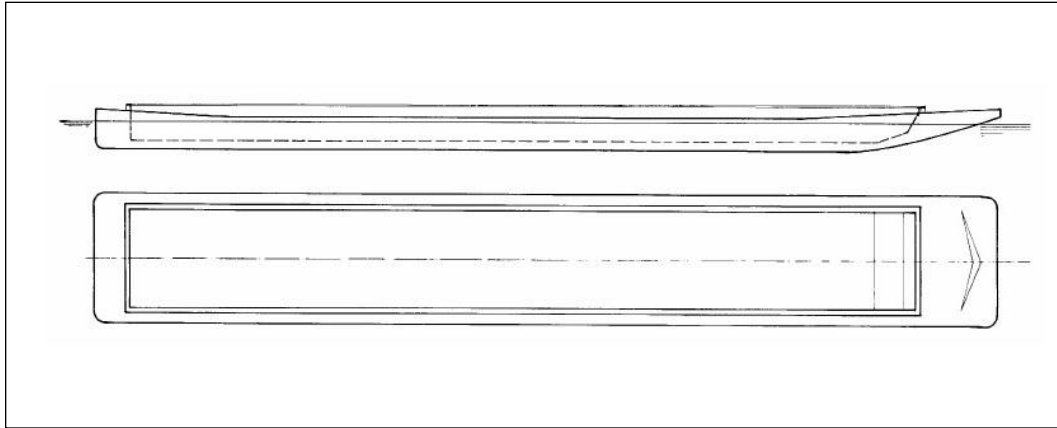


Figure 2. General plan of barges for dry cargo with carrying capacity of 1.700 t

Source: "Dunavbrod" Beograd, Business association of Yugoslav river shipbuilding, catalogue

Table 2. Basic characteristics of barges for dry cargo

Characteristic	denotation	value
maximal length of the vessel, (m)	L_{oa}	77,00
length at CWL, (m)	L_{CWL}	75,70
width at CWL, (m)	B_{CWL}	10,96
freeboard (m)	H_K	2,83
highest draught, (at CWL) (m)	T_{max}	2,65
displacement at T_{max} (CWL), (m^3)	V_{CWL}	2047,96
registered carrying capacity, (t)	Q_r	1700
block coefficient	C_b	0,9314

Source: Yugoslav Register of inland vessels, Belgrade 1994

Shape of pushed convoy for which the stopping distance and time calculations have been done is presented in the figure 3.

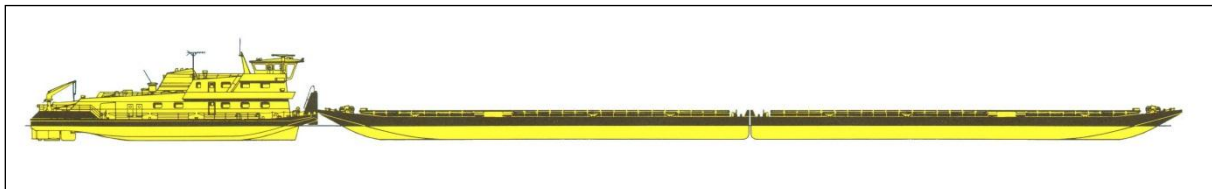


Figure 3. Shape of pushed convoy

Source: La voie navigable – une voie d'avenir, L'Office National de la Navigation, catalogue

Graph of active stopping of pushed convoy shown in the figure 3 with the use of propellers (maneuver full speed ahead-full speed reverse), loaded to the maximal draught ($T_{max}=2,65$ m) which navigates in calm water where depth of waterway is $H_{pp}=6,0$ m with the speed $v=14,0$ km/h is shown in the figure 4. Adopted times of the first and the second period important for the calculation of the total stopping distance, as well as calculated values which refer to the third period are:

- in the first period time $t_1=12$ s and stopping distance $S_1=46,66$ m;
- in the second period time $t_2=15$ s and stopping distance $S_2=56,267$ m;
- in the third period time $t_3=267,897$ s and stopping distance $S_3=167,421$ m.

Based on adopted and calculated values it follows that total time and total stopping distance of this pushed convoy are:

$$\Sigma t = 294,897 \text{ (s)} = 4,915 \text{ (min)}$$

$$\Sigma S = 270,354 \text{ (m)}$$

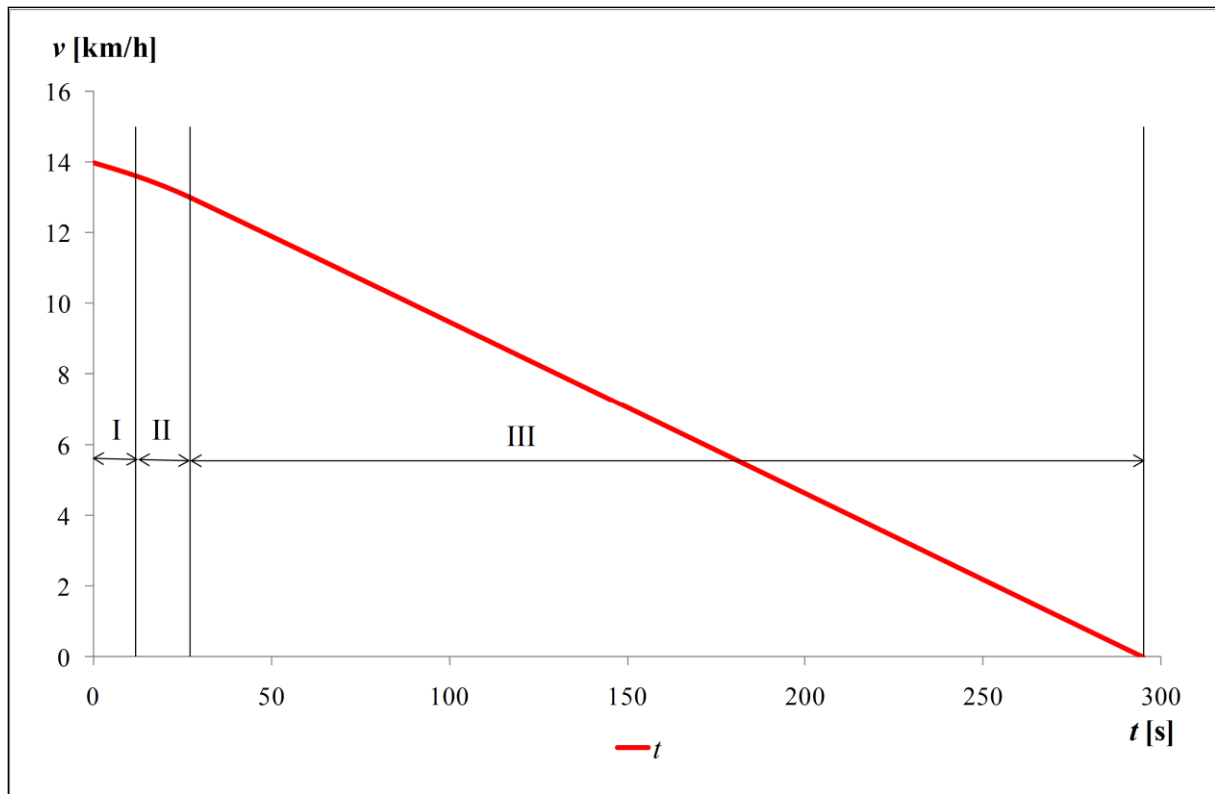


Figure 4. Graph of stopping time of pushed convoy with the use of propellers of push boat
Source: Authors

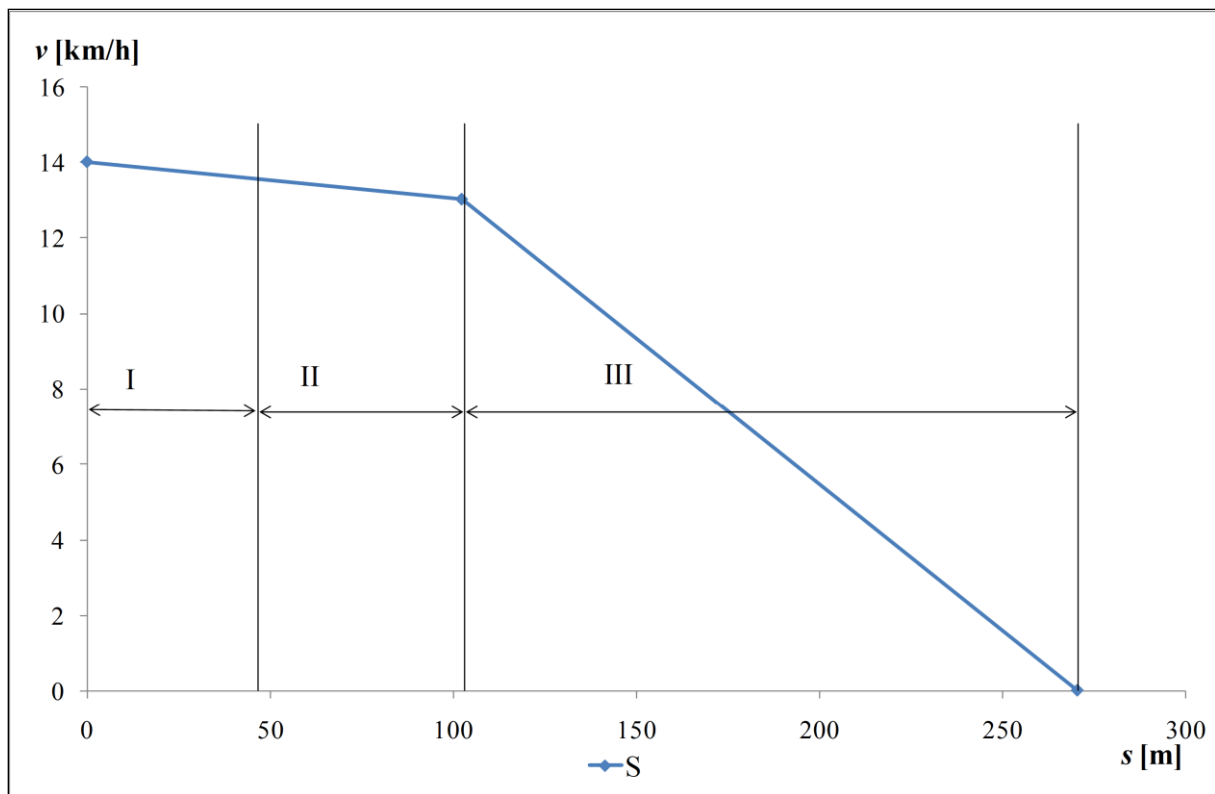


Figure 5. Graph of stopping distance of pushed convoy with the use of propellers of push boat
Source: Authors

5. CONCLUSION

In order to provide secure navigation stopping distance and time when it is possible to change them within given boundaries, as well as character of those changed in time are considered as very important inertial characteristics. Knowing the stopping distance and time of vessels is of special interest for navigators. These characteristics must be well studied, and they are determined by calculations and experiments with already built vessels.

Since inertial characteristics are directly related to the mass of the body and acceleration generated during the process of change of the movement, then these characteristics will depend on the displacement of a vessel and the starting speed of its movement.

Besides that it is necessary to know that characteristic of active slowing down are influenced, besides stated factors, by the power of propelling engines and possible speed of their change of direction. Last characteristic depends both on objective factors (such as, for example, type of the engine, power etc.), as well as on subjective factors – experience of the navigator which should switch the engines from forward to backwards.

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PROSPECTS OF REDUCING CO₂ EMISSIONS IN INLAND NAVIGATION REGARDING SHIP BASED TECHNOLOGIES

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ABSTRACT

The White paper on Transport released by European Commission in 2011 emphasise the need for reducing greenhouse gas (GHG) emissions from transport sector of at least 60 % by 2050. Inland waterway transport (IWT) is recognized as environment friendly mode although according to the Mid-term progress report on the implementation of the NAIADES Action Programme there is still a room for innovations in the fields of emission reduction and new technologies for vessel power supply. Current low GHG emissions from IW vessels including the most significant CO₂ are the result of its present modest transport share. The paper presents ship based technologies measures collected through PLATINA project and CCNR Workshop organized in April 2011 analyzing their possibilities and advantages as well as risks and difficulties in possible implementation. It concludes with guidelines for lowering the potential risks and costs of their further development and implementation as well as cognition of existing benefits from similar measures already in use in maritime transport.

KEYWORDS

greenhouse gas emissions, carbon dioxide, inland waterway transport, ship based technologies measures

MOGUĆNOSTI SMANJENJA EMISIJA CO₂ KOD PLOVILA UNUTARNJE PLOVIDBE TEHNIČKO-TEHNOLOŠKIM MJERAMA

SAŽETAK

Europska komisija je u 2011. godini izdala Bijelu knjigu o prometnom sustavu koja više od prethodnih naglašava potrebu smanjenja emisija stakleničkih plinova u tom sektoru za najmanje 60 % do 2050. godine. Istovremeno, usprkos prepoznatoj ekološkoj prihvatljivosti prometa na unutarnjim plovnim putovima, Izvješće o srednjeročnom napretku implementacije Akcijskog programa NAIADES upozorava da ima još prostora za inovacije koje vode smanjenju emisija stakleničkih plinova i nove tehnologije u području brodske energetike. Ističe se da je razlog niskom udjelu emisija stakleničkih plinova, a osobito najznačajnijeg među njima – ugljičnog dioksida CO₂ iz prometa na unutarnjim plovnim putovima zapravo njegov malen udio naspram ostalim modovima transporta. U ovom su radu predstavljene mjere za smanjenje emisija CO₂ temeljene na istraživanju i primjeni tehničko-tehnoloških poboljšanja vezanih uz propulziju i hidrodinamiku plovila, a koje su prikupljene iz PLATINA baze podataka i prezentirane na radionici koju je organizirala Komisija za navigaciju na rijeci Rajni u travnju 2011. Nakon njihove analize autori ukazuju na smjernice koje će smanjiti potencijalne rizike i troškove njihovog daljnjeg istraživanja i implementacije uz spoznaju dobrobiti onih mjera koje se već koriste u pomorskom prometu.

KEYWORDS

Emisije stakleničkih plinova, ugljični dioksid, promet na unutarnjim plovnim putovima, mjere tehničko-tehnoloških poboljšanja plovila

1. INTRODUCTION

The greenhouse gas (GHG) emissions from transport increased throughout the last three decades by an average of 1.6% Carbon dioxide (CO₂) in fossil fuel use, reaching 1.9 %/year [1]. According to the Kyoto Protocol regulations all countries have to make a progress in reducing their total emissions of GHG. In the terms of traffic and transportation, there is a need to shift to sustainable transport patterns as well to take into the consideration the possibilities of using alternative energy sources and investing into research and development of new technologies.

In 2011 European Commission released the White paper on transport¹ with remark that although there was a lot of achievements since the 2001 White Paper on transport, the transport system is still not sustainable. That problem is especially important within the need of EU to reduce greenhouse gas (GHG) emissions by 80–95 % below 1990 levels by 2050, which means that from the transport sector a reduction of at least 60 % of GHGs by 2050 is expected. Another problem is that EU transport still depends on oil and oil products for 96 % of its energy needs and if there will be no changes to present way of doing things, the oil dependence of transport might still be little under 90 % [2, 3] and CO₂ emissions from transport would remain one third higher than their 1990 level by 2050.

The White paper 2011 established ten goals for a competitive and resource-efficient transport system that included benchmarks for achieving the 60% GHG emission reduction target. Within them is that 30% of road freight in distances over 300 km should shift to other modes such as rail or waterborne transport by 2030 and more than 50 % by 2050, facilitated by green freight corridors. Strategy emphasises the need for innovation in European transport system by acting on vehicle's efficiency through new engines, materials and design, cleaner energy use through new fuels and propulsion systems, better use of network and safer and more secure operations through information and communication systems.

Almost at the same time two of the EU documents concerning the related issues were published – the European Union Strategy for Danube Region² and the Mid - term progress report on the implementation of the NAIADES Action Programme for the promotion of inland waterway transport³, covering the time frame from 2006 to 2013.

The Strategy's directions leads to the better prospects of prosperity for all citizens of the Region by 2020 within a safe and environment secure area and a sustainable development approach that include modernised transport interconnections. The first part of the Strategy is focusing on determining the Region's challenges and opportunities and as one of them - high pollution of Danube - the environmental impact of transport links, tourist developments or new energy-producing.

Second document, the Action Plan represents an integrated response to the first document by identifying the crucial and concrete priorities for the macro – region and the responsibility for implementation within the different administrative levels and institutions in the Region. Major elements in the structure of the Strategy are Pillars that address main issues for achieving prosperity in the Region, as well as contributing to EU objectives and reinforcing policy initiatives, especially the Europe 2020 strategy. Two of the four Pillars of the Strategy are: connecting the Danube Region – focusing on transport, energy and culture/tourism issues and protecting the Environment in the Danube Region – with Priority

¹ European Commission, White Paper on transport — Roadmap to a single European transport area — Towards a competitive and resource-efficient transport system, Luxembourg: Publications Office of the European Union, 2011, ISBN 978-92-79-18270-9, doi:10.2832/30955

² European Commission, COM(2010) 715 final, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: European Union Strategy for Danube Region, {SEC(2010) 1489 final}, {SEC(2010) 1490 final}, {SEC(2010) 1491 final}

³ European Commission, Mid-term progress report on the implementation of the NAIADES Action Programme for the promotion of inland waterway transport, Commission Staff Working Document, Brussels, 04.04.2011, SEC(2011) 453 final

2. THE CURRENT STATE OF CO₂ EMISSIONS AND FUEL CONSUMPTION IN EU – 27 INLAND WATERWAY TRANSPORT

Inland waterway transport offers an environment friendly alternative in terms of both energy consumption and noise and gas emissions. Its energy consumption per km/ton of transported goods is approximately 17% of that of road transport and 50% of rail transport. Nowadays, total length of inland waterway (IWW) in the European Union approximately 36,500 km and it will continue to grow with the enlargement of the Union.

The majority of inland navigation ship types are standardized in their main dimensions (although within certain tolerances). The wide variety of vessel sizes is mainly caused by both the market requirements and the area of navigation. On the one side, larger shipment sizes, stable markets and favorable nautical conditions along the route are the main prerequisites for the operation of larger ships. But on the other side, larger ships cannot operate on smaller waterways if draught, width or air draft restrictions are too big. That allows smaller vessels also have a place in the fleet. One of a large variety of classification methods for floating objects used in inland navigation is presented in Table 1.

Table 1. Fleet classification in inland navigation

1) According to the area of navigation
• River (canal) ships • River – sea vessels (sea-going vessels properly equipped also for the operation in inland waterways) • Lakers (vessels designed and built to cope with specific conditions on the lake where they operate)
2) According to the dedicated purpose
• Commercial vessels including: ○ Cargo ships ○ Passenger ships for daily excursions or for cruising (equipped with cabins) ○ Technical floating objects (push boats, tugs, dredgers, floating cranes, floating docks, workboats etc.) • Pleasure crafts (motor or sailing yachts and boats, water bikes, wind surfing-boards etc.) • Special ships (police, customs, survey, fire-fighting ships, icebreakers, military vessels, supply ships etc.)
3) According to the installed machinery (self-propelled and non-self-propelled vessels)
4) According to the kind of propulsion
5) According to the floating regime when running
6) According to the hull configuration (conventional monohulls, twin-hulls, trimarans)

Source: authors according the PINE⁴ classification

It is difficult to compare the impact of the various different greenhouse gases [8], but CO₂ is the most significant GHG worldwide, far ahead of CH₄ (methane), nitrous oxide (N₂O) and fluorochlorohydrocarbons. The proportion of CO₂ that contributes to the greenhouse gas emissions from the operation of inland navigation is far more than it is on average, worldwide. On average, the proportion of the total mass of exhaust gas from diesel engines, which are to be found on practically every inland vessel, accounted for by CO₂ is about 20% and the proportion of NO_x is significantly less than 0.1% [9] in accordance with [10].

N₂O only constitutes a fraction of the total mass of NO_x (nitrogen oxides) in exhaust gases or older fire-fighting systems. That is why from now on only fire-fighting systems that operate without climate-harming substances are permitted on inland vessels [11]. This explains why the climate warming potential of N₂O from diesel engines used on inland vessels is estimated to be less than 1% of that of CO₂ [12]. N₂O is thus irrelevant as a greenhouse gas emitted by inland navigation [13]. Almost no CH₄, another of the most

⁴ Buck Consultants International (The Netherlands), ProgTrans (Switzerland), VBD European Development Centre for Inland and Coastal Navigation (Germany), via donau (Austria): PINE -Prospects of Inland Navigation within the enlarged Europe, March 2004

significant greenhouse gases, is currently emitted by inland vessels mostly because of that at the present, it is practically only gasoil that is approved as fuel due to current regulations, although the process of approval of LNG as a fuel for inland vessels on the Rhine and inland navigation in general is already underway.

Table 2. Characteristics of key greenhouse gases

CRITERION	GREENHOUSE GAS			
	Carbon dioxide (CO ₂)	Methane (CH ₄)	Nitrous oxide (N ₂ O)	Chlorofluorocarbons
Primarily caused by inland navigation	Combustion of gasoil ¹	Leaks of incomplete combustion of LNG (to be used in future)	Combustion of gasoil (NO _x)	Air conditioning systems, fire extinguishing systems
Global warming impact relative to CO ₂	1	Approx. 25	Approx. 300	Some CFCs as high as 14,800
Lifetime in the atmosphere	Varies, some as long as 100 years	Approx. 12 years	Approx. 115 years	Up to several 1000 years
Outlook	Accumulates in the atmosphere faster than other GHGs	Relatively stable total amount in the atmosphere, accumulating at present	Continuous accumulation in the atmosphere	Some reduction due to international agreements and treaties

¹ gasoil is understood as fuel for diesel engines on board of inland vessels, independently of the quality of the fuel that is actually used. In the EU the fuel used in inland navigation is specified by Directive 2009/30/EC

Authors according to: Possibilities for reducing fuel consumption and greenhouse gas emissions from inland navigation, Report by the Inspection Regulations Committee for the 2012 Autumn Meeting (Annex 2 to protocol 2012-II-4 of the Central Commission for the Navigation of the Rhine, 29 November 2012)

For the EU-27, the contribution made by inland navigation to total CO₂ emissions from land-based modes of transport is estimated to be less than 1% [14]. The European Commission refers to a 1.8 % figure for 2008 [15] with all modes of transport except the electric traction of railways serving as a reference. According to that the GHG emissions from inland navigation are very small in comparison to the total amount of GHG emissions caused by transportation; this is a result not only of the high energy efficiency of inland navigation but also of its generally minor role in the traffic mix. Inland navigation is almost irrelevant for passenger transport and it only accounts for about 6% of all goods traffic in the EU-27 by land-based modes of transport (tkm) [16]. So if inland navigation wants to retain its competitive advantage as being “environmentally friendly”, it also needs to further reduce its greenhouse gas emissions because road and rail transport have made significantly more progress in reducing emissions than this transport mode.

But still, there is a problem concerning methods for calculating the carbon footprint and specific CO₂ emissions in transport in general and from inland navigation. The broad range of values resulting from many studies on that issue rise wide range of the quality of the output data used for calculating a model using emission factors. For example, CE Delft's STREAM model is using emission data per vehicle-kilometre from most authoritative European sources preferably resulting from (real world) measurements. It includes factors that influence the emission per tonne-kilometre (for all modes of transport) such as: vehicle utilisation, detouring and pre- and end-haulage, scale of transport, emission technology and energy efficiency. It includes the whole transport chain into account except vehicle and infrastructure construction, but the indirect emission of fuel and electricity production (upstream) are included. The transport modes are defined for two types of cargo: bulk and general cargo and containerised cargo, and the vehicle types are characterised by their average load

capacity in tonne and TEU⁵. Table 3 is presenting CO₂ emission factors for voluminous bulk and general cargo transport on inland waterways for 2009 given by the CE Delft's STREAM model:

Table 3. CO₂ emission factors tank-to-wheel (WTW) and well-to-tank (TTW) for voluminous bulk and general cargo transport on inland waterways for 2009

Inland waterway vehicle type	Infrastructure	Load capacity (tonne)	TTW MJ/tkm	TTW emission CO ₂ (g/tkm)	WTW emission CO ₂ (g/tkm)
Spits-Peniche	CEMT I	350	0.66	48	56
	CEMT V	350	0.56	41	48
	CEMT VI	350	0.52	38	44
	River Waal	350	0.48	35	41
Campine Barge	CEMT II	550	0.48	36	41
	CEMT V	550	0.55	40	47
	CEMT VI	550	0.53	39	45
	River Wall	550	0.54	40	46
Rhine Herne Canal Ship	CEMT IV	1,350	0.48	35	41
	CEMT V	1,350	0.49	36	42
	CEMT VI	1,350	0.54	39	46
	River Waal	1,350	0.46	34	40
Large Rhine Ship	CEMT V	3,013	0.37	27	32
	CEMT VI	3,013	0.39	29	33
	River Waal	3,013	0.40	29	34
Convoy Europe II-C3b	CEMT VI	5,500	0.38	28	32
	River Waal	5,500	0.32	23	27
Pushed Convoy 2x2	CEMT VI	12,000	0.23	17	20
	River Waal	12,000	0.22	16	19
Pushed Convoy 3x2	CEMT VI	18,000	0.19	14	16
	River Waal	18,000	0.16	12	14

Source: authors according to CE Delft's STREAM model

Table 3 is presenting results of measurement and calculations based on energy consumption per vehicle-kilometre, using emission factors per Mega Joule and according to IW model developed by TNO and the Dutch Ministry of Infrastructure and Environment. The presented data is without pre- and end- haulage and without detouring that is included when comparing different modes. Dimensions, speed, load of the IWW vessels and cross-section waterway and velocity of flow are data for the model inputs. The results show that ships and convoys of bigger load capacity have lower CO₂ emission factor from fuel consumption and production both tank-to-wheel or well-to-tank [17].

There is a range of measures available today to inland navigation for reduction of GHG emissions from shipping operations, that include the operation, construction and equipping of vessel, along with the measures that aim at „decarbonisation“ of the fuel, i. e. the use of fuels with lower CO₂ emissions. Less progress that is made in inland waterway transport concerning issue of emissions to the air than in road and rail transport lays partly in the fact that the barge operators have no strong economic or regulatory incentives to reduce inland waterway transport emissions. Obligatory emission standards exist for new engines, but tighter emission standards for engines already installed have never been applied in EU transport policy. However, in 2008 the IMO⁶ agreed upon an upgrade for existing engines. Other examples of setting standards for existing installations can be found in the IPPC Directive (1996/61/EC). From the beginning of 2012, re-engining a ship with an existing revised engine is forbidden. Engines can only be replaced by new ones.

⁵ TEU: Twenty feet Equivalent Unit – Container volume capacity expressed in the volume of a twenty feet container

⁶ International Maritime Organization

The European Commission services are now preparing new measures for inland waterway transport and for the medium term, a proposal amending Directive 97/68/EC on emissions from non-road mobile machinery could introduce Stage IV emission limits for new engines used in Inland waterway vessels. As it has been already said, in a long term there is a need for the framework for improvement of the environmental performance of the fleet including innovative propulsion systems and in particular with more rigorous measures which are also applicable to the existing fleet.

In the light of that, the Central Commission for the Navigation of the Rhine (CCNR) in the year 2009 asked its Inspection Regulations Committee to provide a report about the greenhouse gas emissions from inland navigation. It refers to the GHG emissions from inland navigation, i.e. CO₂ emissions generated by the operation of inland vessels. With the exception of CH₄, the emissions of other pollutants apart from CO₂ are not taken into consideration, nor are emissions not resulting from the operation of the vessels. One of the reasons is the lack of the usable studies and the other is that CO₂ is the most significant greenhouse gas emitted by inland navigation.

3. MEASURES FOR REDUCING FUEL CONSUMPTIONS AND CO₂ EMISSIONS FROM INLAND WATERWAY TRANSPORT

Although the fuel consumption in inland waterways is far lower than that of the road and rail transport, the use of alternative energy sources and the development of new technologies is in line with the global strategy for sustainable development. Fossil fuels and energy imports dependency reduction increase security of energy supply, thus creating new opportunities for entrepreneurship development and the economy.

The inland navigation sector together with the European Commission have created PLATINA, an FP7 project consisting of 23 partners from nine different countries including Croatia, in order to accelerate the achievement of the NAIADES aims. This multi-disciplinary knowledge network is allowing PLATINA the systematic collection and dissemination of research results on fleet innovations, transshipment equipment and new logistics concepts. Some of those innovations were presented in the Workshop⁷ organized by the CCNR in April 2011 as a contribution of trying to measure and reduce CO₂ emissions and fuel consumption in inland waterway transport. It was perceived that there is a large diversity in measuring, gathering and analyzing data about CO₂ emissions and fuel consumption in transport in general as well as in IWT. In the light of that the United Nations Economic Commission for Europe (UNECE) developed an uniform methodology named For Future Inland Transport System (ForFITS) for calculating detailed transport CO₂ emissions on the basis of existing assessment models, streamlined according to UN requirements, terminology, definitions and classification of vehicles, transport modes as well as analysing scenarios and suggesting strategies in transport policy.

Ship based technologies presented measures in Workshop can be roughly divided in propulsion-related measures and the hydrodynamic measures for reducing the CO₂ emissions in inland navigation. The reduction potential of propulsion engines varies but are still limited and can offer better results in combination with different measures. Propulsion related measures are exploring possibilities of using LNG as a fuel and diesel-electric drive concepts. Diesel-electric propulsion systems offer a variety of considerable benefits – they enhance manoeuvrability, minimise environmental risk and their quiet, low-vibration operation increases onboard comfort. The most significant advantage, however, is their potential for achieving extremely reliable operation due to their redundant design. The advantages of using LNG are in reducing CO₂ emissions up to 25% relative to gas oil and blending LNG with biogas for further reduce of GHG emissions. The main issue is guaranteeing the safety for ships that use LNG and quality standards for it's supply and storage on land and on board. The reduction of GHG is also related to prevention of methane-slip and off-gassing of LNG that can happen when LNG is not completely burned.

⁷ <http://www.ccr-zkr.org/13020220-en.html>

For all these reasons it is also important for the crew working on LNG vessels that they receive good and thorough education and training for every possible situation.

As for waste heat recovery – main engine exhaust gas energy is by far the most attractive among the waste heat sources of a ship because of the heat flow and temperature. The primary source of waste heat of a main engine is the exhaust gas heat dissipation, which accounts for about half of the total waste heat, i.e. about 25% of the total fuel energy. In the standard high-efficiency engine version, the exhaust gas temperature is relatively low after the turbocharger, and just high enough for producing the necessary steam for the heating purposes of the ship by means of a standard exhaust gas fired boiler of the smoke tube design. It is possible to generate an electrical output of up to 11% of the main engine power by utilising this exhaust gas energy in a waste heat recovery system comprising both steam and power turbines, and combined with utilising scavenge air energy for exhaust boiler feed-water heating.

The use of the adjustable tunnel leads to the realization of a high quasipropulsive coefficient for a ship without tunnel in partly loaded condition. Moreover, the dynamic tunnel flapped downwards enables the vessel to run in a partly loaded condition, in which the propeller is larger than the draught without any air inlet impeding the trust. This invention might be helpful in all countries with shallow water navigation.

Regarding hydrodynamic measures for reducing CO₂ emissions - the considerable reductions are possible although some of them are already exploited on large modern ships. For example, contra rotation propeller (CRP) is in use for marine vessels since 1988, and since 2007 there are 14 Diesel Electric CRP vessels namely “Super Eco Ships” that are under the service for Japanese coastal trading. The adoption of contra-rotating pod propellers makes it possible to achieve improvements in propulsion system efficiency due to the contra-rotating effect and thus obtain greater freedom in ship design. The adoption of a new “buttock flow” hull form that takes full advantage of these innovative characteristics in the Super Eco-Ship also makes it possible to realize substantial improvements in propulsive efficiency that can lead to fuel savings. The adoption of an electric propulsion system makes it also possible to reduce the size of the machinery space because of the compact size of the engine system itself and the bigger degree of freedom that becomes possible in laying out machinery, equipment and the expanded amount of cargo space.

MARIN's code ReFresco is already experienced in optimizing vessels with CFD in marine navigation and now it will be used on inland vessels. It consists of hydrodynamic tools to optimise the ship in terms of optimisation of the hull, speed/power performance and studies on cavitation, noise and vibration. Within the EU-backed project RISING - The River Information Services for Transport & Logistics, the task of MARIN was to model the hydrodynamics of an inland waterway vessel so its speed could be calculated taking the environment, such as wind and waterway parameters, into account. In addition to the powering performance, a module was developed for optimising fuel consumption given a fixed voyage consisting of different fairway segments. For some years now, MARIN has tested and expanded its tools and capacities to support hull form design for minimal fuel consumption in everyday use, minimizing SO_x and NO_x emissions. Tools such as viscous flow calculations in an explorer mode, calculating numerous hull form variations overnight in order to maximize the performance of the vessel, and voyage simulations to determine true service margins are essential when designing a ship.

Damen shipyard has been part of the PELS Project (Project Energy-saving air-Lubricated Ships) and by looking at air lubrication, PELS originally focused on sustainability using pushbarges. Tests were carried out along the River Rhine and at inland waterway locations. Several loading conditions were tested, but the big step was the decision to change over the bottom construction. A totally new concept, designed by Damen's R&D department and Marinvention, using a corrugated construction was used on the model and after successful model tests this was also used on the vessel. Then the traditional flat bottom was changed to the air lubrication construction at full-scale.

Table 4. Measures for the reduction of fuel consumption and CO₂ emissions in inland navigation

Name of the measure described	Short description and website-links
ForFITS – assessment and monitoring toll for inland transport CO ₂ emissions	Development of uniform monitoring and common assessment web-based tool for evaluating the CO ₂ footprint of inland transport. It is a global project involving all UN regions of the world and it includes a transport policy converter that analyze alternative strategies for designing the most effective intervention measures and transport policies. www.unece.org/trans/theme_ForFITS.html
Hybrid Diesel Electric Propulsion	CO ₂ emission reduction and reduced maintenance costs can be achieved by optimized utilization of installed power on board using Hybrid Diesel Electric Propulsion. Optimization is provided by Diesel Engines of less total installed power in combination with alternative energy sources (Battery, Fuel Cell, photo voltaic etc.) and integration of Auxiliary Systems. www.siemens.com/marine
Waste Heat Recovery	The Waste Heat Recovery system is fully automatic and independent from main engine function and should provide a reduction of fuel consumption. The unused amount of exhaust heat energy from a combustion engine is convert into effective mechanical energy by VoithTrac system and ti enables reduction of fuel consumption by min. 8%. www.voithturbo.com/vt_en_paa_marine.htm
LNG (Liquefied Natural Gas) as fuel for inland navigation	LNG used as a substitute for diesel oil (or, in case of dual fuel engine – a combination of both LNG and diesel oil) for propulsion and auxiliary engines on IWT vessels. It enables 15-25% fuel savings depending on power system configuration and sailing pattern. www.scheepsemissies.nl/themas_scheepsemissies.php?thema=reductie&onderwerp=56
Adjustable tunnel	Ship with adjustable tunnel wich is – dependent on the draught – aligned with the shell or with fins folded downwards to prevent incoming air at low draught. It not only enables vessel operating in wide range of water depts but also a fuel saving of about 10 % in loaded condition.
Removable filling for gaps in pushed coveys	Reducing fuel consumption of some 15 % by means of a flexible dismountable filling that reduces the appearing formation of vortex and waves between a push barge and the pushing motor vessel or another push barge. The fillings are made of different materials (foam, rubber-inflatable). www.dst-org.de/intro.htm
Line-shaft type Contra Rotating Propeller („CRP“)	Less fuel consumption and GHG emmissions by installing contra Rotating Propeller („CRP“) configuration that also enables the vessel smaller capacity of propulsion systems. CRP systems are available for diesel electric and conventional diesels engine directly driven propulsion systems. www.ihl.co.jp/ihimu/
Support of replacement of older engines by those with modern technology	Promotion of new motor technologies and adjustment of the regulations by government and authorities. Improving energy efficiency and reducing exhaust emissions by replacing the old motors that are still in use with new motors and using alternative energy sources and carriers that are new to inland shipping.
LNG as fuel for IN vessels	Reducing fuel costs and emissions by using natural gas instead of diesel/gasoil for inland navigation vessels.
Cooling and heating by means of excess engine heat	Using concept of cooling and heating accomodation area by the heat of exhaust and cooling water of the engines and generators. The objective is to reduce 135 tons of Carbon dioxide yearly. www.tricobv.nl
Shore-based electricity for	User-friendly service of shore power facilitie for inland shipping and using electricity grid ashore. The service is organised with the use of a mobile phone via a computer

inland navigation	by providing the code of the socket. A daily SMS informs the client about the level of energy consumption and upon departure the client cancels the service and pay monthly by direct debit or by credit card. www.walstroom.nl
Reduction of CO ₂ emissions through optimisation of the hull by using CFD	Usage of the MARIN's CFD code ReFRESCO and his linkage to the propeller analysis programme PROCAL enables preparing a report for each vessel containing recommendations for improving it and the pay-back time of these improvements as well as building new IWT vessels in future. www.marin.nl/web/Ships-Structures/Inland-ship-1.htm
TORQUE Marine IPS	TORQUE Marine Innovative Propulsion Systeme GmbH + Co-KG provide propulsion in all operating profiles at the required torque while simultaneously and consequently reducing NO _x and CO ₂ emissions. A modular system allows distributed location of the units that permits more efficient vessels hulls suitable for draft 2130 of a 110m IN vessel with special shallow water properties. www.innovatives Binnenschiff 2130 ausgerüstet mit einem Torque.System
Engines/systems for the use of LNG/Dual fuel systems	Development of engines / systems for the use of LNG or dual fuel systems and certification of vessels that are using them.
New diesel-electric vessel power and ship propulsion concept	The innovative topology system which provides greater strength to the smaller size enables fuel savings of at least 10%. Compact design allows for reduced installed diesel power of approximately 20%, reduced the number of subsystems and simplifying installation during ship construction.
Damen ACCESS (Air Chamber Concept Energy Saving System)	Energy conservation of the inland transport using effectiveness of air chambers for reducing the resistance of the ship. The frictional resistance of the sailing vessel is decreased by means of air-filled recesses in the bottom. In relevant for inland navigation speeds, fuel consumption is reduced by 10% to 20%. www.damen.nl

Source: made by authors according to the PLATINA Innovation Database and presented on CCNR Workshop 2011

The vessel was tested in deep and shallow water, facing up and down river. This resulted in a new ship type: the air lubricated ship that was named the ACES, an acronym of "Air Chamber Energy Saving". ACES has been patented by Damen and Marinvention. Damen specialists concluded that the system itself was working very well but the outcome depended on the situation. When the vessel was sailing at lower speeds the outcome was much better, leading to vastly improved fuel savings. Results varied from a 5% fuel saving up to a 40% fuel saving. Overall, the project partners found that there were annual savings of 15% when calculating the results over a year using a normal sailing profile.

Table 5. Estimated potential for reducing fuel consumption and CO₂ emissions from inland navigation by the use of known technologies

MEASURES	Savings CO ₂ /tkm	Combined	Combined
Increase in engine efficiency	2% - 5%	10% - 25%	10% – 50%
Diesel-electric propulsion	0% - 20%		
Hybrid propulsion	0% - 20 %		
Waste heat recovery	0% - 5%		
More efficient propulsion organs	5% - 20%	0% - 25%	
Alternative propulsion organs	0% - 25%		
Lightweight construction	0% - 5%	5% - 25%	
Air lubrication	0% - 15%		
Ship hull form optimisation	0% - 10%		
Exhaust flow plate	0% - 10%		
Adjustable tunnel apron	0% - 10%		

Coupling point optimisation	0% - 15%		
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Source: *Possibilities for reducing fuel consumption and greenhouse gas emissions from inland navigation, Report by the Inspection Regulations Committee for the 2012 Autumn Meeting (Annex 2 to protocol 2012-II-4 of the Central Commission for the Navigation of the Rhine, 29 November 2012)*

Table 5 is showing the estimated potential of measures for reducing fuel consumption and CO₂ emissions from inland navigation by the use of known technologies. The exploitation of these measures depends on supporting measures such as provision of relevant information, legal regulations and/or subsidized or voluntary measures.

The low figures in the Table 5 shows the savings potential definitely expected and higher figure shows the maximum potential in respect to the comparative average of the current fleet. The figure 0% means that some vessels are exploring the potential or that the measure is not suitable for all vessels. For the combination of measures the lower figure shows the savings potential in comparison to vessels that are already built and operated very energy efficiently today. The higher figure shows the savings potential relative to already built vessels that are not very energy efficient, but it has to be emphasized that a number of experts don't agree with such high estimations. Another problem lies in the fact that cost efficiency of the individual measure or combinations of measures has not been taken into the consideration so it is better to accept these figures as an educated guess.

4. CONCLUSION

Anticipation of the introduction and implementation of European legislation for determining restrictions of GHG emissions in inland navigation are in accordance with the recommendations of the White Paper released in 2011. IWT through high energy efficiency does not have a large share of total CO₂ emissions related to transportation of goods. Another reason lies in the fact that in several European countries IWT is still underrepresented mode of transport. Conducted measurements and studies have shown that it is too little effort invested in finding ways and technologies that can reduce GHG emissions from inland navigation especially those concerning implementation of technology innovations on vessels. Therefore a database of innovation as part of the project PLATINA has been established and in 2011 CCNR organized a workshop on measurement / amount of inland navigation CO₂ emission and possibilities for its reducing. The Workshop presentations showed that, apart from using LNG as a fuel for IN vessels, the reduction potential of propulsion measures is very limited. There is also a safety issue regarding technical requirements as well as training and educational aspect for crew on board. That is specially in case of using LNG either solely or in combination with other energents along with its handling for storage on land. The other problem is cost related – some of the measures need high investments not only for implementation, but in the phase of development and testing too. That requires thorough analyzing and estimation of its suitability in terms of age, size and capacity of vessels they are about to be implemented on, transport volumes and other important factors. A good way to start is gathering data about accomplished reduces of fuel and CO₂ emissions from ocean and coastal ships that already use some of the proposed methods. Results getting of Waste Heat Recovery, Hybrid Diesel Electric Propulsion, LNG as a ship fuel, Contra Rotating Propeller and some other new motor technologies that are in use for some time in marine navigation should be taken into account with a respect to differences regarding navigation and vessels conditions.

The same gathering data can be done from applying hydrodynamic measures with special concern given to the fact that the size and capacity of ship is direct opposite to the amount of CO₂ emissions. Hydrodynamic measures can also be very cost-intensive – because of its costs testing of inflatable version of removable filling for gaps in pushed conveyors was not properly done. Nevertheless, the benefits of some others, e.g. Adjustable tunnel or Contra

Rotating Propeller enable shallow draft that is suitable for waterways of lower CEMT classes⁸.

In conclusion, the size, the state and the equipment of the vessel in accordance to its operational mode and area are the most significant parameters for emission reduction potential. Due to reasons of long ship engine lifetimes and progress made in road transport emissions, IWT needs to improve its air pollution profile. To turn its potential into real growth, it is important to improve the air pollutant profile of inland shipping and take responsibility to maintain the air quality levels along inland waterway corridors over Europe. It is necessary to continue with research and dissemination of ideas and possibilities that will conserve advantages of inland waterway transport in terms of safety, economy and environmental friendliness.

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THE FUTURE RECEPTION OF POST-PANAMAX CONTAINER SHIPS; A COMPARISON BETWEEN THE PORTS OF KOPER AND RIJEKA

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ABSTRACT

Container terminals represent a key part of ports, tasked with providing efficient, rapid, and reliable manipulation of container units. On the other hand, rapidly increasing international trade has led to the construction of ever larger container ships. Due to the problems that arise in the ports that accept large ships, it is of vital importance for them to increase the current capacities of the existing terminals in order to be able to accept larger post-Panamax ships and improve their competitiveness with neighbouring ports. In the northern Adriatic, the competition to obtain more direct lines with larger ships between the ports of Koper and Rijeka is very strong. To be able to determinate the part of the terminal that those ports would have to improve, we created a model which makes it easier for the ports to prepare themselves for the reception of these larger container vessels. The model consists of six parts of the terminal which are related to the sea, coast and storage areas. The performed analysis gave as satisfactory results, which proved the reliability of the model. Because of its generality it is also suitable for use in other smaller ports that in the future want to increase the capacity of existing container terminals.

KEYWORDS

Maritime container terminal competitiveness, container ship capacity, container terminal operations, port optimization.

PRIHODNOST SPREJEMANJA POST-PANAMAX KONTEJNERSKIH LADIJ; PRIMERJAVA MED PRISTANIŠČEMA KOPER IN RIJEKA

POVZETEK

Kontejnerski terminali predstavljajo ključni del pristanišč. Osnovna naloga kontejnerskih terminalov je zagotavljanje učinkovitih, hitrih in zanesljivih pretovornih manipulacij s kontejnerskimi enotami. Po drugi strani pa je hitro naraščajoča mednarodna trgovina povzročila gradnjo vse večjih kontejnerskih ladij. Zaradi težav, ki se pojavljajo v pristaniščih, ki sprejemajo velike ladje, je za njih ključnega pomena konstantno povečevanje kapacitet obstoječih terminalov, da bi le ta bila sposobna sprejemati večje post-Panamax ladje in s tem izboljšala konkurenčnost z bližnjimi pristanišči. V severnem Jadranu, je bitka za pridobitev direktnih servisov z večjimi ladjami med pristaniščema Koper in Rijeka zelo močna. Za določitev delov terminala, ki bi jih omenjeni pristanišči morali izboljšati, smo izdelali model, ki olajšuje pristaniščem postopek priprave na sprejem tovrstnih kontejnerskih ladij. Model je sestavljen iz šestih delov terminala, ki povezujejo morje, obalo in skladiščne površine. Z izvedeno analizo smo dobili zadovoljive rezultate, kar izkazujejo zanesljivost modela. Zaradi svoje splošnosti, je model primeren za uporabo v vseh srednjih in manjših pristaniščih, ki v bodoče želijo povečati kapacitete obstoječih kontejnerskih terminalov.

KLJUČNE BESEDE

Konkurenčnost kontejnerskih terminalov, kapaciteta kontejnerskih ladij, operacije na kontejnerskih terminalih, optimiziranje kontejnerskih terminalov.

1. INTRODUCTION

The processes of globalization have had a significant impact on the development of international maritime transport. According to UNCTAD the highest growth in this area was

made in container transport, which from 1990 to 2011 has grown at an average annual rate of 8.2 %. In 2011 it reached 151 million TEUs (a 7.1% increase over 2010), which consequently caused an increase in the global port throughput-561.5 million TEUs (increase more than 560% over the last twenty years) [10]. Container terminals have therefore become a more important part of the port system, and they must be specially built and equipped facilities for the transshipment of containers between sea and land (or vice versa), providing efficient, rapid, and reliable manipulation of cargo container units.

Meanwhile, rapidly increasing international trade and increasing demand for maritime container transport has led to the construction of ever larger container ships. Today, the largest ship on the market reaches 18,000 TEUs; in the next few years ships are expected to reach capacities of 22,000 TEUs [10]. Such ships will require larger quays as well as deeper sea basins from ports, increasing productivity at the terminals, bigger quay cranes and modern mechanization which will be supported by modern information and communication systems.

The aforementioned trends have also expedited the demand for container ships of the post-Panamax class, which are mainly used by the ship-owners on direct lines in medium and smaller container ports. This will lead to capacity problems for smaller container terminals, which will not have adequate equipment for the reception of such ships; yet at the same time ship-owners will demand facilitation of rapid transshipment and reduced costs.

Port authorities are dealing with these issues in different ways; of crucial importance here is the size of the port or container terminal itself, its features, as well as the financial capacity of the port. In the first phase their decisions are not focused on the construction of new terminals, as that would require significant financial investments. They are therefore deciding on the optimization of their existing terminal capacities.

The paper presents the problems that two smaller container ports (members of the North Adriatic Ports Association), Koper and Rijeka, have in this field.

2. FACTORS DETERMINING PORT COMPETITIVENESS

The increase in container transport, the constant tendency toward specialization and the increase in ship capacities encourage shipping companies to focus their business on lines with a limited number of ports. Deep-sea container operators, as a maritime transport stakeholder, expect and require rapid transshipment and reduced costs in the ports, tightening the criteria for the selection of the port when establishing direct lines. This process has increased competition between ports in the same area.

For economic reasons, or, more precisely, for the achievement of an economy of scale, the chosen ship capacity on all routes has increased significantly in recent years. According to Sys et al. 2008, unit costs are thus the main factors influencing the choice made by shipping companies regarding the size of the container vessel. This varies according to the trade route.

The selection of the port for a liner service is conditioned by several factors. The most important carrier's choice criteria are [2]:

- port physical and technical infrastructure (nautical accessibility profile, terminal infrastructure and equipment, hinterland accessibility profile)
- geographical location
- port efficiency (port turnaround time, terminal productivity, cost efficiency, port operating hours)
- interconnectivity of the port
- reliability, capacity frequency and costs of inland transport services (rail, truck, barge)
- quality and costs of auxiliary services (pilotage, towage, customs..)
- efficiency and costs of port management and administration
- availability, quality and costs of logistics value-added activities
- availability, quality and costs of port community systems
- port security/safety and environmental profile of the port

- port reputation

As the size of the ship used on trade routes is increasing, a large segment of the selection factors are related to the optimal conditions for accepting larger container ships (sea depth, berth capacities, equipment, storage area, connections with other transport modalities). Those are thus the main factors on which smaller container ports have based their competition.

2.1. Container fleet market trends

The container ship fleet is the fastest growing maritime fleet. Until the economic crisis, the annual growth of the fleet was 13%, and in 2011 reached 184 million dwt. Today the container fleet covers approximately 13% of the world shipping fleet. The orders for new container ships in recent years have risen despite the recession, although with a lower growth rate. These orders were made mostly for larger container ships (exceeding 10,000 TEUs) but also for smaller ones (5,000-10,000 TEUs). According to the forecasts of Williams (2011), the container fleet is expected to reach approximately 19 million TEUs in 2014. The largest container ships, with a capacity of 12,000 TEUs or more, are now mostly employed between northern Europe and the Far East, where the largest cargo exchange is made and where the ports have adequate facilities to accept them, while post-panamax ships are employed in direct lines between the Far East and medium and smaller ports in southern Europe. This represents a major problem for many container ports which do not have adequate facilities to accept such large ships in the port, while they are trying to be part of the operator's network (direct service) [10].

Table 1. Past and expected vessel sizes on main trade routes

	2000	2005	2010	2015	2010 vs 2000	2015 vs 2000
Deepsea east/west						
Far East - Europe	4500-5500	5500-7000	8000-9000	10500	+70%	+110%
Transpacific	4500-5000	5500-6500	7000	8500	+47%	+79%
Transatlantic	3500	4000	5000	6500	+43%	+86%
Deepsea north/south						
	2500	3000	3000	3500	+20%	+40%
Feeder						
	550	650	700	850	+27%	+55%

Source: Notteboom, T. (2009). *Economic analysis of the European seaport system*.

2.2. The link between ship size and terminal operations

The link between ship size and port operations is very strong. On the main routes line operators are constantly increasing the size of container vessels as this allows them to reduce shipping costs. The ports that can accept such large container ships are therefore in a position of advantage in comparison with the ports that do not have adequate facilities. The ports that do not have the facilities to accept larger container ships will have to optimize some parts of their existing container terminals in order to become more competitive on the market. Ports will therefore have to increase sea depth, improve the capacity of individual parts of the terminal, and purchase better mechanization so they will be able to provide shorter berthing time for the ships. To do that they will have to know which part of the terminal needs to be optimized, so right decisions based on the appropriate decision-making tool are of vital importance.

3. CONTAINER TERMINAL OPTIMIZATION MODEL

As the pressure from the market trends is increasing day by day ports have to follow them if they want to remain attractive for shipping lines. Since the construction of new terminals represents such a large financial investment, ports in the first phase are deciding to increase the capacity of existing terminals in order to be able to accept larger ships. The biggest problem in achieving this goal is the decision about the terminal parts that need to be optimized, so we created a model (Figure 1) which facilitates the adoption of such decisions.

Container terminals can be divided into three subsystems: the berth subsystem, storage subsystem and subsystem of the handover area [1]. The model is based on the six parts of the terminal that are part of the three subsystems.

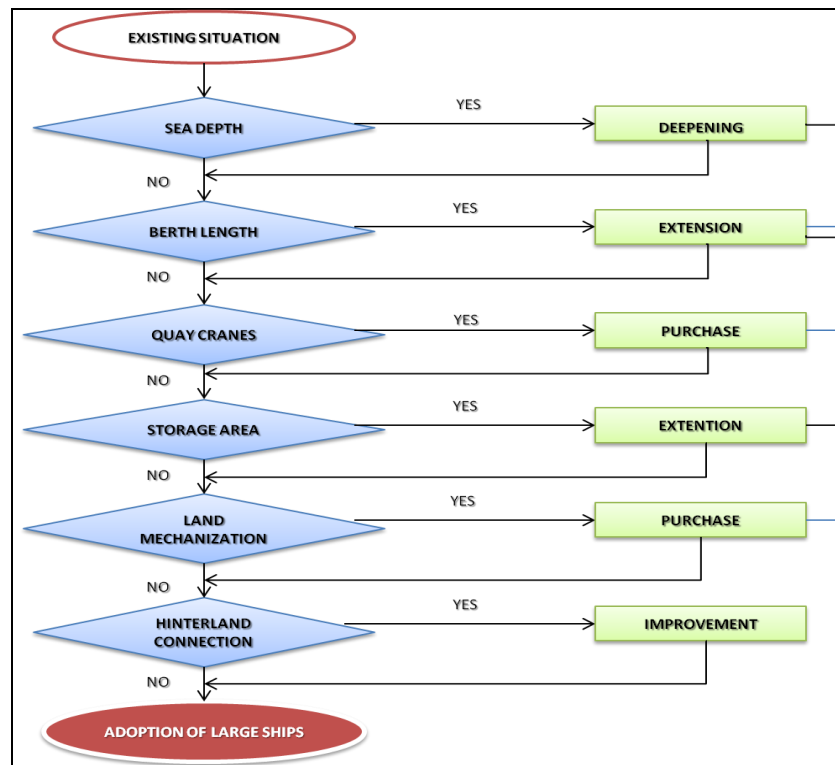


Figure 1. Container terminal optimization model (in terms of ship capacity)

Source: (authors)

The first three components represent the berth subsystem which directly defines the size of the ships that can enter a port, and are therefore the most important. The other three components influence the size of the ship that can be received in port indirectly.

With the model we can therefore determine if the individual part of the terminal capacity is in sufficient condition for the reception of the desired ship size, or the capacities are insufficient and require optimization.

4. THE COMPETITION BETWEEN CONTAINER TERMINALS IN KOPER AND RIJEKA

Northern Adriatic ports, given their geographical location, have the possibility to become an important factor in the maritime trade between central and eastern Europe and overseas countries. The Mediterranean has taken on a new strategic importance, which is reflected in the revitalization of her port operations. Large container ships are not only sailing through the Mediterranean Sea, they also connect international ports to a major trading hub. The route through the northern Adriatic represents the shortest and most economic link between Europe and the Mediterranean, and through the Suez Canal to the countries of Asia. In the

immediate hinterland of the northern Adriatic ports there are new potentials for Europe, which further increase the importance of the ports. To promote the northern Adriatic transport routes the North Adriatic Ports Association, NAPA, was founded in March 2010 to represent the northern Adriatic route as an alternative to the northern European routes, with its advantages of saving costs and time. The port of Koper and Rijeka represent an important part of that association. In 2011 those ports handled 739,991 TEU, which is 41.11% of the total cargo handled in northern Adriatic ports (1.8 million TEUs). The biggest share of throughput among the northern Adriatic ports was attained by the port of Koper (589,314 TEU), which is mainly due to the expansion of terminal capacities in 2009. In 2012 the port of Koper reached 570,744 TEU (a 3.2% drop), which is mainly attributable to the lower number of empty containers handled. The port of Rijeka handled 150,677 TEUs in 2011, while a high 14% drop was recorded in 2012 (129,680 TEU).

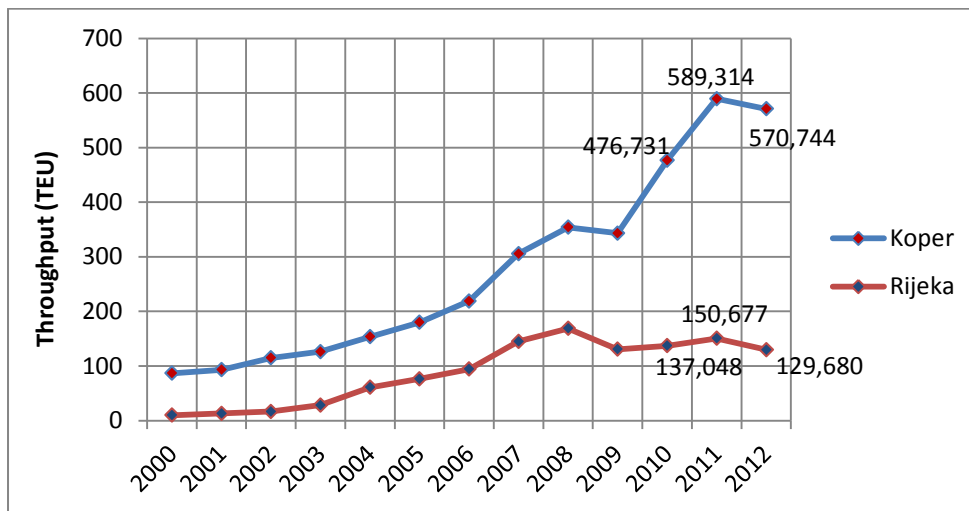


Figure 2. Container throughput in port of Koper and Rijeka (TEU)

Source: (authors)

The ports of Koper and Rijeka share a common transit hinterland and are therefore competitors for the cargo coming from the immediate hinterland zone. The ports have a leading position in the national port system and in the central European countries which do not have direct access to the sea. The biggest part of cargo carried in these ports is therefore coming from the national exchange and the following markets: Italy, Austria, Hungary, Switzerland, Germany, The Czech Republic and Slovakia. The competition of the two ports is mainly centred around the ability to accept larger container vessels and is therefore reflected in the port optimisation and the improvement of terminal capacities in order to obtain direct lines with the Far East.

Both terminals belong to the class of smaller container terminals whose business is currently limited to one direct line to the Far East (performed by the shipping companies Maersk Line and CMA CGM), a few direct lines with the Mediterranean, but mostly feeder lines [4,5].



Figure 3. The main direct service connecting the two ports with the Far East

Source: (<http://www.cma-cgm.com>)

4.1. Container terminal capacities in the ports of Koper and Rijeka

In 2009 the terminal in the port of Koper was subject to an important optimization. The works covered the extension of the quay by 300 meters (adding one berth), the purchase of four post-panamax cranes and a change of the storage system for empty containers. Due to those changes, the terminal was able to accept larger ships (post-panamax class) which helped it to continuously increase its annual throughput and make gains in the marketplace. The current terminal characteristics (after optimization-June 2009) are thus the following [4]:

- annual capacity 750,000 TEU
- quay length 596 m
- no. of berth 3
- sea depth 11.4-12 m (slightly more at high tide)
- quay cranes 4+4 (PP/P)
- storage area 18 ha
- hinterland connection highway/railway (one track)

The largest container ship currently entering the terminal has a capacity of 6,500 TEUs; however the acceptance of such a large ship often represents a problem due to the shallow draft of the terminal. Those capacities are therefore sufficient for the reception of one larger vessel (up to 300 meters in length) and one smaller vessel (up to 200 meters in length) at the same time, while it is impossible to accept two large ships simultaneously. As the competition among the neighbouring ports in the Adriatic is very strong, the achievement of more direct services, operating with larger container vessels in the port is of vital importance for the evolution of the terminal. The terminal capacities are thus sufficient to gain more direct services, although the problem of the ability to serve two large vessels at the terminal together exists, which due to the unforeseen delays in schedules and long unloading times (2-3 days) often represents a problem. The problem was underscored when four important shipping companies, Hanjin Shipping, Hyundai Merchant Marine, United Arab Shipping Company and Yang Ming Marine Transport Corporation cancelled the call in the port of Koper for their liner service with the Far East (after a short operating time) due to long waiting times for a free berth. Before the optimization made in the container terminal of Rijeka (May 2013) the port of Koper represented the first port of call in the area for the direct service operating at both ports, as the draft limitation of 11 meters maximum in Rijeka represented a limit. The port of Rijeka was therefore unable to gain the cargo targeted for the central European market, which affected the annual throughput of the port in recent years. In May 2013 the port of Rijeka invested significantly in container terminal optimization in order to be able to solve the problems of the shallow draft and improve their facilities to such an extent as to be able to receive two post-panamax ships at the quay simultaneously and

better compete with the port of Koper. The investment covered the increase in sea depth, the extension of the quay by 320 meters, the purchase of two post-panamax cranes and enlargement of the storage area, which increased the annual throughput capacity to 600,000 TEU. The current terminal characteristics are thus the following [5]:

- annual capacity 600,000 TEU
- quay length 784m
- sea depth 14,2 m
- quay cranes 4+2 (P/PP)
- storage area 10,4 ha
- hinterland connection highway/railway (one track)

In some parts of the terminal, mostly the berth subsystem, the port of Rijeka has now overtaken the capacities of the port of Koper, while on the land side and in terminal productivity Koper is still in a leading position. In order to become interesting as a port of call for the shipping companies, both ports will have to invest even more in the future for the optimization of the existing terminal capacities that would allow them the acceptance of at least two larger ships at the same time without difficulty. To determine the part of the terminals that still have to be improved in order to satisfy the market trends we used the before described optimization model (Figure 1).

5. APPLICATION OF THE MODEL TO THE KOPER AND RIJEKA CONTAINER TERMINALS

For decision making on the basis of the model we used the vessel of capacity 6,000 TEUs. After detailed research, we came to the conclusion that this capacity is the most appropriate one for the ports of Koper and Rijeka, since there are sufficient cargo flows and the ship size would be interesting enough for the shipping lines to include the ports in a direct line.

To accommodate a 6,000 TEU ship in the port, the terminals should have 13-14 meters of sea depth, a berth of 350 meters equipped with post-panamax cranes and at least 16 hectares of storage area for every berth [6].

5.1. Port of Koper

To be able to accept two ships of 6,000 TEUs simultaneously, the port of Koper would require optimization of the container terminal at all points of the model. The sea depth would have to increase by a meter or two. The number of berths is sufficient; but it would still be necessary to extend the pier by at least 100 meters in order to provide smooth throughput operations for both ships. The extension of the terminal quay would also result in the need to purchase new quay cranes. The current number of cranes is sufficient for the current terminal capacities, as when the largest ship arrives the four post-panamax cranes are available to attend her, while the other four panamax cranes are used to serve smaller ships. For optimal handling of such circumstance from three to five post-panamax cranes are necessary. The port of Koper would therefore have to purchase at least two new post-panamax cranes. The increased throughput at the berth subsystem would certainly affect the functioning of the other two subsystems, which is why in our case the port would have to increase the storage capacity. The current capacities are now barely sufficient, while with the increase of cargo flows the storage area would be too small. They would have to increase the area by 25-30%, regardless of which the storage problem would be solved for just a short time. Current mechanization at the storage area might be sufficient even after the enlargement of the area, but there would exist real risks of delays, which would consequently mean a loss of port efficiency and the risk of losing customers. It would be absolutely necessary to optimize the hinterland connections of the port of Koper. The link from the port to its hinterland is possible by road and rail traffic, although the capacities are already fully exploited. Therefore, the arrival of larger ships in the port and the increased

number of container ships handled in the port would require the construction of another railway track.

5.2. Port of Rijeka

The situation in the port of Rijeka is slightly different. After the recent optimization of the terminal, only four parts of the model would require better capacities. The sea depth and the quay length already satisfy the needs for the acceptance of two 6,000 TEUs ships simultaneously. The problems arise with the insufficient number of post-panamax cranes currently present at the terminal. With the optimization the first two cranes were purchased, but for optimal work on such a large ship at least three cranes per ship are required. Without the purchase of an additional four cranes, the acceptance of two large ships at the terminal will be difficult due to long unloading times and high costs, which will affect the shipping companies' choices. The arrival of such ships at the berth would consequently also affect the operations on the other two subsystems. In the past the port had significant problems with the insufficient storage areas, which was mainly attributable to the inability to spread due to the proximity of fixed city structures. That was partially solved with this year's optimization, which will allow slightly more than 10 hectares of storage area; regardless, the capacities will remain insufficient for such amounts of cargo that two post-Panamax ships would bring, so the port will have to enlarge the storage area by almost 100% in the future. The enlargement of that area would consequently require also the purchase of new land mechanization. A few steps were already made with the purchase of 8 transtainers, but that will not be enough to provide optimal transport operations at the yard and avoid unnecessary movements and delays. Consequently, the hinterland connections would also have to be optimized. The situation in the land connections is similar to that in the port of Koper. The port is connected to its hinterland by road and rail traffic, although those capacities are already exploited to the limit. With the arrival of larger ships at the terminal new road and rail infrastructure will be needed.

6. CONCLUSION

In the near and distant future world container traffic will continue to increase, with consequences for all ports. The problems that smaller container ports will have to face will be related mostly to the vessel size, as this will affect their productivity and competitiveness in the marketplace. Since the construction of new terminals represents significant financial investment and the physical expansion of terminals is often not possible due to urban centres in the immediate hinterland of the port, we can expect that the ports will in the first phase decide to increase the capacity of existing terminals. The appropriate optimization will be possible only with the right decision about the terminal areas that have to be improved in order to facilitate acceptance of larger ships in the port. The model presented in this article was created to facilitate those decisions. The tests made on the port of Koper and Rijeka gave us satisfactory results. We can therefore conclude that in the port of Koper investments in all the three subsystems are necessary, which at first include deepening of the sea, optimization of the current quay facilities and optimization of the facilities on the land side of the terminal. The results obtained with the tests done in the port of Rijeka show that the port has to focus in the future mostly on the purchase of additional mechanization and improvement of the storage area of the terminal. As both ports are competing for the same market share and for the same liner services the time factor will be of crucial importance here.

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ELEMENTS OF CONSTRUCTION OF THE GEOMETRICAL PRESENTATION OF THE SHIP'S ROUTE AS A PART OF PASSAGE PLAN ON AN ECDIS

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ABSTRACT

According to SOLAS convention the intended voyage plan from berth to berth must be made prior to proceeding to sea. SOLAS convention, chapter V, states that voyage planning must taking into account the guidelines and recommendations developed by the IMO which emphasize the main elements of a route. The problem arises in drawing routes either on paper or electronic chart. Traditionally, drawing route on paper chart did not include geometry. Creating routes on ECDIS includes geometry of the route with presetting parameters.

Authors emphasizes importance of understanding elements of geometrical construction of a route. Also, turnpoints, rudder angle, turn radius, ROT, speed, waypoints are explained. On real equipment created routes proved possible catastrophic consequences of non understanding of applying elements of geometrical construction of a route .

KEY WORDS

radius of turn, rate of turn, speed

ELEMENTI KONSTRUKCIJE GEOMETRIJSKOG PRIKAZA RUTE BRODA KAO DIJELA PLANA PUTOVANJA NA ELEKTRONIČKOJ POMORSKOJ KARTI

SAŽETAK

Plan putovanja broda prema zahtjevima SOLAS konvencije mora biti napravljen prije isplovljenja broda po načelu „od veza do veza“. SOLAS konvencija, glava V, navodi da se plan putovanja mora napraviti prema „Smjernicama za planiranje putovanja“ Međunarodne pomorske organizacije (IMO) u kojima se navode bitni konstitutivni elementi. Problem nastaje u dijelu crtanja rute bilo na papirnoj bilo na elektroničkoj pomorskoj karti. Tradicionalni pristup crtanja rute na papirnoj pomorskoj karti uglavnom nije uzimao u obzir geometriju same rute. Kod konstrukcije rute na modernim elektroničkim pokazivačima pomorskih karata (ECDIS) sustav sam obavlja ovaj dio planiranja putovanja prema utvrđenim, unaprijed određenim, parametrima.

Autori u svom radu naglašavaju važnost razumijevanja elemenata geometrijske konstrukcije rute. Nadalje objašnjavaju točku početka okreta broda, odklon kormila, polumjer okreta, mjeru okreta broda, obodnu brzinu i položaj međutočaka rute. Na primjerima napravljenima na stvarnoj opremi dokazuju važnost konstruktivnih elemenata rute, upozoravaju na moguće katastrofalne posljedice uslijed nerazumijevanja primjene ovih elemenata na geometrijsku konstrukciju rute.

KLJUČNE RIJEČI

Polumjer okreta broda, mjera okreta broda, obodna brzina

1. INTRODUCTION

According to SOLAS convention Regulation 34 “Safe navigation and avoidance of dangerous situations” prior to proceeding to sea, the master shall ensure that the intended voyage has been planned using the appropriate nautical charts and nautical publications for

the area concerned, taking into account the guidelines¹ and recommendations developed by the IMO. This regulation states that the voyage plan shall identify a route taking into account any relevant ships' routing systems, ensuring that there is sufficient sea room for the safe passage of the ship throughout the voyage, anticipating all known navigational hazards and adverse weather conditions and taking into account the marine environmental protection measures that apply, and avoids, as far as possible, actions and activities which could cause damage to the environment. Regulation 34-1 "Master's discretion" states that the owner, the charterer, the company operating the ship as defined in regulation IX / 1, or any other person shall not prevent or restrict the master of the ship from taking or executing any decision which, in the master's professional judgment, is necessary for safety of life at sea and protection of the marine environment.

Guidelines For Voyage Planning includes appraisal, i.e. gathering all information relevant to the contemplated voyage or passage; detailed planning of the whole voyage or passage from berth to berth, including those areas necessitating the presence of a pilot; execution of the plan; and the monitoring of the progress of the vessel in the implementation of the plan.

ICS Bridge Procedures Guide related to Passage/Voyage plan states that the passage/voyage plan should incorporate planned track showing the true course of each leg, leg distances, any speed changes required en route, abort/cancellation points for critical manoeuvres, wheel over positions for each course alternation – where appropriate, turn radius for each course alternation – where appropriate, maximum allowable off-track margins for each leg – where appropriate.

2. ELEMENTS OF CONSTRUCTION OF THE GEOMETRICAL PRESENTATION OF THE ROUTE

Bridge procedures Guide implements construction of the geometrical presentation of the route. Speed, true course, leg distance have to be noted on the chart. Besides that, where appropriate, turn radius, wheel over positions and off track margins should be presented.

Voyage plan can be undertaken either on paper charts or using ECDIS² displaying ENC³.

When voyage planning using ECDIS safety contour should be established around the vessel. After that a route can be created taking into account all above mentioned elements. Modern, sophisticated, electronic devices such as ECDIS can do this almost automatically.

A route is sequence of waypoints defining a passage. Each waypoint in a route represents a change of course that take place in a fixed radius turn. The beginning and end points of the turn are called turn points. The straight line between two turnpoints is called leg.

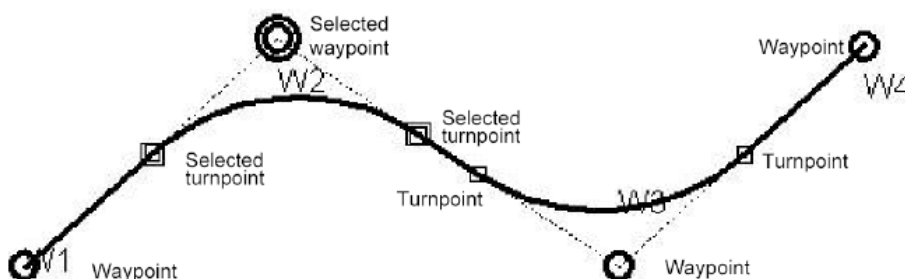


Figure 1. Route with waypoints, turnpoints and leg

When creating route on ECDIS, system should automatically take into account maneuvering characteristics of a ship. Speed, turn radius and off track limits for the

¹ RESOLUTION A.893(21) adopted on 25 November 1999 Guidelines For Voyage Planning

² Electronic chart display and information system

³ Electronic navigational chart

waypoints have maximum and/or minimum default values. For the geometrical presentation of a route only turn radius is important while speed influences Rate of Turn and vice versa.

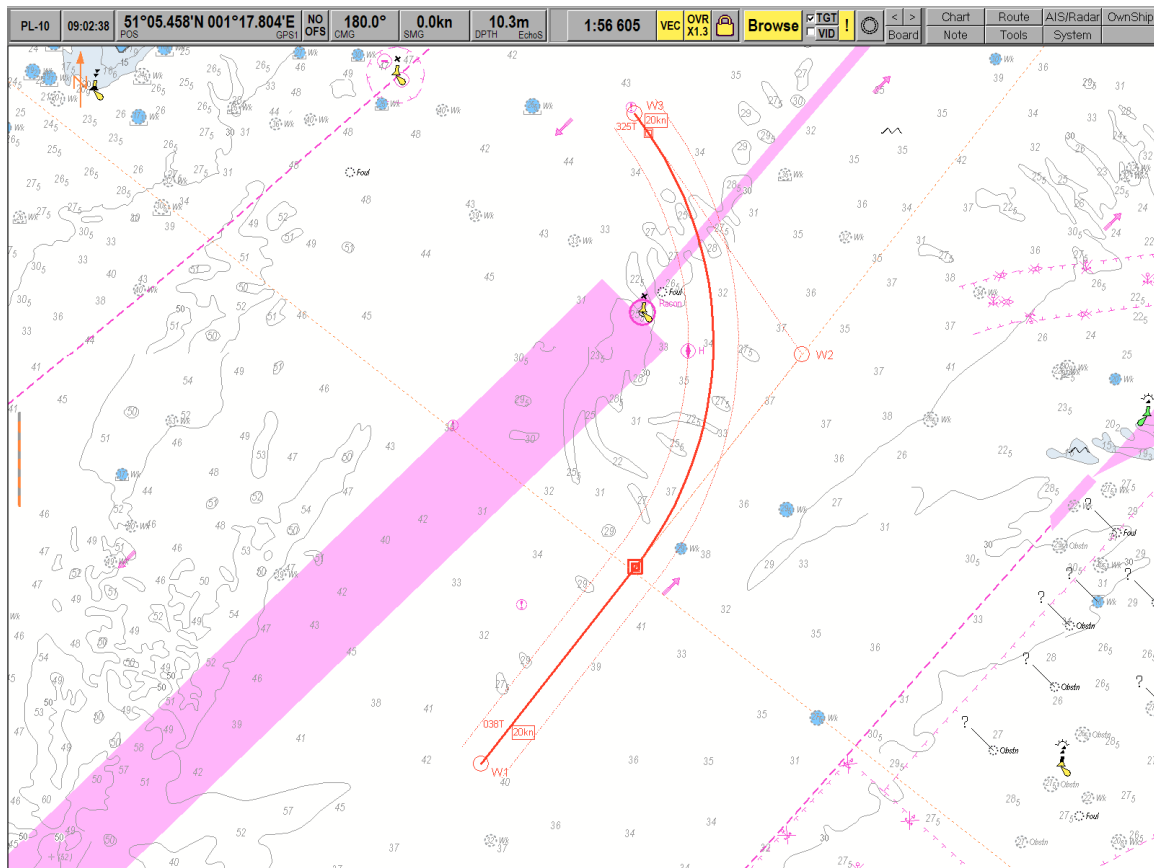


Figure 2. Route elements presented on ECDIS K-BRIDGE

Basic parameters that include waypoints, off track limit, speed, true course, turnpoints (wheel over positions) and turn radius are presented (figure 2.).

When creating a route the most delicate part is a turn radius. Depending on ship's maneuver characteristics minimum turn radius is predetermined and cannot be overridden. In practice this can be very challengeable because a route is consisted of many of waypoints with different turn radius. A navigator must be aware of the minimum turn radius value predefined in ECDIS settings. Because a route is being made on its geometrical base, speed and ROT⁴ do not influence creation of a route but these are very important in the execution and monitoring parts of voyage planning. Vessels usually have tables or graphs representing turn radius in advance/transfer form. In figure 3. it can be seen that a vessel (in this case a celebrity class of cruise vessels) would have an advance of 2 cables and 1.25 cables transfer to follow a turn circle. These tables/graphs are made on 5°, 10°, 15°...to hard a port/starboard rudder alteration basis.

⁴ Rate Of Turn

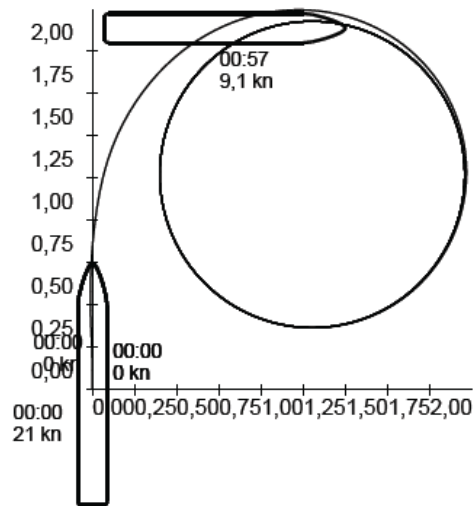


Figure 3. Turning circle at max rudder angle that includes advance and transfer values

A navigator is obliged to carefully study this characteristic of own ship and to correctly implement this in a route. Choice of rudder angle values influences ship's heel and ROT. Speed can be adjust to avoid excessive heel.

$$\text{ROT} = \frac{v \text{ [kt]}}{r \text{ [M]}} \text{ [°/min]}$$

According to this simplified formula navigator determines speed and radius to calculate maximum allowable ROT. Also navigator can calculate radius or speed with fixed value of ROT.

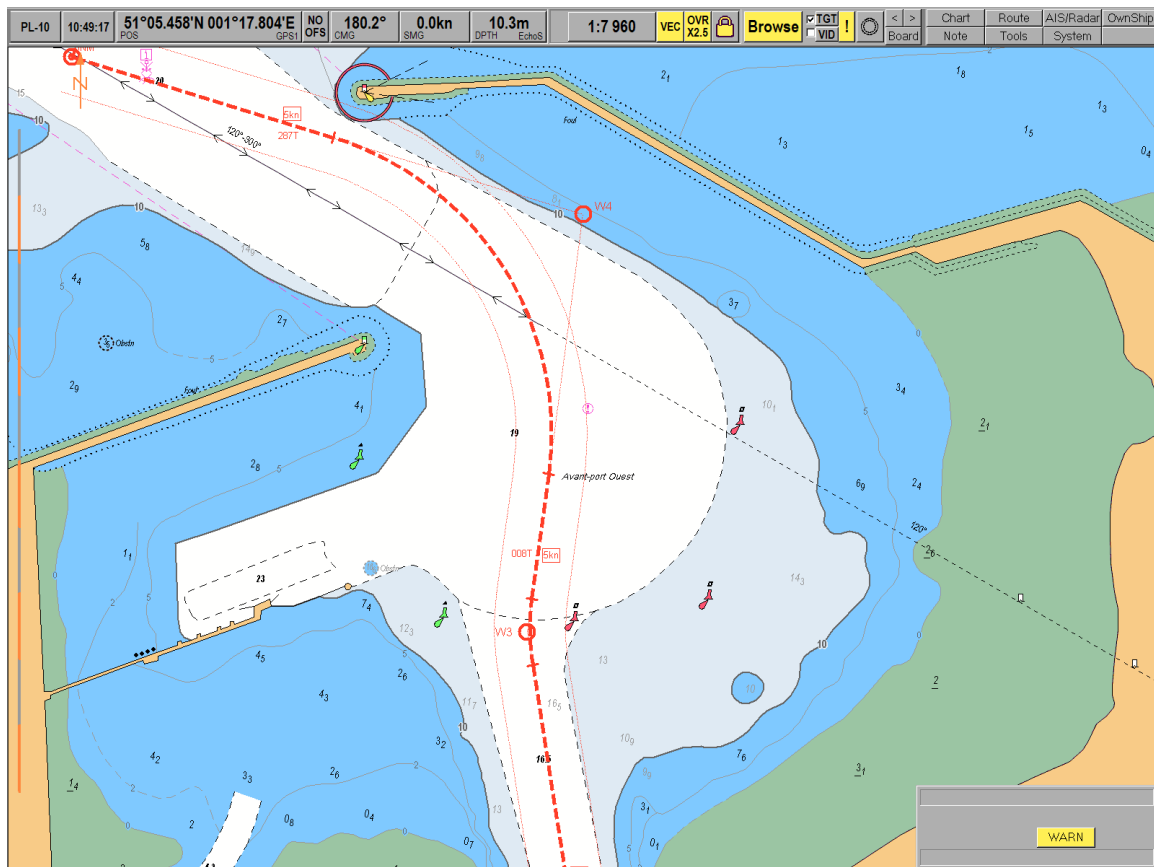


Figure 4. Established safety contour

Following a validated planned route towards waypoint No.4 deep outside safety contour (inside no go area) is still on safe side as a ship is going to be on track presented by dotted line. Using geometrical elements of a route that includes turn radius for creating a route system will draw a route regardless of waypoint position. Problem can arise when this waypoint position is transferred to GPS⁵. Voyage planning programs installed in GPS calculate distances and courses from waypoint to waypoint without taking into account wheel over points and turn radius. Misunderstanding of this can lead to catastrophic consequences. Same problem exists when passage planning is executed on paper charts.

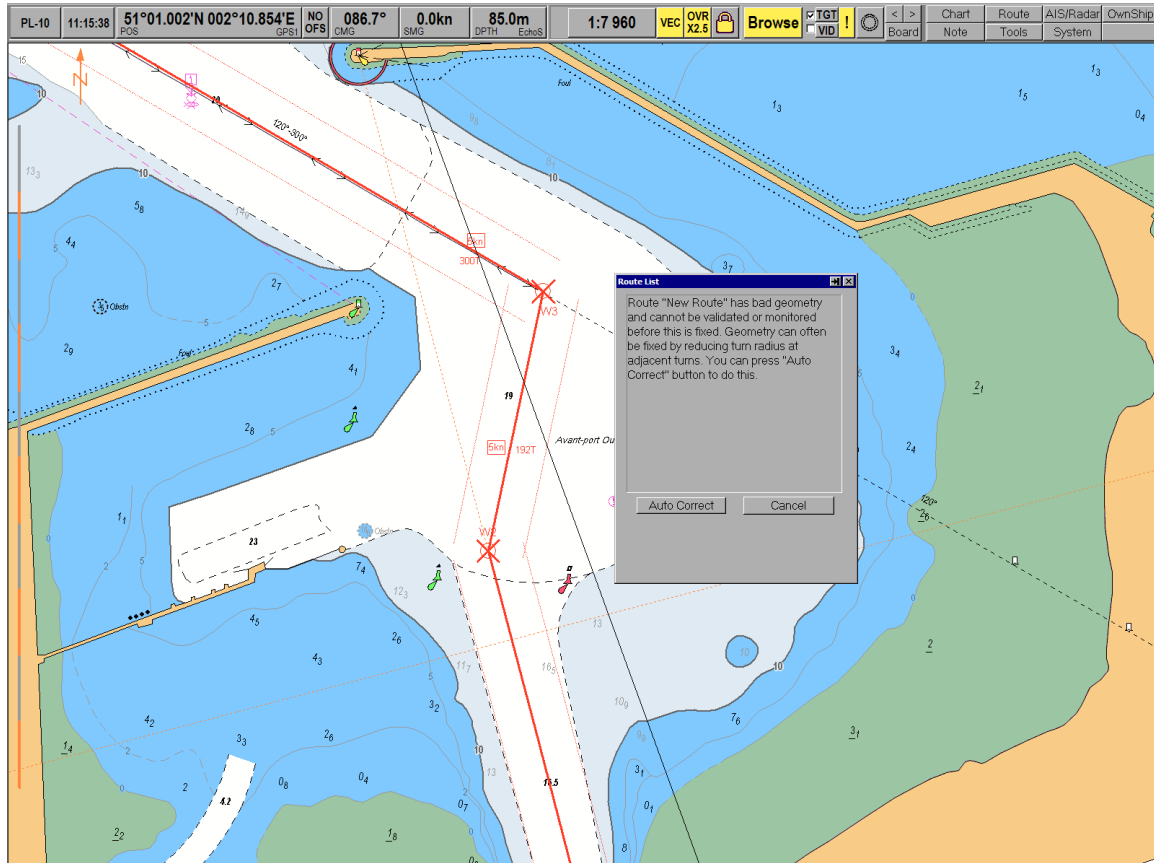


Figure 5. Bad geometry

When basic elements of geometrical construction of a route are ignored then a route cannot be validated or monitored before this is fixed. When the system is interfaced to an Autopilot Track Pilot, programmed routes can be used to steer the ship. ECDIS sends course, upcoming turn radius and the new course, off track distance etc. to the autopilot. The autopilot adjusts the steering accordingly. The autopilot can be controlled in four modes:

Heading mode - The heading set-point for the ship is used as course to steer. No route required.

Course mode – The course set-point and the calculated drift is used to calculate the heading to steer. No route required.

Waypoint mode – The route and calculated drift is used to calculate the heading to steer. The system compensates for any cross track distance in order to reach the waypoint. Waypoint mode is selected for one waypoint at a time. When the ship is close to the waypoint, the mode is changed to course mode to avoid large course change close to the waypoint. Turns must be started manually.

⁵ Global Positioning System

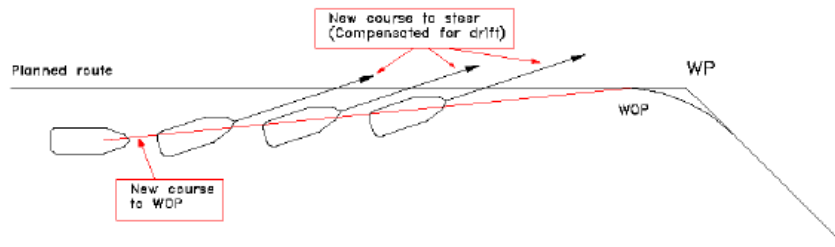


Figure 6. Waypoint mode

Track mode – The system steers the ship according to the programmed route with minimum of course alterations and optimum rudder usage. In this mode turns are executed automatically.

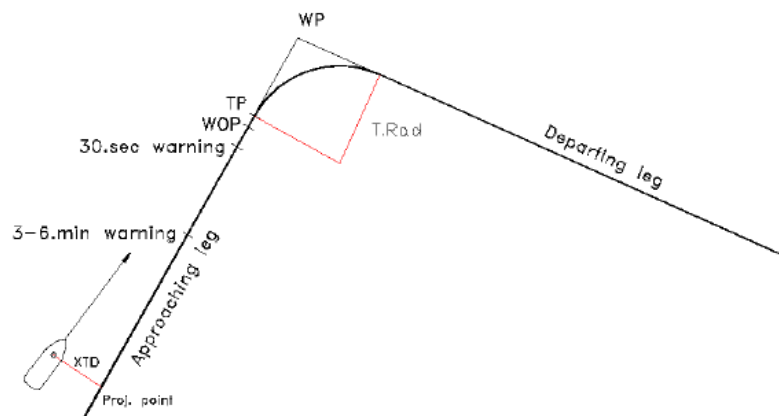


Figure 7. Track mode

Before initiating track steering it is advisable to steer ship manually (or using the autopilot) until the ship is approximately on a straight leg with its heading towards a selected waypoint on the track. This reduces the likelihood of sudden unexpected maneuvers when track steering is initiated. The figure 8. below provides an example: the ship steers towards waypoint 03 by making two turns and following a short straight leg between the turns. It initiates track steering after the second turn on the straight leg just before waypoint 03 on that way avoiding hard alterations of course.

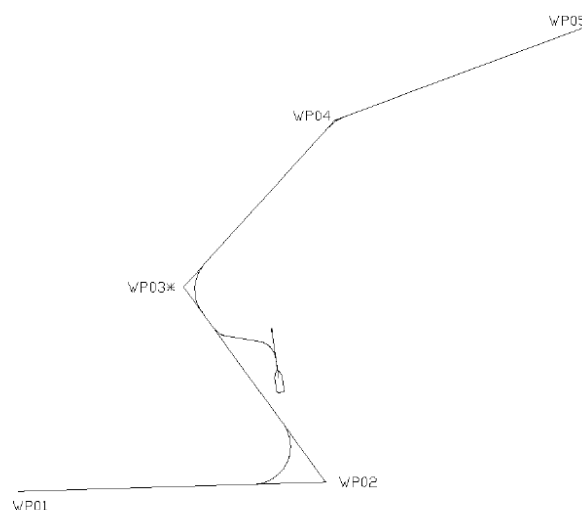


Figure 8. Initiating track steering

3. CONCLUSION

Thoroughly understanding of elements of construction of the geometrical presentation of the route is needed to create executable and safe route especially ones used on modern, sophisticated devices such as ECDIS.

In addition to this, navigator must know limitations and maneuvering characteristics of his own ship.

In this work authors demonstrated problems arising from construction of the geometrical presentation of a route, execution of the passage plan by system which is interfaced to an Autopilot Track Pilot where programmed routes can be used to steer the ship.

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EQUIPMENT

POLARIS BRIDGE SIMULATOR, Kongsberg Maritime AS

RISK ASSESMENT METHODOLOGY ON OIL SPILS

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ABSTRACT

The risk from oil spill pollution in the European seas is high due to the heavy traffic of merchant vessels for transporting oil and gas and to the increasing coastal and offshore platforms related to the oil industry in general. The basic response to major oil spills includes different measures and equipment. However, in order to make optimal use of such devices and to assist the response agencies, oil spill and trajectory models are used in order to provide predictions of the drift and weathering of the oil slicks. During the past years, the development of the GMES¹ MyOCEAN² marine core service³ and of the associated downscaled ones, made possible to provide forecasting data for downstream oil spill predictions. The GMES marine core service, together with the ability to detect oil slicks using ASAR⁴ satellite images, initiated the efforts for the implementation of a multi model integrated downstream oil spill prediction system in the Mediterranean to support in near real time the marine safety. This implementation is carried out in the frame of the Mediterranean Decision Support System for Marine Safety (MEDESS-4MS) project, which is dedicated to the member states, IPA countries and to key users, such as REMPEC⁵ and EMSA⁶. MEDESS-4MS is a MED⁷ strategic project co-financed by the European Regional Development Fund (ERDF) and by National Resources. There are seven (7) Mediterranean countries participating and the Department of Merchant Shipping, Cyprus, is the Coordinating partner, while Maritime Safety Department of Montenegro is the only partner from IPA⁸ region. MEDESS-4MS incorporates all three elements for a comprehensive response to the risks associated with Oil Spills: Prevention, Detection and Control. Prevention within MEDESS-4MS consists of the development of a Risk Assessment Model capable in identification and evaluation of risks as well as in determining the consequences of an Oil Spill Release in the marine environment and the Mediterranean coastline. In this paper, emphasis is given on how a Risk Assessment Model can be developed and incorporated within an Integrated Multi Model Oil Spill Prediction Service, such as the one offered by MEDESS-4MS.

KEYWORDS

Risk, risk assessment, oil spill release, oil spill prediction service, Marine Core Services, prevention, detection, control of oil spills, ship traffic, AIS⁹, slicks, forecasting services.

¹ Global Monitoring for Environment and Security (GMES) is a joint initiative of the European Commission and European Space Agency, which aims at achieving an autonomous and operational Earth observation capacity.

² MyOcean is a series of projects granted by the European Commission within the GMES Program (Seventh Framework Program), whose objective is to define and to set up a concerted and integrated pan-European capacity for ocean monitoring and forecasting. The activities benefit several specified areas of use: Maritime security, oil spill prevention, marine resources management, climate change, seasonal forecasting, coastal activities, ice sheet surveys, water quality and pollution.

³ The Marine Core Service delivers regular and systematic reference information on the state of the oceans and regional seas of known quality and accuracy

⁴ The Advanced Synthetic Aperture Radar (ASAR) is an imaging radar instrument which uses microwave radiation to image the surface of the Earth and the oceans.

⁵ The Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC) assists the Mediterranean coastal States in ratifying, transposing, implementing and enforcing international maritime conventions related to the prevention of, preparedness for and response to marine pollution from ships.

⁶ European Maritime Safety Agency

⁷ The MED programme is a transnational programme of European territorial cooperation. It is financed by the European Union as an instrument of its regional policy

⁸ IPA (Instrument for Pre-accession Assistance)

⁹ AIS (Automatic Identification System)

METODOLOGIJA PROCIJENE RIZIKA NA IZLIVANJE NAFTNIH MRLJA

SAŽETAK

Rizik od zagađenja mora uslijed izlivanja nafte u vodama Evropske unije je visok zbog gustog pomorskog saobraćaja kojim se prevoze naftni derivati, kao i povećanjem broja naftnih platformi, kako na kopnu tako i na moru. Osnovni odgovor na izlivanje nafte uključuje različite mjere, kao i opremu. Da bi na što optimalniji način iskoristili raspoloživu opremu i na taj način pomogli tijelima zaduženim za intervenciju, koriste se modeli za predviđanje kretanja naftne mrlje usled morskih struja i vjetra. Zadnjih godina razvojem GMES i MyOCEAN projekata za razvoj osnovnih servisa za potrebe zaštite morske sredine, kao i drugih projekata, omogućeno je dobijanje prognostičkih podataka potrebnih za predviđanje kretanja naftne mrlje. GMES servisi za zaštitu morske sredine zajedno sa ASAR satelitskim snimcima, su inicirali napore za stvaranje integrisanog multimodalnog sistema za predviđanje kretanja naftne mrlje u Mediteranu u realnom vremenu i time dorinijeli povećanju pomorske sigurnosti. Stvaranje ovakvog sistema jeste cilj MEDESS-4MS projekta, koji je namjenjen zemljama članicama i IPA zemljama, kao i glavnim korisnicima REMPEC-u i EMSA-i. MEDESS-4MS je strateški MED projekat koji se kofinasira preko ERDF-a i nacionalnih kontribucija. Ukupno sedam (7) Mediteranskih zemalja učestvuje u projektu, Uprava trgovačke mornarice Kipra je koordinator projekta, dok Uprava pomorske sigurnosti iz Crne Gore je jedini partner iz IPA područja. MEDESS-4MS uključuje sve tri komponente potrebne za sveobuhvatni odgovor na rizike uzrokovane izlivanjem nafte: pervencija, detekcija i kontrola. Pervencija u okviru MEDESS-4MS se sastoji u izradi modela za procijenu rizika sposobnog za identifikaciju i procijenu rizika, kao i određivanja posljedica uslijed izlivanja nafte morskom području na obalama Mediterana. Ovaj rad je posvećen razvoju modela za procijenu rizika, kao i načinu na koji se taj model može inkorporirati u integrisani multimodalni sistem za predikciju kretanja naftnih mrlja, koji će biti ponuđen preko MEDESS-4MS projekta.

KLJUČNE RIJEČI

Rizik, procijena rizika, ispuštanje nafnih mrlja, predikcija kretanj naftne mrlje, Marine Core Services, pervencija, detekcija, kontrola naftne mrlje, pomorski saobraćaj, AIS, mrlje, servisi za prognozu

1. RISK ASSESSMENT METHODOLOGY ON OIL SPILLS WITHIN MEDESS-4MS

For Oil spills in the ocean and particularly in coastal waters are a matter of concern due to the damaging effect they can have on various coastal resources such as fisheries, recreational facilities, industrial installations and the marine and coastal vegetation and wildlife in general. To mitigate such damage as much as possible, it is common to combat a spill by deploying equipment such as booms and skimmers or to spray chemical dispersants. In order to make optimal use of such devices and to assist the response agencies and the decision makers, it is recommended to employ at first a dedicated numerical model to predict where the spill will most likely move to, in particular which resources are threatened, and how soon it will get there. Such models often also predict the expected state of the oil when it arrives, that is, how much will have evaporated, the degree of emulsification of the remainder, how much will remain be on the surface and how much will be dispersed as fine droplets throughout the water column, and so on. The oil spill models require as input data the location and the time of the observed oil slick, the type of oil and its characteristic, the wind fields, the sea state, the sea surface temperature and the three dimensional sea currents. Therefore, in order to give a sound basis for any user-designed application that tries to manage either the exploitation or the protection of the marine environment from oil spill accidents, it is necessary to offer an efficient estimate of the oil spill predictions using quality controlled marine state forecasting variables, such as those provided by the GMES MyOCEAN marine core service and the associated downscaled ocean forecasting systems.

The permanent risk from oil spill pollution in the European seas is at the basis of the need to organize and establish an operational multi model integrated oil spill prediction and warning system in assisting the response agencies to prevent and mitigate the adverse effects of accidental marine pollution due to oil spills. Such integrated prediction system, particularly for the Mediterranean needs to:

1. Integrate the different well established oil spill models with the ocean data provided by the MyOCEAN regional marine core service and the downscaled ocean forecasting systems;
2. Connect the existing oil spill monitoring systems, such as EMSA's (European Maritime Safety Agency) CleanSeaNet and REMPEC (regional centre of IMO and UNEP/MAP for responding of oil pollution in the Mediterranean) to the integrated multi model oil spill prediction service; and
3. Connect the AIS to the oil spill prediction service and allow the backward predictions of the oil slicks to facilitate the identification of the ship that has potentially originated the spill;

The Mediterranean decision support system for marine safety (MEDESS-4MS) is aiming to fulfil the above requirements and to set up an integrated multi model near real time operational oil spill prediction service for the entire Mediterranean, dedicated to the member and non-member response agencies and to the key users, such as REMPEC, and EMSA. The multi oil spill modelling system of the MEDESS-4MS service will be coupled with the high resolution environmental (met-ocean) data from the MyOCEAN regional marine core service and the associated downscaled ocean forecasting systems and the oil slick data from existing monitoring platforms, such as REMPEC, EMSA CleanSeaNet satellite data, as well with AIS data.

As far as oil spill models are concerned, it is worth noting that few well established models have been used by Member States agencies and services in the Mediterranean during major oil spill incidents. These are: 1) MOTHY; 2) MEDSLIK and 3) Poseidon-OSM. These models are all lagrangian particle models (dispersion is represented by trajectories of numerical particles) but have very different numerical schemes and parameterizations for effects of waves, winds and in general the transformation of oil due to chemical and physical processes in the water.

It should be emphasized that for the first time these models will be consistently used in parallel and intercompared as well as harmonized within the integrated MEDESS-4MS service. Furthermore the MEDESS-4MS service will offer the three of them (multi model approach) to the users, coupled with different (from basin to coastal) operational ocean models, in order to explore sensitivities of the oil spill predictions due to parameterizations and give confidence levels. Therefore, MEDESS-4MS service will be able to cover the whole Mediterranean region, as can be seen in Fig. 1 below

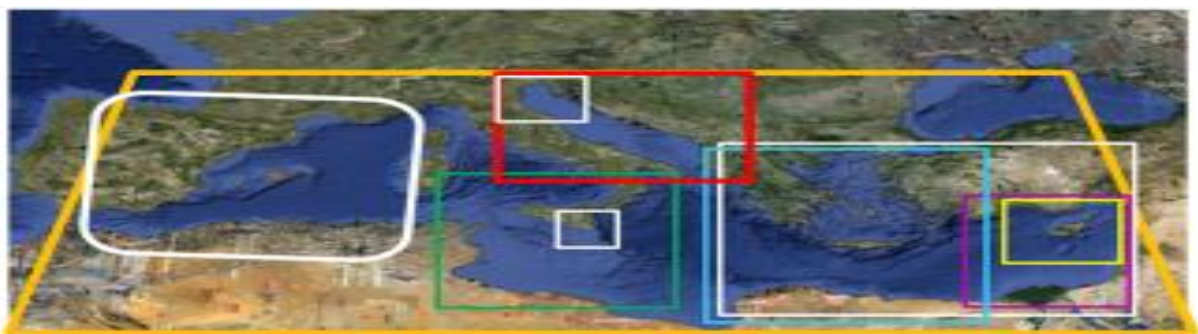


Figure 1. MyOCEAN regional and associated downscaling model domains to be integrated within the MEDESS-4MS oil spill models

All the data from the different type of modelling and observing systems of the MEDESS-4MS will be managed through a Network Data Repository (NDR) Service, using a variety of data formats, housing environmental data as well as outputs of oil spill modelling and forecasting systems into an integrated data warehousing facility (Fig. 2). This facility will not only allow for the storage of data but also for its search, discovery and presentation. Such a capability will allow users involved in oil spill monitoring and forecasting, for operational or

emergency management purposes, to have unified access to all necessary data concerning their operations.

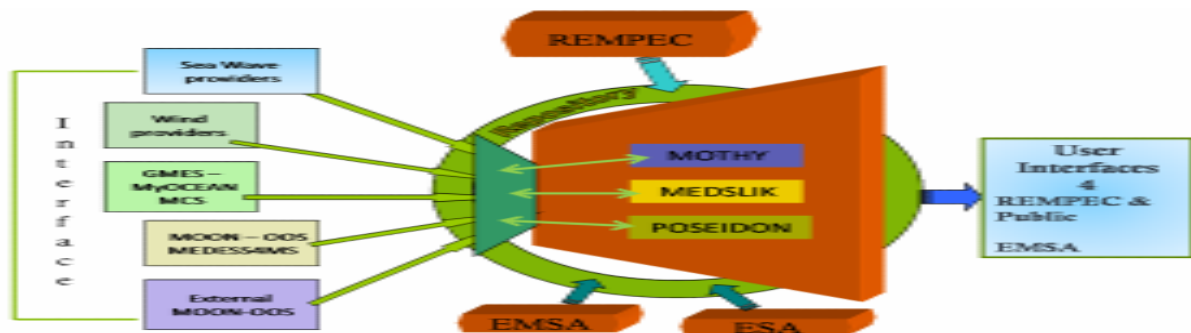


Figure 2. MEDESS-4MS Network Data Repository service component

The NDR Service will also receive all the data to be gathered for the development of the Risk Assessment Model, which is a key element for the MEDESS-4MS service to offer a holistic approach in relation to Oil Spills at the Mediterranean Sea.

The main purpose of this work, apart from describing the importance of the Mediterranean decision support system for marine safety (MEDESS-4MS), is to show how Risk Assessment Model for Oil Spills will be developed within the framework of the MEDESS-4MS project. This will be seen in the next sections.

2. DEVELOPMENT OF A RISK ASSESSMENT MODEL FOR OIL SPILLS

The development of a comprehensive Risk Assessment Model for Oil Spills within the MEDESS-4MS project will require the gathering of data from various sources as well as analysis in the various phases. All these activities can be summarized in the following ten (10) activities:

2.1. AIS Collection

The aim of this step is the collection of AIS data for the Mediterranean region for duration of one year. The collection of AIS data is not straightforward since there are many issues to be considered. These can be summarised as follows:

- Limitation of AIS coverage (meteorological conditions, height of AIS base antenna)
- AIS base stations available?
- No data on oil transport
- The transponder is not operational or the transponder is not properly working
- Vessels equipped with a Class-B AIS transponder

2.2. AIS Analysis

The analysis of the AIS data gathered in the previous step consists of the following:

- AIS data sorting and cleaning
- Traffic density
- Traffic sorting by ship size, ship type

2.3. Oil Transport Data

The collection of the Oil Transport data is important because the ship traffic, as gathered through the AIS, is not enough in determining the high risk areas for oil spills. This step comprises of the following:

- Collection of oil transport data

- Analysis of oil flow data
- Compliance with AIS data regarding time and area
- Inclusion of transit

2.4. Parameter Identification

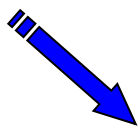
The parameter identification is a step in which we try to evaluate the sensitivity-vulnerability of a certain area, giving emphasis to the coastline. In order to understand what kind of parameters we need to include in this step, one can take into account that 'anything that is vulnerable to an oil spill must be classified as a parameter'.

All parameters can be classified in two big categories, Environmental Parameters & Socio-economic parameters. Environmental Parameters include parameters such as, Shore lines (rocky, sandy, etc.), Protected Areas, Flora, Fauna, among others. Socio-economic Parameters include tourism, ports/ terminals, Power Plants, Desalination plants, Fish grounds, Farm winds.

2.5. Sensitivity Weighting Matrix

The sensitivity weighting matrix is basically the step in which the various parameters are given a specific weight in terms of significance in a specific field. In Fig. 3 below we can see an example of a weighting matrix for the various environmental parameters. These parameters are given a specific weight in four (4) different fields: Ecological Function, Rarity, Vulnerability and Biodiversity. The sum of the weights in all these fields results in the so called, environmental sensitivity. This environmental sensitivity in combination with the socio-economic sensitivity will allow us to have the complete Sensitivity Mapping for the whole Mediterranean.

	ecological function									
Posidonia oceanica	1	0	0	0	0	1	1	1	1	0
Monk seals	0	1	0	0	0	1	0	0	0	1
Turtles	0	0	1	0	0	0	1	0	0	1
Protected areas	0	0	0	1	0	0	0	1	0	0
Rocky shoreline	0	0	0	0	1	0	0	0	1	0
ecological function	3	1	1	2	2	3	3	3	3	1



	Ecological function	Rarity	Vulnerability	Biodiversity	environmental sensitivity
Posidonia oceanica	3	1	2	3	9
Monk seals	1	3	3	1	8
Turtles	1	2	3	1	7
Protected areas	2	1	1	3	7
Rocky shoreline	2	1	1	2	6

Figure 3. Schematic Representation of a sensitivity weighting matrix for environmental parameters

2.6. Oil Response Inventory

In this specific step, we try to identify all means of combat equipment in case of Oil Spill release. Moreover, the various coordination centres and human resources are part of the information necessary to be collected at this step.

2.7. Bi and Multilateral Agreements

In this step we have the identification of the various agreements. These can be summarized as follows:

- Bilateral
- Multi-lateral
- European/EMSA

2.8. Accidents at Sea Analysis

The main part of the 'Analysis of accidents at sea' is to figure out the probability (frequency) of a specific accident to occur, that is calculating the risk probability of a specific accident based on the AIS data and statistical parameters. The Analysis of Accidents at Sea includes Collision accidents, Grounding accidents, Fire and Explosion accidents, Ship damage and Foundering due to various causes, such as hard weather, Collisions with fixed objects (i.e. offshore structures) and STS operations, among others.

Collision and Grounding types of accident are linked directly with *the AIS data analysis* and more specifically, with the position of the vessels and how close they come to each other. All the other types of accidents are less important, since collision and groundings account for 95% of the modelling efforts of all the types of accidents. Moreover, all the other types rely on statistical data only.

2.9. Accidental spill of oil Analysis

The main part of the 'Accidental Spill of Oil Analysis is to take into account the amount of risk calculated in the Accident At Sea Analysis (probability of occurrence) and find the closest match against 'collision model scenarios' with the aim to 'forecast/predict' the amount and type of oil spill at sea.

2.10. Environmental Damage Assessment

The damage analysis is used to determine the consequence from an accidental spill of oil in a uniform way throughout the project area. The model for environmental damage will be developed with input from the accidental oil spill analysis and the sensitivity analysis.

Below we can see in a schematic representation of all the activities necessary for the development of the Risk Assessment Model and the milestones related to these activities.

Table 1. Schematic Representation of the milestones related to the various steps for a Risk Assessment Model for Oil Spills

ACTIVITY DESCRIPTION	MILESTONE
AIS Collection	IDENTIFICATION OF HIGH RISK AREAS
AIS Analysis	
Oil Transport Data	
Parameter Identification	IDENTIFICATION OF SENSITIVE AREAS
Sensitivity Weighting Matrix	
Accidents at Sea Analysis	PROBABILITY OF OCCURENCE
Accidental spill of oil Analysis	OIL SPILL EVALUATION (SIZE, TYPE)
Environmental Damage Assessment	CONSEQUENCES
Oil Response Inventory	MITIGATION OF CONSEQUENCES
Bi and Multilateral Agreements	

3. CONCLUSIONS

The MEDESS-4MS service will improve maritime risks prevention, maritime safety, ecosystem protection and will assist the operational response agencies to implement the Directive 2005/35/EC on ship-source pollution and on the introduction of penalties for infringements and therefore it will support the operational response agencies contingency plans by providing validated risk mapping. MEDESS-4MS is designed to serve the needs of international and European organizations, the Mediterranean operational responsible agencies defined by REMPEC and Member State operational responsible agencies as defined by EMSA. Most of the partners are operating forecasting centres, within the framework of Marine Core Services and at national level, and providing individual oil spill predictions at local and sub-regional level, while other partners are response agencies to oil spill incidents. Therefore, the partners experience and their long existing collaboration with REMPEC, EMSA and local response agencies will ensure the sustainability of the integrated multi model oil spill prediction service long after the end of the project.

MEDESS-4MS main elements, such as the integrated data repository, users interfaces for service scenarios to regional and local response agencies, etc., can be easily adapted for other European seas, such as the Black and Baltic seas, where ocean forecasting systems, oil spill detection platforms and oil spill models integrated with forecasts are already in place in a disconnected way.

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ANALYSIS OF THE ACCIDENT OF M/V "COSTA CONCORDIA"

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ABSTRACT

Analyses and investigations of marine accidents can be divided into different categories and assigned to various marine experts for further investigation depending on the category of accidents. This paper analyses the elements which have led to the maritime disaster of the passenger vessel "Costa Concordia". The paper defines and proposes new measures which should be taken in the area where the accident occurred with regard to the existing navigational risk.

KEYWORDS

Accident, navigational risk, risk assessment, key elements in accident, cause of accident

ANALIZA POGIBELJI M/B COSTA CONCORDIA

SAŽETAK

Analize i istrage pomorskih pogibjelji se mogu podijeliti u različite kategorije i dodijeliti različitim pomorskim vještacima radi daljne istrage ovisno o kategoriji nesreće. U radu se analizira pomorska nezgoda putničkog broda "Costa Concordia". Analiziraju se elementi koji su doveli do pogibjelji. Predlažu se nove mjere koje treba poduzimati na području gdje se nezgoda dogodila s obzirom na postojeći navigacijski rizik.

KLJUČNE RIJEČI

Nezgoda, navigacijski rizik, procjena rizika, ključni elementi u nezgodi, uzrok nezgode

1. MARINE ACCIDENTS

Maritime accidents belong to the category of accidents that are caused by:

- Weather conditions (storm, reduced visibility, ice...)
- Navigation errors in pilotage (accidents occurring in confined areas due to heavy traffic, etc.)
- Collision with unidentified object or underwater obstructions
- Collision with other vessels
- Manoeuvring in confined areas or under adverse conditions within the port
- Transport of dangerous cargo, cargo loaded on the main deck(s), heavy cargo transportation
- Failures of the steering system, main engine or other machinery and equipment.

The reports on accident investigation are grouped into the categories that are defined by the event causing the accident [1]:

1. Collision
2. Grounding
3. Contact
4. Fire or explosion
5. Failure of the hull or watertight doors
6. Engine room failure
7. Damage to the vessel or her equipment
8. Capsizing or listing

9. Disappearance of the vessel
10. Accident related to life-saving equipment

When maritime accident takes place, it is recommended to form workgroups that should analyse the accident and produce the following reports in line with their respective fields of specialisation:

- Report on the maritime accident analysis
- New insights and findings arising from the very accident and presentation of the accident information to seafarers
- Safety issues
- Safety recommendations.

The flowchart model (Figure 1) is suggested for an efficient analysis of the maritime accident.

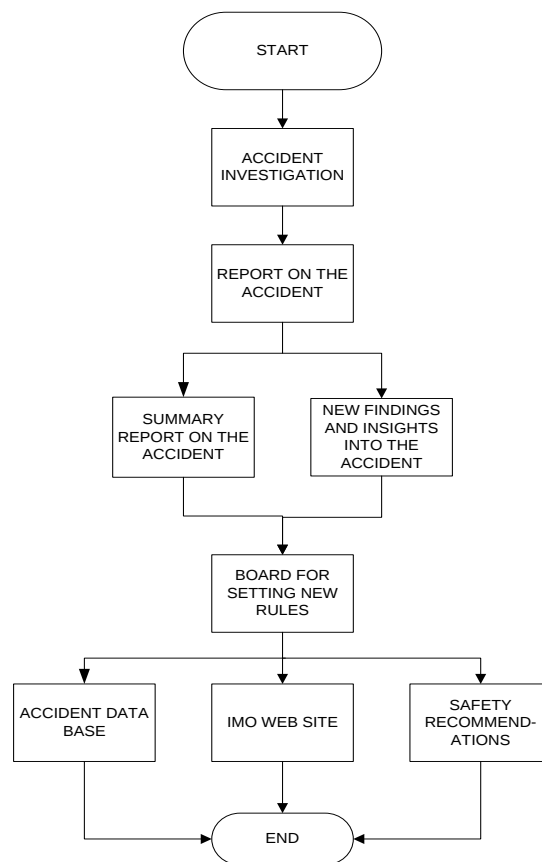


Figure 1. Flowchart model of the sea accident investigation

Source: <http://www.imo.org/OurWork/Safety/Implementation/Casualties/Documents/CASUALTY%20ANALYSIS%20PROCEDURE.pdf>

2. ANALYSIS OF THE M/V COSTA CONCORDIA DISASTER

On 13th January 2012, under fair weather conditions, the cruise ship *Costa Concordia* carrying 4229 persons on board (3206 passengers and 1023 crewmembers) hit an underwater rock called Le Scola off the Island of Giglio, about 800 metres south of the entrance to the harbour of Giglio Porto.



Figure 2. M/V Costa Concordia



Figure 3. Passage plan of the M/V Costa Concordia

Source: Ministry of Infrastructure and Traffic - Italy

The vessel's route is shown in Figure 3. She was sailing too close to the shore, as the captain deviated from the ship's computer-programmed route in order to perform an unofficial near-shore salute to the local islanders, claiming that he was familiar with the local seabed. The cruise ship's speed was too high for performing such a risky manoeuvre (15.5 knots), which eventually resulted in the collision with the reef. Engine rooms were flooded, the vessel began to tilt and power was temporarily lost.

The ship's emergency generator was started but performed intermittently. The rudder remained stuck in starboard position and could not be moved again. The ship began listing to starboard without control and, with the aid of wind and tidal stream, drifted and stranded on the rocky sea bed by Giglio Island at 23:00 LT, tilted by 15°. The damage assessment confirmed that watertight compartments No. 4, 5, 6 and 7 were damaged and the water started to flood in through the damaged hull. The compartments comprised the following areas:

- Compartment No. 4 included: main propulsor, hydraulic unit and cooling compressor room;
- Compartment No. 5 included: electrical propulsion engine, fire pump and bilge pump;
- Compartment No. 6 included: three (stern) diesel generators;
- Compartment No. 7 included: three (bow) diesel generators;
- Compartment No. 8 included: ballast pump and bilge pump.

The captain did not promptly notify the Search and Rescue Authorities. The emergency call was sent by the observers from the shore. At 22:54 the order was given to abandon ship. The first lifeboat was launched at 22:55. Fifteen minutes later the first passengers were brought ashore. The total toll included 32 dead, 2 missing and presumed dead, and 64 injured.

2.1. RESULTS OF THE INVESTIGATION OF THE COSTA CONCORDIA DISASTER

The main part of the investigation refers to the conduct of the captain and his decision to navigate in shallow waters. The computer simulation shows a delay in manoeuvring at the critical moment. Considering all the information, the following critical elements may be the most relevant factors leading to the disaster:

- switching from vertical courses to parallel courses along the shore;
- instead of selecting the waypoint, the vessel proceeds to sail towards the shore;
- maintaining a high speed of 16 knots while sailing along the coast at night;
- failing to use adequate sea charts;
- failing to use adequate nautical publications;
- failing to carry out the hand-over between the captain and the first mate;
- captain's poor diligence due to the presence of other persons on the bridge and due to a telephone call which has no reference to navigation;
- captain's order to the helmsman to monitor the compass course and not the rudder angle indicator;
- although the bridge is manned sufficiently, the crew do not pay enough attention to the ship's position, watch-keeping and monitoring of steering;
- captain's attitude with regard to the initial passage plan;
- captain's excessive authority and failure of the officer of the watch to warn him;
- accepting a risky manoeuvre as routine.

2.2. RESULTS OF THE INVESTIGATION IN LINE WITH THE STCW CONVENTION

Depending on the circumstances under which a maritime accident has occurred, it is considered important to focus on the issues that arise from the framework of the international convention on Standard Training Certificate of Watchkeeping (STCW):

1. Watchkeeping on the bridge must be arranged in line with the situation and should be supported by additional watchkeepers during coastal navigation;
2. Speed of the vessel must be maintained within manoeuvring limits and safe crash-stop in case of failure or unpredictable circumstances (collision, fire, grounding, etc.);
3. Compulsory use of the radar as an auxiliary means of the lookout.

The investigation performed after the accident produced the following results:

1. *Watchkeeping on the bridge* was arranged in compliance with the STCW requirements but the crew did not carry out their duties efficiently, given the demanding near-shore navigation;

2. *Speed of the vessel* was not reduced and remained between 15 and 16 knots. The ship's manoeuvring characteristics show that such a vessel requires the stopping distance of 0.7 NM (1299 m);
3. *Radar settings* were set properly.

3. ANALYSIS AND SIMULATION OF THE NAVIGATION

The computer simulation has been obtained with the aid of the data from Voyage Data Recorder (VDR) and other sources:

- reports from witnesses;
- reports produced by the investigation;
- data available from VDR.

The purpose of the analysis and simulation has been to obtain a realistic presentation of the ship's movement prior to and after hitting the underwater rock. The simulation of the impact has been reconstructed on the basis of the ship's movement and the positions entered into the ship's simulator, and on the basis of the commands that the captain gave to the duty officers and the helmsman. The simulation has been performed during daylight in order to present consistently that the vessel was sailing too close to the shoreline.

The simulation of the same event occurring at night has also been shown. Figure 4 features the navigation route as obtained by the simulation on the basis of the data gathered with the aid of VDR. Figure 5 shows the area where the cruiser ship hit the rock, while Figure 7 presents the vessel's movement detected by the Automatic Identification System (AIS).

The blue area in Figure 7 presents the movement of the vessel in a northward direction (approaching the rock, colliding with it, and shifting northwards by means of inertia), whereas the red area presents the ship's movement towards south (wind and tide). Figure 6 shows the heeling degrees to port (red) immediately after hitting Le Scolo reef and the heeling evolution (green) when stranding on the sea bed by the Giglio Island coast.



Figure 4. Overview of the navigation route prior to collision with the underwater rock (obtained by simulation)

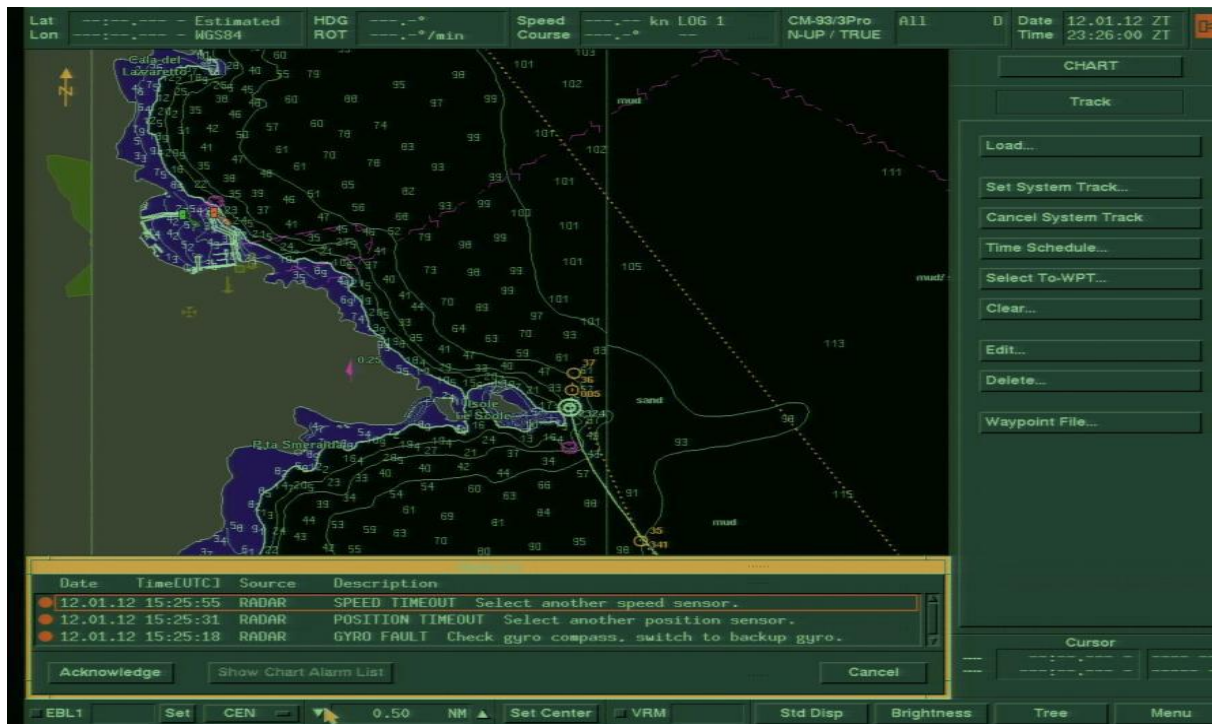


Figure 5. The area of the impact with the rock (obtained by simulation)

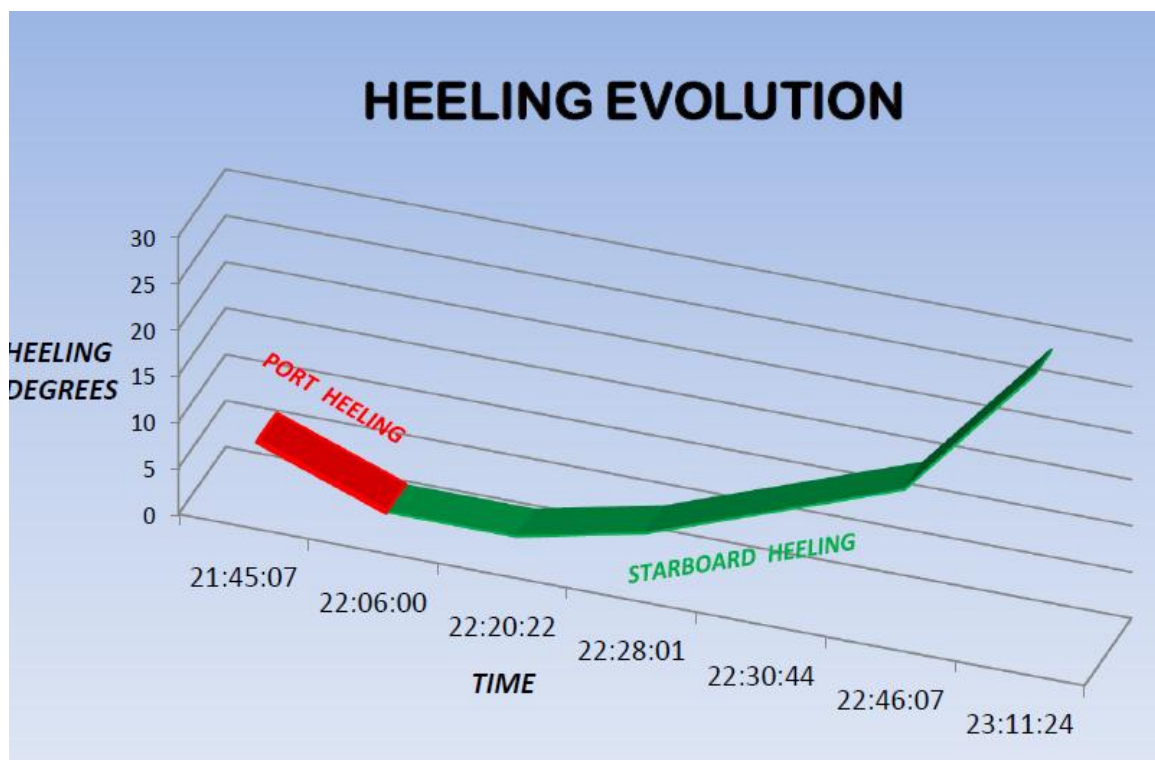


Figure 6. Chronological overview of the ship's heeling at the moment of impact on the Le Scolo rock and after stranding on the sea bed by the Giglio Island coast (obtained by simulation)

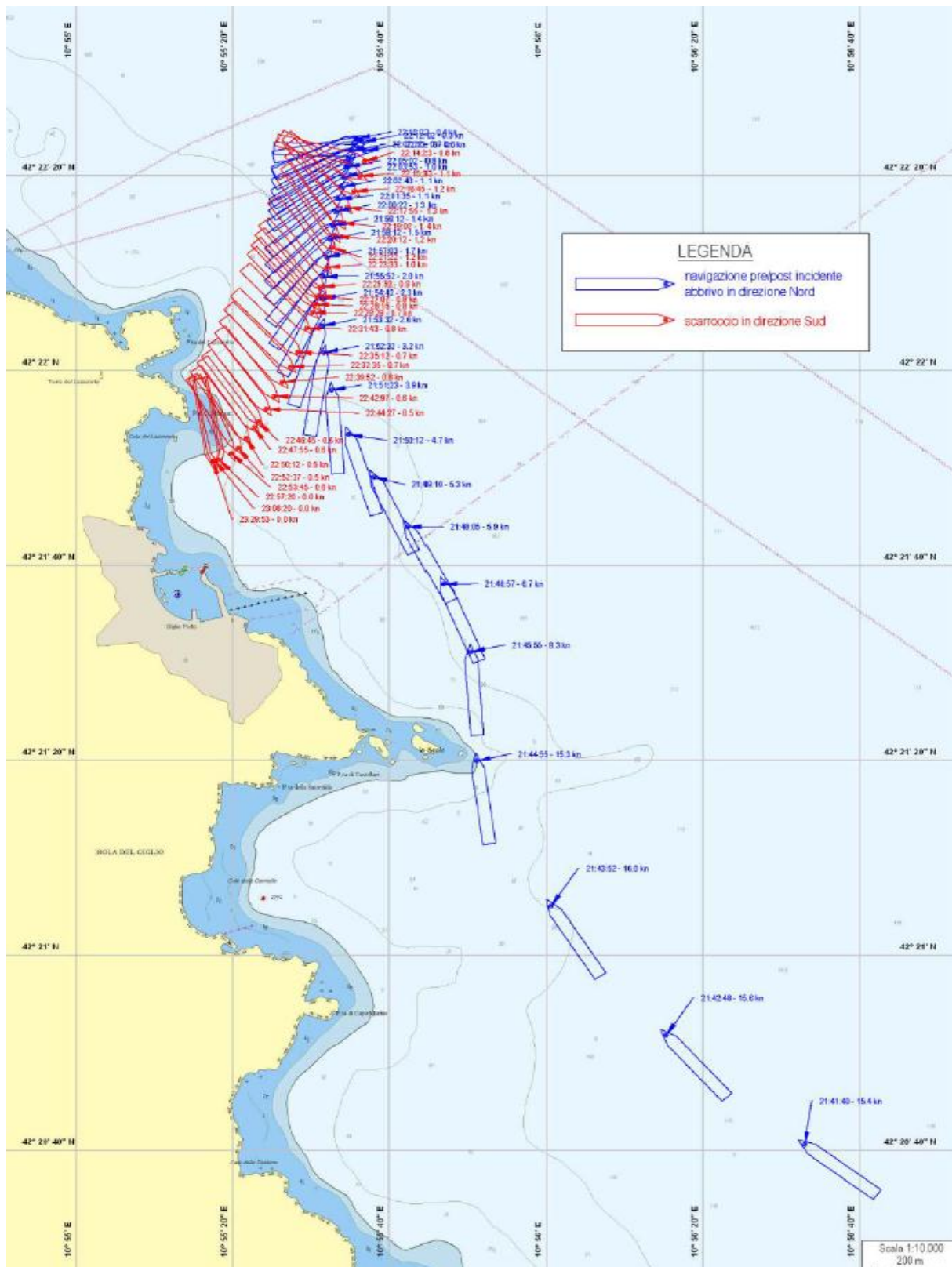


Figure 7. Layout of the area (simulation of the ship's movement prior to collision with the Le Scolo rock, proceeding by inertia, and drifting towards the Giglio Island coast)

4. CONCLUSION

Most of the manufacturers of the navigational equipment onboard large passenger vessels tend to install higher class equipment in order to make higher profit. The International Maritime Organization defines the minimum level of equipment that should be fitted to the vessels over 500 GT (gross tonnage). It is suggested that a tabular list of the required equipment is introduced for the passenger vessels with regard to the level of the navigational risk that arises from the navigation areas they are sailing through. This is not yet a commonly adopted practice onboard passenger vessels.

Taking into consideration the complexity of the technical and technological systems that are used in navigation and manoeuvring, it can be concluded that these systems are still insufficiently automated as the control of the processes of navigation and manoeuvring is still dependent on human factor (pilot, master, duty officer). The above described maritime accident proves that the present level of automation of the equipment onboard new generations of passenger vessels and the insufficient training of pilots and masters have not yet resulted in the increased level of safety of the navigation and manoeuvring of large vessels. This conclusion has been tragically supported by the Costa Concordia case.

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MARKET LIBERALIZATION AND POTENTIAL FOR THE DEVELOPMENT OF INTERMODAL TRANSPORT

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ABSTRACT

Intermodal transport, as one of the most important segments of the economy of a country, becomes more and more interesting for investing by the private sector and the state as well. Port of Bar has been neglected recently and with insufficient investment in its infrastructure and development. Since it is located at the entrance of the Adriatic Sea, Port of Bar has a very favorable position compared to competing ports in the region. An additional problem in its development and exploitation of the full capacity is outdated and underdeveloped connection to highways and rail traffic, which we will particularly pay attention to in the following sections. Also, Port of Bar is not located in any of the trans-European shares, which represents a very interesting case since Montenegro is the only country in the Balkans which is not on the map of Trans-European Networks. For now there are only plans to establish another section of Trans-European Networks, but they are far from turning into reality. But Port of Bar has the potential and ability to change that and be the first and most important link in the inclusion of the above in the race to achieve better results in the transportation of goods and services.

KEYWORDS

Intermodal transport, Trans-European Transport Networks (TEN-T), development

LIBERALIZACIJA TRZISTA POTENCIJALI ZA RAZVOJ INTERMODALNOG TRANSPORTA

APSTRAKT

Intermodalni transport kao jedan od najbitnijih segmenata u ekonomiji neke države, sve više postaje interesantan za ulaganje kako privatnog sektora tako i državnog. Luka Bar je do skoro bila zapostavljena i sa nedovoljno ulaganja u infrastrukturu i njen razvoj. S obzirom na to da se nalazi na samom ulazu u Jadransko more, Luka Bar ima veoma povoljan položaj u odnosu na konkurentne luke u okruženju. Dodatni problem u njenom razvoju i iskorišćavanju punih kapaciteta je zastarela i nedovoljno razvijena povezanost magistralnim putevima i željeznickim saobraćajem o čemu ćemo u narednim poglavljima posebno obratiti pažnju. Takođe, Luka Bar se ne nalazi ni na jednoj Trans-Evropskoj dionici, što predstavlja jedan veoma interesantan slučaj, budući da se Crna Gora kao jedina od zemlja na Balkanu ne nalazi ni na mapi Trans-Evropskih mreža. Za sada postoje samo planovi o uspostavljanju još jedne dionice u Trans-Evropskim transportnim mrežama, a koji je daleko od pretvaranja u realnost. Međutim Luka Bar ima potencijala i mogućnosti da to promijeni i bude prva i najbitnija karika u uključivanju Crne Gore u trku za ostvarivanje boljih rezultata u uslugama i transportu dobara.

KLJUČNE RIJEČI

Intermodalni transport, Trans- Evropske mreže, razvoj

1. INTRODUCTION

Port of Bar is a modern port, which has an international reputation of quality services for transshipment of cargoes, since many countries in the hinterland may be served through it. First of all, it's about Montenegro and Serbia, then Bosnia and Herzegovina, Albania and Hungary, Slovakia, the Czech Republic, as well as Romania, Bulgaria and Croatia. However, most of the traffic is directed to Montenegro and Serbia.

The number of ports in the world is getting smaller and they are usually found in developing countries, especially in Africa. Most public ports are in the process of controlling and ownership transformation towards landlord model. Service ports are mainly used as a transition to the landlord port model in cases where the confidence in the private sector is not fully established, and when you consider that the risks of the investments are major. The landlord model is the most common form of the port organization in Europe (including the whole Mediterranean, the USA, Singapore, etc.). Typical examples of a completely private form of organization are the ports in the UK.

With the growing needs of Port of Bar (which takes place in the traffic of more than 95 percent) to fight for its place in the market, the Government of Montenegro has adopted a Program of restructuring of the port. With the restructuring and privatization program, Port of Bar is envisaged as a port organized precisely on the model of a landlord port.

2. PORT OF BAR POTENTIALS

Trading ports in the economic activities of a country are an extremely important resource that should be the generator of development of the overall economy. It is estimated that one euro, earned in port cargo handling, multiplies as an indirect effect on overall traffic and economic system in 10 to 14 times. Port of Bar is the main commercial port of Montenegro, which is divided by restructuring process into the Port of Bar JSC and a Container Terminal and General Cargo JSC. The overall objective of this program was to get through organizational, management and functional optimization and maximize the overall efficiency of business operations and the competitive position of the port in the transport market, as well as to remove restrictions on private sector participation in the provision of port services and the necessary investment into development projects. So far, the port was not able to catch up with the development trends of Mediterranean ports and to get integrated into a regional logistics network to a significant extent. Compared to its competitors, Port of Bar has a very favorable geographic position at the entrance of the Adriatic Sea. Integrated with the Belgrade-Bar railway and the network of roads, the port is an important link in the intermodal transport chain. Port of Bar is closer to the largest hub ports in the Mediterranean (eg. Gioia Tauro, Malta, Taranto, etc.) than the main competitors in the northern Adriatic Sea. Also, the distance from the entrance of the Mediterranean (Gibraltar and Suez) are 200 to 300 nautical miles shorter, compared with the northern competitors. From the perspective of shippers (assuming that the average speed is 15 knots), docking in Bar instead of Koper or Rijeka means savings in time from 30 to 40 hours. This means that, if, for example, overseas ships operating daily costs 50,000 euros, docking at Port of Bar would save between 60,000 and 80,000 euros per docking.

The favorable position of the port, except in relation to overseas transport, reflects also in the closeness of the market in its hinterland. When comparing the distance by road or rail services from Bar to the markets of Serbia, Kosovo, Hungary, Romania and Bulgaria in relation to Rijeka, Koper or one of the major north European ports (eg. Hamburg, Rotterdam, Bremen Antwerpen), the benefits of Port of Bar can be concluded. Given that Koper and Rijeka are much closer to central Europe (eg. Vienna), it is logical that those ports will focus more on that market in the future. In this way, Port of Bar strengthens its position in the region of the central Balkans.

It is estimated that the size of the regional markets of South-Eastern Europe for the relevant ports is around 50 million tons of cargo annually. One-third of that has Thessaloniki, and it is followed by Koper and Rijeka. The main reasons for the dominant market position of Thessaloniki, Koper and Rijeka are: much greater economic activity, population, purchasing power in the area that immediately gravitates to these ports, significantly improved road and rail infrastructure in the hinterland of the ports connecting them with key industry and consumer centers in region as well as with the main corridors of trans-European transport Network, and moved ahead and completed reform processes which mean the restructuring and privatization of business systems.

However, although the geographical detachment to the main consumption centers in the region is smaller, compared to the competition, the economic distance may be greater. In fact, all the ports in the northern Adriatic Sea, as well as the Thessaloniki port, are with almost the entire length associated with highways, while Bar is connected to the road with two lanes, the width of 7 meters. It is similar to the railway infrastructure. The network consists of three lines: the international railway Bar - Vrbnica, Podgorica - Tuzi and Podgorica - Niksic.

Average speed in line Bar – Vrbnica is about 50 km/h. Permissible axle load of the line is 22.5 t.



Figure 1. Port of Bar

3. REVIEW OF THE RAILWAY INFRASTRUCTURE

As a prerequisite and a consequence of economic development of each country, the infrastructure has a complex content and meaning to the socio-economic structure. It is an essential input to the overall progress of social reproduction - a general input to the "production" of every society.

From the economic aspect, the infrastructure is the circulatory system that serves the economic body, allowing its operation and development.

The role of infrastructure in regional development can be critical, especially in less developed countries. Transportation infrastructure is a prerequisite and a consequence of development. Because of the importance and roles, the infrastructure has been declared as an aim of special public interest.

Although the total length of the railway network in Montenegro is only 250 km, it is an important resource for the economic development of Montenegro. Bar-Vrbnica railroad, recognized as Route 4 in SEETO network, is currently the only railroad that through Belgrade links Montenegro to the European rail network and has a strategic importance for Montenegro, as it connects Port of Bar and Port of Belgrade, which is located at the intersection of major pan-European multimodal corridors: Corridor X and Corridor VII. On the other hand, the railroad Podgorica - Shkoder – Tirana, recognized as Route 2 in SEETO network, is connected to Corridor VIII.

Unfortunately, now only one-seventh of the throughput and transport power line is used, expressed through the volume of passengers and goods.

4. MARKET LIBERALIZATION - LEGAL FRAMEWORK

The legal framework and operational procedures in Port of Bar are set in a way to eliminate business barriers and create the preconditions of a successful business.

The law on ports established the basis for the granting of concessions, whose subject may be the construction, reconstruction, maintenance of the port infrastructure and superstructure under the BOT system, including other forms of this system. Therefore, after the completion of the Restructuring Program of the Port, a foundation to approach finding a strategic partner was created and it will provide increased traffic and suitable structure and investment, both in port equipment, devices, facilities and buildings and in the development projects of construction and improvement of infrastructure and facilities. Reforms mean system optimization through the restructuring process, the application of the model of the landlord and privatization of all operational activities.

In addition, in the new law on railways, in part related to the port railway infrastructure and in order to create favorable conditions and non-discriminatory access to the market, the obligation of making statements about the network was established. Thus, with the production of this document, all interested parties will be able to know the status of the network in a simple way and they will, under the same conditions and at a certain amount, apply for the access to the infrastructure.

Furthermore, in accordance with the Law on Free Zones, the entire port area was declared a free zone, which means that Port of Bar has the rights and obligations of operators of free zones. The total area of the territory in which it is possible to perform operations in the free zone regime is over 130 hectares, with a final commitment to develop and expand the depth of Bar field, in accordance with the requirements of potential users on the one hand and providing formal legal prerequisites (planned purposes, arranging adequate space, obtaining the consent of the customs authorities...) on the other.

When we talk about the background of the port related to railway infrastructure, it is important to say that the railway has never had a better chance in modern history to become a business and has never been as interesting to the private equity as now. The new Railway Act provides an opportunity for stable and long-term investments. Most importantly, the new legislative framework in Montenegro also created the obligations of the infrastructure to transparently and efficiently assign and plan route timetables, which will greatly enable easy access to the infrastructure. On the paper, we have all the conditions for everyone who wants to form a railway company and to carry train traffic – they may do so by completing the security and operational and formal requirements.



Figure 2. Montenegro railway

Montenegro, with the new law, gets the control over the railway market for the first time. Preconditions are more than perfect if we observe the legal regulations and the government body responsible for the railways.

5. THE POSSIBILITY OF ORGANIZING INTERMODAL TRANSPORT

From all the above, and bearing in mind the obligations of Montenegro stemming from the Stabilization and Association Agreement and Protocol IV on land transport, we can conclude that mutually coordinated measures necessary for the development and promotion of rail and combined transport are largely adopted, as a way that will help to ensure the performance of most of the transit traffic through Montenegro under environmentally friendly conditions in the future. However, it is necessary to continue to take the steps necessary to encourage the development of combined transport. The purpose of these measures is reflected in: encouraging senders and users to use combined transport; achieving competitiveness of combined transport to road transport; encouraging the use of combined transport over long distances, particularly the use of interchangeable boxes, containers and transport without an escort; improving the speed and reliability of combined transport, especially to increase the frequency of convoys to the needs of the sender and the user, reducing the waiting time at terminals and increasing their productivity, removal (as appropriate) of all obstacles from the approach routes to improve access to combined transport; harmonization, where it's necessary, of weight, dimensions and technical characteristics of specialized equipment, especially to ensure the necessary compatibility of platforms, as well as taking coordinated action to order and install equipment required for the level of traffic.

Port of Bar, as practically the only commercial port in Montenegro which takes part in about 95% of maritime transport, has the resources and development potential (length of operational quay, depth waters, connection with railroad and a large area for expansion) giving it a major regional importance and the role in the development of the motorways. Also, Port of Bar, as a modern port which has an international reputation of transshipment port for all types of cargo, provides great opportunities for the further development of combined transport and connectivity of the region, because in its hinterland there is the necessary road and rail infrastructure. To such possibilities, it is necessary to construct new terminals and reconstruct the existing terminals for combined transport, as well as the railway stations such as Bar, Podgorica and Bijelo Polje, which will encourage the further development of combined (truck-rail) transport on the most important lines.



Figure 3. Position of Port of Bar in Adriatic Sea

6. CONCLUSION

Forasmuch that combined transport is one of the most modern forms of transport transport units of different dimensions, and that its main advantage the costs by streamlining and flexibility, and the fact that Montenegro is with its position Mediterranean and Balkan country, and that the main transport direction of the country is link between ports on the Adriatic and Balkan interior in the background, it can be concluded that the position of the Port of Bar is more than enough for the development of intermodal transport.

Montenegro still has no legal framework related to organization of the intermodal transport, but the basic laws concerning the liberalization of the market, this state has strong potential to comply with requirements of intermodal transport, which include the formation of a unified transport system of the country, increasing the quality of transport services, minimizing distribution costs, creating conditions for the introduction and application of new technologies, and so on.

Also it should be taken into account that Railway infrastructure of Montenegro JSC (Infrastructure manager) is member of the association Rail Net Europe, within has open One Stop Shop office, which means that each of the 33 members of this association is allowed for quick and easy access to information from the Network Statement, as well as simple to application for path allocation at any One Stop Shop office around the Europe, which significantly facilitates the access network to 230,000 km Rail Net Europe railway lines.

This once again confirms that Montenegro, as an ecological country, must support more effective and economical form of transportation especially sympathetic to environmental protection, if wants to preserve the reputation of wild beauty and at the same time protect the economic interests of maritime and rail market.

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INFLUENCE MOTIVATIONAL FACTORS AND LEARNING STYLES ON EFFICIENCY E-LEARNING

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ABSTRACT

In this study we are primarily engaged in the examination of motivational factors in e-Learning and their impact on learning styles. The aim was to examine whether different learning styles require different forms of motivation. It is well known that there are two basic types of motivation (intrinsic and extrinsic), the study found correlation of each with a different learning style preferred by users Moodle platform, the Faculty of Maritime Studies Kotor.

KEYWORDS

E-Learning, learning styles, intrinsic motivation, extrinsic motivation

UTICAJ MOTIVACIONIH FAKTORA I STILOVA UČENJA NA EFIKASNOST E-LEARNING-A

SAŽETAK

U ovom radu smo se prvenstveno bavili ispitivanjem motivacionih faktora u e-Learning-u i njihovim uticajem na stilove učenja. Cilj je bio ispitati da li različiti stilovi učenja zahtijevaju različite oblike motivacije. Kako je poznato da postoje dvije osnovne vrste motivacije (intrinzična i ekstrinzična), u istraživanju je pronađena povezanost svake od njih sa različitim stilom učenja koji preferiraju korisnici Moodle platforme, na Fakultetu na pomorstvo Kotor.

KLJUČNE RIJEČI

Elektronsko učenje, stilovi učenja, unutrašnja motivacija, spoljašnja motivacija

1. INTRODUCTION

E-Learning is one of the most popular tools for the development of human resources in institutions.

Such solutions are increasingly being used in businesses, non-governmental organizations, public authorities and institutions of pedagogical activities (school and college). These types of platforms have a number of advantages that affect the presentation of information, adoption information and user connectivity. Although there are a number of benefits that are more than in the beginning used these platforms, perceived, there are limitations that are evident. One of the chief drawbacks is the motivation of e-Learning system. Although the identified shortcomings, they often continue to exist thereafter, suggesting removable hard vulnerabilities.

2. MOTIVATION

Motivation can be defined as the totality of the processes that drive and maintain certain activities and behaviors towards achieving the set goals. Motives are some internal factors that drive and direct the activities, determine their content, duration and strength. In the process of motivation are relevant three elements:

- *motive* - such personality dispositions,
- *activity* - which runs and maintains the motive and

- *goal* - which the activity is directed.

There are two types of motivation: intrinsic and extrinsic. Intrinsic motivation starts from within a person. This is the motivation that is intrinsic value character of a person. These are activities that meet the psychological needs of the individual, a healthy ambition to have any kind of external reward. An example of intrinsic motivation is a hobby activity, which often brings no financial benefit, a person often aspires to perform the same. This is called Chiksentmihaly Flow-experience. In particular, mental and physical condition of the person, a kind of ecstasy, and some kind of creative inspiration. The second type of motivation is extrinsic. That kind always has an external triggers, in the form of prizes. This type of motivation involves goals, values and interests of others and not ourselves. Example extrinsic motivated student is a student who learns a subject so to get a good grade, to avoid punishment or receive a reward.

In a study 2010th years (Mykowska, A., Wolski, K) were examined factors that influence intrinsic motivation. The results indicate that this is one of the most important factors that influence the willingness to use e-Learning.

Research has shown that promoting the student's intrinsic motivation, communication is very important in the classroom or in the hall and the way in which daily produce and present information. What is the focus of these results is that the "dry facts" eventually become monotonous and that it would be important that any information presented through a practical example. It runs beside the motivation and creativity and abstract thinking. Thus forming their individual way of assimilating information. In addition, autonomy is one of the most important factors for the development of intrinsic motivation.

2.1. Theories and models of motivation

2.1.1. Maslow's theory

According to Maslow's theory of motivation it means result of the hierarchy of needs:

- The need of self-actualization;
- The need for respect;
- Social needs (sense of belonging, love ...)
- The need for security and survival, self-protection;
- Physiological needs (hunger, thirst, sleep...).

2.1.2. Social-cognitive model of learning

Social-cognitive model of learning emphasizes the importance of self-efficacy and self-regulation in e-Learning. Self-efficacy is primarily related to an individual's belief about his ability to perform a certain task at a certain level, while self-regulation refers to the control of the learning activities. Based on this we can conclude that social-cognitive model to connect the cognitive and affective processes.

2.1.3. Keller's ARCS model

The model is named as an acronym for the four basic factors: Attention, Relevance Confidence and Satisfaction.

2.1.4. Moshinski model

There are two types of students: those with an active attitude towards life or those with intrinsic motivation, which takes very little extrinsic motivation and those with a passive attitude towards life, they need a extrinsic.

3. LEARNING STYLES

Teachers were not often aware of the importance of equality and respect for the student-teacher relationship. Did not work students to actively listen and make notes in class. Its role is far more complex. It is clear that in the learning process are activities that are presented in different ways. Every of these methods won't be appropriate for each student. It is necessary to distinguish between the students, not just their ability and motivation for learning, but also for the individual styles of learning.

VAK model: Visual learning style,
Auditory learning style and
Kinesthetic (physical) learning style.

VISUAL learning style

- it is necessary to "see" the information
- prefer illustrations, read written, excellent in written recording of lectures
- most material explained: "It looks good ..." "Let me see ..." "I have a complete picture ..."
- "see" words
- meticulous they are good organizers
- fast talking
- plan in the long run
- observed details
- acquire material with visual associations, remember physiognomy
- oblivious jokes
- have a good sense of color, can engage in various arts (painting)
- noise it does not interfere with the perception of information
- forget verbal instructions
- good readers and love reading more than they read
- during tel. talks, lectures like to draw
- easier to conceive an idea than it is a description
- withdrawn nature

AUDITIVE learning style

- information is necessary to hear in order to remember
- prefer listening
- generally understood as explaining: "I hear what you're saying ..." "I'm listening ..." "That sounds good ..."
- learn listening material
- mainly "talking" to themselves during the execution of activities
- during the interview noise can often be disturbing factor for them
- when they read most often to make the voice or moving a little lip
- like to read aloud
- prefer listening and prefer lectures about what they know
- can't imitate other people
- do not pay attention to the manuscript
- like to frequent the details when describing something
- they have problems with activities that include visualization
- prefer music instead of art

KINESTHETIC (physical) learning style:

- adoption of information commonly used by manipulating objects
- used to describe as: "I'm not following you ...", "Return-I got lost ..."

- used verbs in conversation
- in conversation with others often poke to explain something
- communication is usually closer to the person they speak
- prefer physical activity
- like dancing
- tend to dress casually and sports
- like to create things and try new activities
- remember best performing certain movement
- not enjoy reading, and often text accompanying finger
- respond well to physical rewards
- used gestures and facial expressions
- often have good results in sports
- prefer to learn using computers to make learning This stimulated by touching the keyboard
- they are extroverted person

In the end it can be concluded that cognitive learning styles in a large measure of influence on the design and effectiveness of e-Learning. It is important to recognize that cognitive style suits the student and adjust to e-materials. As it is very difficult and requires a lot of time e-corrected material every time you start a course, it is best to e-materials to make a variety so that it contains all the components that require cognitive learning styles. With ever-advancing technology, e-teacher should not be a problem to create such diverse e-materials.

Quality e-Learning is the ability to get students alike devote every cognitive learning style. This means that in the process of e-Learning by applying the method of learning that suit every learning style. Collaborative and cooperative e-Learning is enabled by grouping students into groups to facilitate electronic communication and collaboration, but should take into account that groups are composed of students who have similar learning styles, expectations, knowledge.

4. SCOPE AND PURPOSE

The main subject of this empirical research is an overview of nature (direction and intensity) correlation of motivation and learning styles to the VAK model. More specifically, the relationship was perceived intrinsic and extrinsic motivation with all three learning styles.

Research goals:

- *The scientific goal* is significant in the sense that it examines the nature of the relationship, which in psychological and statistical terms is relevant to science in general and for further research related topics.
- *The practical goal* is to obtain data to contribute to more efficient solving practical problems of e-Learning in institutions of different character. It is necessary to present the data obtained, so that teachers have a clearer picture of the factors that significantly affect the motivation of students.

Research variables:

- *Dependent:* intrinsic and extrinsic motivation
- *Independent:* three styles of VAK learning

5. RESEARCH METHODOLOGY

5.1. The sample of respondents

The sample consists of 100 students from the Faculty of Maritime Studies in Kotor. The sample is of medium size. It is a deliberate and random basis. Intentional, because we are

solely focused on students FZP Kotor, as users Moodle platform, and random, because the randomly selected 100 students.

5.2. Research methods and instrument

This was systematic non-experimental research.. The study used measurement instruments:

- Scale intrinsic motivation, constructed by the authors. The scale of Likert-type and contains 8 items. Chrombah alpha coefficient was $r = 0.623$
- Scale-extrinsic motivation, constructed by the authors. The scale of Likert-type and contains 8 items. Chrombah alpha coefficient was $r = 0.687$
- VAK questionnaire to assess learning styles, taken from: http://www.asoo.hr/userdocsimages/andragoski_modeli_poucavanja.pdf

6. REVIEW AND ANALYSIS OF RESEARCH

All those involved in teaching using all three channels to receive information from the outside world. Thus was created the VAK model of learning. Figure 1 shows the statistics data VAK model obtained on a sample of students from the Faculty of Maritime Studies Kotor.

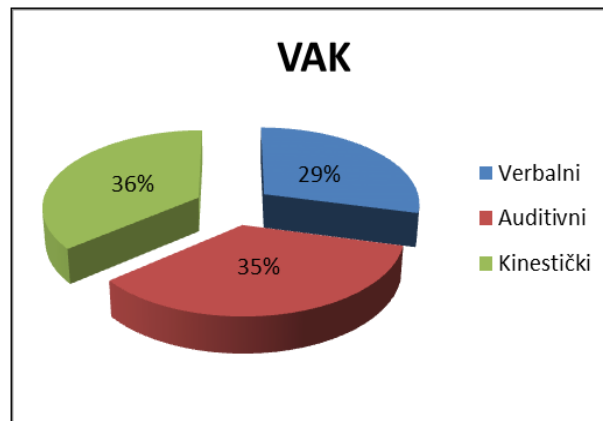


Figure 1. Statistics VAK model of learning

Table 1. Intrinsic motivation and VAK model

Intrinsic motivation and visual type VAK model $\chi^2=2,547$ $df=2$ $C=.256$ $p=.233$
Intrinsic motivation and auditory type VAK model $\chi^2=10,007$ $df=2$ $C=.392$ $p=.009$
Intrinsic motivation and kinesthetic type VAK model $\chi^2=1,998$ $df=4$ $C=.182$ $p=.619$

Table 1 can be examined to see the connection between intrinsic motivation and 3 types of VAK model. The results imply that no statistical significance at the 0.01 level between intrinsic motivation and type of auditory VAK model. This means that with 99% probability can be argued that these two variables are correlated. This could be attributed to auditory learning style to the personality that have intrinsic motivation for adoption information. They have a good motive to be learned. Without the additional motivators they just enough theory to assimilate information and process them in a cognitive system in its conception. In the other two types of no relationship between the dependent variable in the study, motivation.

Table 2. Extrinsic motivation and VAK model

Extrinsic motivation and visual type VAK model $\chi^2=8,771$ df=2 C=.257 p=.060
Extrinsic motivation and auditory type VAK model $\chi^2=3,22$ df=2 C=.120 p=.721
Extrinsic motivation and kinesthetic type VAK model $\chi^2=4,008$ df=2 C=.11 p=.199

Table 2 shows that between extrinsic motivation and three VAC model is no statistical significance on any level. However, in the visual type VAK model p value is .060 and the chi-square value is 8.771, which leads to the tendency of the larger sample was probably obtained statistical significance at the 0.05 level. This means that with 95% probability can be argued that students who belong to the type of visual learning have more extrinsic motivation. This is simply explained by the fact that such a learning style to the personality that require external stimuli as a motivator. Their imagination and creativity excites the visual material, with charts, tables, colorful content.

7. CONCLUSION

From the results it can be seen that motivation is one of the most important factors that influence the acquisition of knowledge. As its divided into internal and external, each of which is associated with some of the learning styles. It is important to have access to that are closely related to intrinsic motivation and auditory type VAK model and extrinsic motivation and visual type VAK model. It is relevant to conclude that these are all indicators that contribute to successful teaching and improved student achievement.

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DEVELOPMENT OF THE INTERNATIONAL STANDARDS FOR HYDROGRAPHIC SURVEYS

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ABSTRACT

This article presents the standards for hydrographic survey developed by the International Hydrographic Organization. Hydrographic activity has a distinct international character because the products of hydrographic organizations are designed to use in international maritime transport. For this reason, any information on nautical charts and publications must have the required level of accuracy and reliability. Therefore, it was necessary at the global level to develop appropriate regulations and standards which will regulate the international hydrographic activity in the field of hydrographic survey.

KEYWORDS

International Hydrographic Organization, Hydrographic survey standards

RAZVOJ MEĐUNARODNIH STANDARDA HIDROGRAFSKOG PREMJERA

SAŽETAK

Članak prikazuje standarde hidrografskog premjera koje je razvila Međunarodna hidrografska organizacija. Hidrografska djelatnost ima izrazit međunarodni karakter jer su proizvodi hidrografskih organizacija namijenjeni za uporabu u međunarodnom pomorskom prometu. Iz tog razloga svaki podatak na pomorskim kartama i navigacijskim publikacijama treba imati zahtijevanu razinu točnosti i pouzdanosti. Zato je na globalnoj razini bilo potrebno razviti odgovarajuće propise i standarde koji će regulirati međunarodnu hidrografsku djelatnost u području hidrografskog premjera.

KLJUČNE RIJEČI

Međunarodna hidrografska organizacija, Standardi hidrografskog premjera

1. INTRODUCTION

International hydrographic activity plays an extremely important role in maritime activities. It covers a whole range of activities from standardization, production of charts and publications to training. Although there is no single international standard today, it can be said that there has been a high degree of standardization in the field of hydrography, especially in the field of hydrographic survey.

Regulations and standards that govern this activity are contained in the provisions of the UN Convention on the Law of the Sea 1982 (UNCLOS), agreements and recommendations of the International Maritime Organization (IMO), standards of the International Hydrographic Organization (IHO) and national regulations.

Hydrographic activity today is a part of overall maritime policy of countries that have access to the sea. Because of its specificity and expressed international character only authorized Hydrographic Organization can perform this activity on behalf of the government.¹

The most important activity of national hydrographic organization is the hydrographic survey. It is done in accordance with the IHO standards. IHO has been developed so far five editions of standards for hydrographic survey. Their development depended on the development and improvement of means for hydrographic survey and positioning.

¹ The analysis of the data from the IHO Yearbook (2010) showing that the national hydrographic organizations are owned by the states and they perform all tasks related to the hydrographic activity on behalf of their states. IHO: *IHO Yearbook 2010*, International Hydrographic Bureau, Monaco, 2010.

This paper analyzes the international regulations on hydrographic activities and role of the IHO in the development of standards of hydrographic survey. In this paper particular analysis has been given of the fourth and fifth edition of these Standards. Their basic determinants have been given in order to increase the accuracy and reliability of nautical charts and publications.

2. LEGAL BASIS FOR PRODUCTION OF NAUTICAL CHARTS AND PUBLICATIONS

In accordance with the amendments to the International Convention for the Safety of Life at Sea (SOLAS 2002), which came into force in 2004, Contracting States have a legal obligation to conduct hydrographic research, produce and maintain up to date charts and navigational publications²

Nautical chart is a specially designed map aimed to meet the requirements for maritime navigation.³ It has shown (among other things) the depth, bottom type, terrain elevation and different structures such as lighthouses or towers, the configuration and characteristics of the coastline and navigational hazards.⁴

A content of nautical chart depends on its purpose and scale. One symbol on the chart may appear more than once, because of it the total number of displayed symbols ranges from dozens to about 50.000.⁵ Reliability of nautical charts directly affects the safety of navigation, therefore IMO and IHO regulations require that nautical charts being regularly maintained and refreshed. Hydrographic offices are responsible for the collection and dissemination of information relevant to the maintenance of the charts.

Hydrographic activity has particularly international character and therefore international regulations and standards are its backbone. The paper analyzes the provisions of UNCLOS and SOLAS Convention relating to international hydrographic activity.

2.1. The United Nations Convention on the Law of the Sea

The UNCLOS is the basic legal document related to the delineation between coastal States in marine areas and in safety of navigation. The Convention encourages the development of international and national hydrographic activities. In this regard, the nautical chart is a very important element of many technical and legal issues contained in UNCLOS. It can also be said that the interpretation and understanding of the UNCLOS is almost impossible without adequate nautical charts.

UNCLOS refereed in nautical charts on the matters of sea belts, baselines, internal waters, estuaries, bays, harbours, anchorages, sea level, sea routes, separation schemes, closed and semi-closed sea, etc.⁶ Sea borders are determined from the baselines indicated on nautical charts, which is officially recognized by the coastal State.⁷

² Maratos, A., Weintrit, A.: *The IHO Supporting Maritime Demands. Report on the Occasion of Celebrating the World Hydrography Day with theme for this year: "Electronic Navigational Charts (ENCs): an Essential Element of Safety at Sea and Efficient Maritime Operations"*, TransNav'2007 - The 7th International Symposium on Navigation, Proceedings, p. 733, available at http://transnav.am.gdynia.pl/proceedings/pdfs/Art-XX-Maratos_Weintrit.pdf, retrieved 04 Sep 2009., Bermejo, F.: *National Maritime Policies and Hydrographic Services*, *The Hydrographic Journal*, Issue 98, 2000., available at <http://www.hydrographicsociety.org/Articles/journal/2000/98-3.htm>, retrieved 04 Sep 2009.

³ IHO: *Hydrographic Dictionary*, Special Publication No. 32, Part 1, Vol. 1, 5th Edition, International Hydrographic Bureau, Monaco, 1994., p. 37.

⁴ Forbes, V.: *ECDIS and Potential Legal implications: Proceeding with Caution*, *The Hydrographic Journal*, No. 111, January 2004., The Hydrographic Society, University of East London, p. 4.

⁵ Kasum, J.: *Doprinos optimizaciji reambulacije primjenom elektroničkih i informatičkih tehnologija*, PhD Thesis, unpublished, Pomorski fakultet u Rijeci, 2002., p. 14.

⁶ Maratos, A.: *Nautical Charts and UNCLOS*, *Hydro International*, Volume 12, Number 3, April 2008, available at http://www.hydro-international.com/issues/articles/id909Nautical_Charts_and_UNCLOS.html, retrieved 11 Sep 2009.

⁷ The coastal State may issue its own nautical charts or a charts issued in another country. Rudolf, D.: *Međunarodno pravo mora*, JAZU, Zagreb, 1985., p. 61.

The basis for determination of these boundaries are the baseline, as an starting line to determine the outer limit of the territorial sea,⁸ continental shelf⁹ and exclusive economic zone.¹⁰

The Convention in its provisions requires from coastal states that a copy of each such chart (or a list of coordinates) have to be deposited with the UN Secretary General.¹¹

In terms of safety of navigation the Convention explicitly requires from coastal states that have to publish in an appropriate manner any known hazard to navigation.¹² Also, the provisions of UNCLOS are required that maritime routes and separation schemes being indicated on nautical charts.¹³

It follows that the hydrographic activity is extremely important, and its core product – nautical chart – is much more than simple aid to navigation.

2.2. The International Convention for the Safety of Life at Sea

Provisions relating to the hydrographic activity have been developed under the auspices of the IMO. These provisions are contained in Chapter V of the SOLAS Convention. Chapter V, called The safety of navigation, in Rule 2, Section 2, adopts the definition of nautical charts and nautical publications. "Nautical chart or nautical publication is a chart or publication of a special purpose, or specially compiled database from which the chart or publications derived, which was officially released on or under the authority of government authorized Hydrographic Office or the relevant government institutions and that is designed to meet requirements of maritime navigation."¹⁴ This definition is related to the paper and electronic charts. Explanation of the aforementioned rule explicitly referred that in their preparation authorized Hydrographic Office should follow the appropriate resolutions and recommendations of the IHO.

Rule 9 (Hydrographic Services) in its four paragraphs regulates hydrographic activity of the Member States. In accordance with the Rule, Member States have a legal obligation to the collection, compilation, processing, exchange and refresh all nautical information necessary for safe navigation.¹⁵ Member states are required to ensure the implementation of hydrographic survey, released charts and publications, and distributes notices to mariners.¹⁶

It is also required the greatest possible uniformity in the preparation of charts and publications, as well as coordination of activities at the highest possible level to ensure timely, reliable and unquestionable availability of hydrographic and nautical information on the global level.¹⁷

The most important innovation of Rule 9 was the introduction of obligations to member states to issue nautical charts and publications.¹⁸ It was not prescribed prior 2002.

Rule 19 (Requirements for marine navigational systems and equipment) required of all ships, regardless of size, having a navigational charts and publications. It is considered that

⁸ The baselines for measuring the width of the territorial sea, as determined in accordance with Articles 7, 9 and 10, or the limits that are resulting therefore, and the demarcation line, drawn in accordance with Articles 12 and 15 shall be shown on charts of a scale or scales adequate for ascertaining their position. Instead, it is allowed to create a list of geographical coordinates or points specifying the geodetic data. *Konvencija UN-a o pravu mora*, Art. 16 Para 1, Narodne novine, Međunarodni ugovori, br. 9/2000.

⁹ UNCLOS, Art 7. Para 9 and Art. 84 Para 1.

¹⁰ UNCLOS, Art. 75 Para 1.

¹¹ UNCLOS, Art. 16 Para 2, Art. 75 Para 2 and Art. 84 Para 2.

¹² UNCLOS, Art. 24 Para 2.

¹³ UNCLOS, Art. 22 Para 4, Art. 41 Para 6 and Art 53 Para 10.

¹⁴ SOLAS 2002, Chapter V, Regulation 2, Para 2., IMO, London, 2002.

¹⁵ *ibidem*, Regulation 9 Para 1.

¹⁶ *ibidem*, Para 2.

¹⁷ *ibidem*, Para 3 and 4.

¹⁸ Before the entry into force of the revised provisions of the SOLAS the states has been only required to conduct hydrographic research and collaborate with other governments (in matters of safety of navigation) where this is necessary, but not the obligation to produce nautical charts. *IMO and the Safety of Navigation*, 1998, p. 14, available at <http://www.imo.org>, retrieved 17 Jul 2009.

vessel meets the requirements of this Rule in case of possessing of Electronic Chart Display and Information System (ECDIS).¹⁹

Rule 27 (Nautical charts and publications) stipulates that nautical charts and publications should be suitable and up to date.²⁰ IMO introduced the obligation to use updated nautical charts since 1980.²¹

3. ACTIVITIES OF THE INTERNATIONAL HYDROGRAPHIC ORGANIZATION

IHO is an intergovernmental consultative²² and technical organization.²³ IHO has emerged from the International Hydrographic Bureau (IHB), which was established on 21st of June 1921, headquartered in Monaco.²⁴

IHB was established as a permanent body to coordinate the work of hydrographic offices and the goal was "to make navigation around the world easier and safer by improving navigational charts and documents".²⁵ Over the time the role of IHB has gradually expanded. Thus the Convention on the IHO, which entered into force on 22nd of September 1970, renamed the Organization from IHB²⁶ in IHO. Today IHO has 78 member states, while 10 states are in the process of accession to the Organization.²⁷

The objectives of IHO are:

1. harmonization of activities of national hydrographic organizations,
2. achievement of the greatest possible uniformity of nautical charts and documents,
3. the adoption of reliable and efficient methods of implementation and exploiting hydrographic surveys and
4. the development of science in the field of hydrography and the techniques employed in descriptive oceanography.²⁸

A numerous activities of the IHO can be derived from these goals. The most important activities are standardization, production of the International Charts according to IHO recommendations, issuing of radionavigation warnings, organization and management of digital databases and their presentation, training, technical assistance, deposit and sharing of charts and nautical publications, management of digital tides databank, the establishment of regional hydrographic commissions, cooperation with a number of international bodies and publishing of periodical publications.²⁹

Certainly the most important place of the many activities of the IHO belongs to standardization in the field nautical charts and publications. The IHO, working for many years, has developed the International hydrographic standards, which are now widely accepted all over the world.

¹⁹ SOLAS 2002, Chapter V, Regulation 19 Para 2. Subpara 1.4.

²⁰ *ibidem*, Regulation 27.

²¹ IMO Safety of Navigation Circular Letter No. 99 (IMO SN/Circ.99), *Carriage of up-to-date charts*, 12. Jun 1980.

²² The Organization is a consultative agency that has no authority over the hydrographic offices of the Member States of the Convention on the IHO. IHO: *M-1, Basic Documents of the International Hydrographic Organization (IHO)*, Revised version 2007, International Hydrographic Bureau, Monaco, 2007., General Regulations of the IHO, Article 1, p. 17.

²³ Pribičević, B.: *Pomorska geodezija*, Geodetski fakultet Sveučilišta u Zagrebu, Zagreb, 2005., p. 201.

²⁴ Maratos, Weintrit: *op. cit.*, p. 734.

²⁵ *ibidem*.

²⁶ The IHB exists today. Its role has been regulated by Articles VIII and IX of the Convention on the IHO and refers to a wide range of activities from the harmonization of cooperation among national hydrographic offices through technical and administrative issues to cooperation with international organizations and related research institutions. It is also the name of the headquarters of the Organization. *IHO M-1*, p. 8. i 9.

²⁷ Maratos, Weintrit: *op. cit.*, p. 734.

²⁸ *IHO M-1*, Convention on the IHO, Article 2., p. 7.

²⁹ Pribičević: *op. cit.*, p. 202. and 204.

4. THE INTERNATIONAL HYDROGRAPHIC STANDARDS

International Hydrographic Standards represent a framework for conducting hydrographic survey. Hydrographic survey in the strict sense means a survey of water areas.³⁰ In a modern conditions hydrographic survey is carried out with the aim of collecting data such as depth of water, configuration and natural characteristics of the bottom, the direction and speed of ocean currents, time and height of tides and the position of solid objects important for navigation and survey.³¹ The primary purpose of the hydrographic survey is to collect data for creation of nautical charts.³²

Hydrographic survey includes collection, processing and display the data. The final products of hydrographic survey are nautical charts, bathymetric maps and navigational publications, whose accuracy and reliability directly depend on the accuracy of the data collected.

IHO prescribes minimum standards of accuracy for hydrographic survey. These standards are contained in the publication "IHO Standards for Hydrographic survey - S-44".³³

The development of these standards has been highly dependent on the possibilities and limitations of the equipment for depth measurement and positioning systems. The first edition of these standards was published in 1968 with subsequent editions in 1982 and 1987. It should be noted that the IHO Standards are voluntary and are provided as guidance to Member States and others in their conduct of hydrographic surveys. Previous editions of S-44 concentrated primarily on classifying accuracies for hydrographic surveys for the compilation of nautical charts. It has now been recognized that users of hydrographic data make up a much more diverse group than previously recognized. Hydrographic data is also important for coastal zone management, environment monitoring, resource development (hydrocarbon and mineral exploitation), legal and jurisdictional issues, ocean and meteorological modelling, engineering and construction planning and many other uses. To increase its usefulness, users require data that is more up to date, detailed, reliable and in digital form. Even if the standard does not always specifically address these additional users' needs, it is felt that the standard provides them with a basis to assess the quality of hydrographic data.³⁴

A Working Group, comprised of experts from 13 Member States, was established in 1993 to review the existing Standards and develop recommendations for changes to S-44 that were relevant to newly developing technology in satellite positioning, wide swath sonar and increased shipboard computer capability. The resulting proposal for the Fourth Edition of the Standards was approved in January 1998 by the IHO Member States and published in April 1998.³⁵

As a result of advances in precise positioning from satellite systems (GPS – Global Positioning System and GLONASS) and the ability to accurately plot digital spatial data, S-44 has been modified to utilize real-world metric positioning accuracy standards. Shallow water multibeam echo sounder systems and side scan sonars with dramatically increased data density have resulted in changes to the Standards to describe adequate bottom coverage in lieu of specified line spacing based on scale. With the development of Geographic Information Systems (GIS), hydrographic survey data is being used by a much more diverse group than previously. This not only increases the demand for data in digital form but also for metadata about the quality of the data and the methods and procedures used for acquisition

³⁰ IHO: *M-13, Manual on Hydrography, 1st edition*, International Hydrographic Bureau, Monaco, 2005, p. 7.

³¹ IHO: *Hydrographic Dictionary*, Special Publication No. 32, Part 1, Vol. 1, 5th Edition, International Hydrographic Bureau, Monaco, 1994., p. 237.

³² IHO: *M-13, Manual on Hydrography*, p. 7.

³³ The 5th edition of standards is currently in force.

³⁴ IHO: *S-44, IHO Standards for Hydrographic Surveys 4th Edition*, April 1998, International Hydrographic Bureau, Monaco, 1998, p. 1.

³⁵ Pribičević: *op. cit.*, p. 204.

and processing.³⁶ These were the reasons that led to the drafting of a new edition of the IHO standards.

According to the 5th Edition of the Standards the Hydrographic Survey is classified in the following orders:

- Special order,
- 1a order,
- 1b order and
- 2 order.³⁷

The Special order is the most rigorous of the orders and its use is intended only for those areas where under-keel clearance is critical. Because under-keel clearance is critical a full sea floor search³⁸ is required and the size of the features³⁹ to be detected by this search is deliberately kept small. Since under-keel clearance is critical it is considered unlikely that Special Order surveys will be conducted in waters deeper than 40 meters. Examples of areas that may warrant Special Order surveys are: berthing areas, harbours and critical areas of shipping channels.

Order 1a is intended for those areas where the sea is sufficiently shallow to allow natural or man-made features on the seabed to be a concern to the type of surface shipping expected to transit the area but where the under-keel clearance is less critical than for Special Order above. Because man-made or natural features may exist that are of concern to surface shipping, a full sea floor search is required and however the size of the feature to be detected is larger than for Special Order. Under-keel clearance becomes less critical as depth increases so the size of the feature to be detected by the full sea floor search is increased in areas where the water depth is greater than 40 meters. Order 1a surveys may be limited to water shallower than 100 meters.

Order 1b is intended for areas shallower than 100 meters where a general depiction of the seabed is considered adequate for the type of surface shipping expected to transit the area. A full sea floor search is not required which means some features may be missed although the maximum permissible line spacing will limit the size of the features that are likely to remain undetected. This order of survey is only recommended where under-keel clearance is not considered to be an issue. An example would be an area where the seabed characteristics are such that the likelihood of there being a man-made or natural feature on the sea floor that will endanger the type of surface vessel expected to navigate the area is low.

Order 2 is the least stringent order and is intended for those areas where the depth of water is such that a general depiction of the seabed is considered adequate. A full sea floor search is not required. It is recommended that Order 2 surveys are limited to areas deeper than 100 meters as once the water depth exceeds 100 meters the existence of man-made or natural features that are large enough to impact on surface navigation and yet still remain undetected by an Order 2 survey is considered to be unlikely.⁴⁰

The principal changes made from the 4th Edition are:

- The division of Order 1 into 1a where a full sea floor search is required and 1b where it is not required.
- The removal of Order 3 as it was considered that there was no longer a need to differentiate this from Order 2.

³⁶ Mills, G., B.: *International Hydrographic Survey Standards*, NOAA, Office of Coast Survey, Hydrographic Surveys Division, Silver Spring, Maryland, USA, p. 1.

³⁷ IHO: *S-44, IHO Standards for Hydrographic Surveys 5th Edition*, February 2008, International Hydrographic Bureau, Monaco, 2008., p. 5 i 6.

³⁸ A systematic method of exploring the sea floor undertaken to detect most of the *features*. The method utilizing adequate detection systems, procedures and trained personnel. In practice, it is impossible to achieve 100% ensonification / 100% bathymetric coverage (the use of such terms should be discouraged). *ibidem*, p. 4.

³⁹ Feature in the context of this standard means any object, whether manmade or not, projecting above the sea floor, which may be a danger for surface navigation. *ibidem*, p. 17.

⁴⁰ *ibidem*, p. 5 and 6.

- The replacement, in most cases, of the words “accuracy” and “error” by “uncertainty”. Errors exist and are the differences between the measured value and the true value. Since the true value is never known it follows that the error itself cannot be known. Uncertainty is a statistical assessment of the likely magnitude of this error.⁴¹

It should be noted that the issue of this new edition to the standard does not invalidate surveys, or the charts and nautical publications based on them, conducted in accordance with previous editions, but rather sets the standards for future data collection to better respond to user needs.

Neither these standards nor the previous editions has not adopted the provisions of the frequency of hydrographic survey. It should also be noted that where the sea floor is dynamic (e.g. sand waves), surveys conducted to any of the Orders in these Standards will quickly become outdated. Such areas need to be resurveyed at regular intervals to ensure that the survey data remains valid. The intervals between these resurveys, which will depend on the local conditions, should be determined by national authorities.⁴² Table 1 show Minimum Standards for all Hydrographic Surveys categories.

Table 1. Minimum Standards for Hydrographic Surveys

Order	Special	1a	1b	2
Description of areas	Areas where under-keel clearance is critical	Areas shallower than 100 metres where under-keel clearance is less critical but features of concern to surface shipping may exist.	Areas shallower than 100 metres where under-keel clearance is not considered to be an issue for the type of surface shipping expected to transit the area.	Areas generally deeper than 100 metres where a general description of the sea floor is considered adequate.
Maximum allowable Total Horizontal Uncertainty (95% Confidence level)	2 m	5 m + 5% of depth	5 m + 5% of depth	20 m + 10% of depth
Maximum allowable Total Vertical Uncertainty (95% Confidence level) (1)	a=0,25 m b=0,0075	a=0,5 m b=0,013	a=0,5 m b=0,013	a=1,0 m b=0.023
Full sea floor search (2)	Required	Required	Not required	Not Required
Feature detection (3)	Cubic features > 1m	Cubic features > 2 m, in depths up to 40 m; 10% of depth beyond 40 m	Not applicable	Not applicable
Recommended maximum Line Spacing (4)	Not defined as full sea floor search is required	Not defined as full sea floor search is required	3 x average depth or 25 m, whichever is greater For bathymetric lidar a spot spacing of 5 x 5 m	4 x average depth
Positioning of fixed aids to navigation and topography significant to navigation. (95% Confidence level) (5)	2 m	2 m	2 m	5 m

⁴¹ *ibidem*, p. 1.

⁴² *ibidem*, p. 4.

Positioning of the Coastline and topography less significant to navigation (95% Confidence level) (5)	10 m	20 m	20 m	20 m
Mean position of floating aids to navigation (95% Confidence level) (5)	10 m	10 m	10 m	20 m

Source: IHO S-44, IHO Standards for Hydrographic Surveys 5th Edition.

- (1) The Maximum allowable "Total Vertical Uncertainty"⁴³ (at the 95% confidence level) have to be introduced into the following formula:

$$\pm \sqrt{a^2 + (b \times d)^2} \quad (1)$$

Where:

- a represents that portion of the uncertainty that does not vary with depth
- b is a coefficient which represents that portion of the uncertainty that varies with depth
- d is the depth
- b x d represents that portion of the uncertainty that varies with depth

- (2) For safety of navigation purposes, the use of an accurately specified mechanical sweep to guarantee a minimum safe clearance depth throughout an area may be considered sufficient for Special Order and Order 1a surveys.
- (3) A cubic feature means a regular cube each side of which has the same length. It should be noted that the IHO Special Order and Order 1a feature detection requirements of 1 meter and 2 meters cubes respectively, are minimum requirements. In certain circumstances it may be deemed necessary by the hydrographic offices / organizations to detect smaller features to minimize the risk of undetected hazards to surface navigation. For Order 1a the relaxing of feature detection criteria at 40 meters reflects the maximum expected draught of vessels.
- (4) The line spacing can be expanded if procedures for ensuring an adequate sounding density are used. "Maximum Line Spacing" is to be interpreted as the:
- Spacing of sounding lines for single beam echo sounders, or the
 - Distance between the useable outer limits of swaths for swath systems.
- (5) These only apply where such measurements are required for the survey.

Thus, these standards have set the level of accuracy of determining the depth, position, density of survey and the minimum size of objects (features) that must be detected during hydrographic surveys.

5. CONCLUSION

Hydrographic activity has an intensive international character. This activity on behalf of the the states is performed by authorized Hydrographic Organizations. IHO directs their work and mutual coordination. The legal framework of the international hydrographic activity is given by the provisions of UNCLOS, SOLAS Convention and the IHO regulations.

The most important activity of the IHO is standardization in performing hydrographic survey. Since then the IHO has developed five editions of International hydrographic

⁴³ The total vertical uncertainty is a component of total propagated uncertainty calculated in the vertical dimension. It is a one-dimensional value. *ibidem*, p. 18.

standards. The development of these standards depended on the development of devices for depth measurement and positioning systems on hydrographic ships.

Analyzing the fourth and the fifth edition of the Standards the conclusion is that very high level of accuracy and reliability of data obtained by hydrographic surveys is achieved. The question remains how much national hydrographic organizations are technically and technologically capable to conduct hydrographic survey in accordance with these standards. Anyway hydrographic survey data obtained in accordance with these standards will satisfy the needs of the growing number of users. These Standards will also increase the confidence level of nautical charts and publications, which will be direct contribution to increasing the level of safety of navigation.

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ROAD TRAFFIC SAFETY IN SLOVENIA: TRENDS AND FORECASTS

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ABSTRACT

Traffic safety in general, and in particular road traffic safety is one of the most important social issues. Based on European guidelines Slovenia introduced its traffic safety goals within the National Programme for Road Safety of the Republic of Slovenia in 2001. This Programme was updated twice since then.

The paper assesses the success of Slovenia towards achieving the goals set by National Road Safety Programmes from 2001 and 2006 as well as the feasibility of the goals set for 2021. For this purpose linear regression and Autoregressive Integrated Moving Average (ARIMA) models are used in addition to basic statistics and generalized Accident Point Weightage (APW) method.

KEYWORDS

Road traffic safety, traffic flows, vision zero, linear regression, ARIMA method, APW method

PROMETNA VARNOST V SLOVENIJI: TRENDI IN NAPOVEDI

POVZETEK

Prometna varnost na splošno, posebno pa prometna varnost cestnega prometa, je eno izmed ključnih družbenih vprašanj. Glede na evropske smernice, je Slovenija leta 2001 predstavila nacionalne cilje prometne varnosti v dokumentu Nacionalni program varnosti cestnega prometa v Republiki Sloveniji. Od takrat je bil ta program dvakrat posodobljen.

V referatu ocenjujemo uspeh Slovenije pri doseganju ciljev na področju prometne varnosti, ki so bili opredeljeni z dvema nacionalnima programoma, in sicer prvim programom iz leta 2001 in ažuriranim programom iz leta 2006 ter preverjamo izvedljivost glavnih ciljev novega programa cestno prometne varnosti. Pri tem uporabljamo metodo linearne regresije, ARIMA metodo ter metodo ponderiranja težavnosti posameznih prometnih nesreč na različnih kategorijah cest.

KLJUČNE BESEDE

Cestno prometna varnost, prometni tokovi, vizija nič, linearna regresija, ARIMA metoda, metoda ponderjev

1. INTRODUCTION

Road traffic accident is an accident on a public road or on non-classified road that is used as public transport infrastructure, in which at least one moving vehicle has been involved and material damage or injury or death has occurred [12].

National road traffic safety is usually reported in terms of health risk, that is the number of road accident fatalities per year per 100,000 inhabitants or in terms of traffic risk, which denotes the number of road fatalities per year per 1 billion motor vehicle kilometres of travel [5]. This allows positioning country's road traffic safety progress in international view.

Slovenia follows the European objectives in the field of traffic safety. Thus, in 2001 the first National Road Safety Programme was written. It emphasized the need to halve the number of road fatalities in 2005 in comparison to 1995. This meant no more than 210 deaths on Slovenian roads in 2005 [14]. In the Resolution on the National Road Safety Programme for the period from 2007 to 2011 the goal of maximum 124 fatalities on Slovenian roads in 2011 was set [13]. And finally, currently valid Road Safety Programme

that covers the period from 2012 to 2021 sets the goal of less than 70 people to be killed and no more than 420 people to be seriously injured on Slovenian roads by the end of 2021 [1].

The objective of this paper is to assess the progress in achieving the goals set by the first two National Road Safety Programmes in Slovenia as well as to determine the feasibility of the goals set by the latest Programme.

2. DATA AND METHODS

2.1. DATA

Slovenia has a long tradition of traffic accidents data collection; first records on traffic accidents date back to early 1950s and today Slovenian police provides detailed data on traffic accidents. However, it is well known that the reporting of road accidents in official statistics is often incomplete and biased. Incomplete road accident reporting is a part of a larger problem concerning the availability of accurate information of road accidents [5]; many accidents, even such that would need to be reported to the police remain unreported, while the accuracy of recorded data of those reported might be questionable.

Brvar [2] expresses doubts about the credibility of official statistics on road accidents in Slovenia and draws attention to the fact that official statistics does not consider cases in which the accident occurred due to a sudden cardiac arrest or sudden outage of brain functions among the deaths in traffic accidents. According to Brvar 17 road traffic fatalities were left out of official statistics in 2010.

Regardless of Brvar's findings and concerns expressed by Elvik and others we used official data provided by the Slovenian Police, because this data is the most comprehensive as well as the most suitable for time series analysis on traffic accidents. We assumed that if deviations exist they are roughly constant over time.

We obtained detailed data on traffic accidents for the period from 1999 to 2012, although Slovenian Police provides detailed data from 1995 on. However, after the data unification, the preliminary data analysis was performed and it showed irremediable inconsistency in reporting road category in data covering the period from 1995 to 1998, thus preventing to reliably conduct the analysis for the entire period that is from 1995 to 2011.

2.2. METHODS

We used several methods to assess the improvements in traffic safety as well as to give prediction of traffic safety in Slovenia.

To get the first picture on traffic safety progress in Slovenia we used two coefficients, namely average annual growth rate (AAGR) and compound annual growth rate (CAGR). AAGR is the arithmetic mean of a series of growth rates, but can in certain cases yield misleading results and is as such not regarded as the correct way to measure growth. Many analyses thus use the CAGR which on the other hand assumes a steady rate and does not show exact annual changes.

$$AAGR = \frac{1}{n} \sum_{i=1}^{n-1} \left(\frac{x_{i+1} - x_i}{x_i} \cdot 100 \right) \quad (1)$$

$$CAGR = \sqrt[n]{\left(\frac{x_n}{x_1} \right)} - 1 \quad (2)$$

Subsequently we applied Accident Point Weightage – APW method (see e.g. [8; 9]) which is usually used to assess traffic safety on road segments and consequently for black spots elimination. However we used it in a generalized way to assess overall improvement of road traffic safety in Slovenia as well as to assess the performance of roads of different categories. In this way it was possible to get more complete estimation of traffic safety progress.

$$APW=6 \cdot X_1+3 \cdot X_2+0,8 \cdot X_3+0,2 \cdot X_4 \quad (3)$$

where: X_1 – number of fatal accidents
 X_2 – number of serious injury accidents
 X_3 – number of slight injury accidents
 X_4 – number of damage only accidents

The ARIMA procedure analyses and forecasts equally spaced univariate time series data. ARIMA models are often used in traffic safety forecasting.

ARIMA models include combined concepts of autoregressive model, a model of integration of time series and a model of a moving average. This approach was used also by the Slovenian company Omega Consult to model data on fatalities and serious injuries in traffic on Slovenian roads during the period between 1994 and 2004.

Time series to which ARIMA model will be fitted needs to be stationary. This means that a time series has a constant mean and a constant variance over time.

Data on traffic accidents show seasonality, thus it is necessary to use a seasonal ARIMA method, which is denoted as $SARIMA(p,d,q)(P,D,Q)_S$, where (p, d, q) represent the non-seasonal, while (P, D, Q) represent the seasonal part of the model. p, d , and q (or P, D, Q) are non-negative integers that refer to the order of the autoregressive, integrated, and moving average parts of the model. S denotes the length of the seasonal periods. A $SARIMA(p,d,q)(P,D,Q)_S$ model can be presented with the following formula:

$$\Phi_p(B^S) \cdot \phi_p(B) \cdot (1-B^S)^D \cdot y_t = \theta_q(B) \cdot \Theta_q(B^S) \cdot \varepsilon_t \quad (4)$$

where: $\Phi_p(B^S)$ – seasonal autoregressive operator
 $\phi_p(B)$ – autoregressive operator
 $\theta_q(B)$ – moving average operator
 $\Theta_q(B^S)$ – seasonal moving average operator
 B – backshift operator
 ε_t – error term

Linear regression is the simplest way of forecasting based on time series, however certain assumptions need to be met (see e.g. [7]). Linear regression provides a linear relationship between the dependent variable and the independent or explanatory variables.

$$Y=X\beta+\varepsilon \quad (5)$$

where: Y – vector dependent variable
 X – matrix of independent variables
 β – vector of coefficients
 ε – vector of random errors (residuals)

Contemporary traffic safety forecasting models can be thus written as (see e.g. [4; 5]):

$$E(\lambda)=\alpha \cdot Q^{\beta} \cdot e^{\sum \gamma_i \cdot x_i} \quad (6)$$

The estimated expected number of accidents, $E(\lambda)$, is a function of traffic volume, Q , and a set of risk factors, x_i ($i=1, 2, \dots, n$). The effect of traffic volume on accidents is modelled in terms of an elasticity, that is a power, β , to which traffic volume is raised and the effects of various risk factors that influence the probability of accidents, given exposure, are generally modelled as an exponential function, that is as e (the base of natural logarithms) raised to a sum of the product of coefficients, γ_i , and values of the variables, x_i , denoting risk factors [4].

It would be good to make the selection of explanatory variables that are included in an accident prediction model based on theory, however data availability is often a limiting factor, thus formula (3) often takes the following form as suggested by Elvik and others [5]:

$$E(\lambda) = AADT^{\beta} \quad (7)$$

where *AADT* stays for Annual Average Daily Traffic which is a proxy for traffic volume.

3. RESULTS AND DISCUSSION

Traffic safety has significantly improved in recent decades in Slovenia as shown in the following figure. Between 1970 and 2010, the number of fatalities in Slovenia decreased by almost 80% while distances travelled were multiplied nearly fivefold [10].

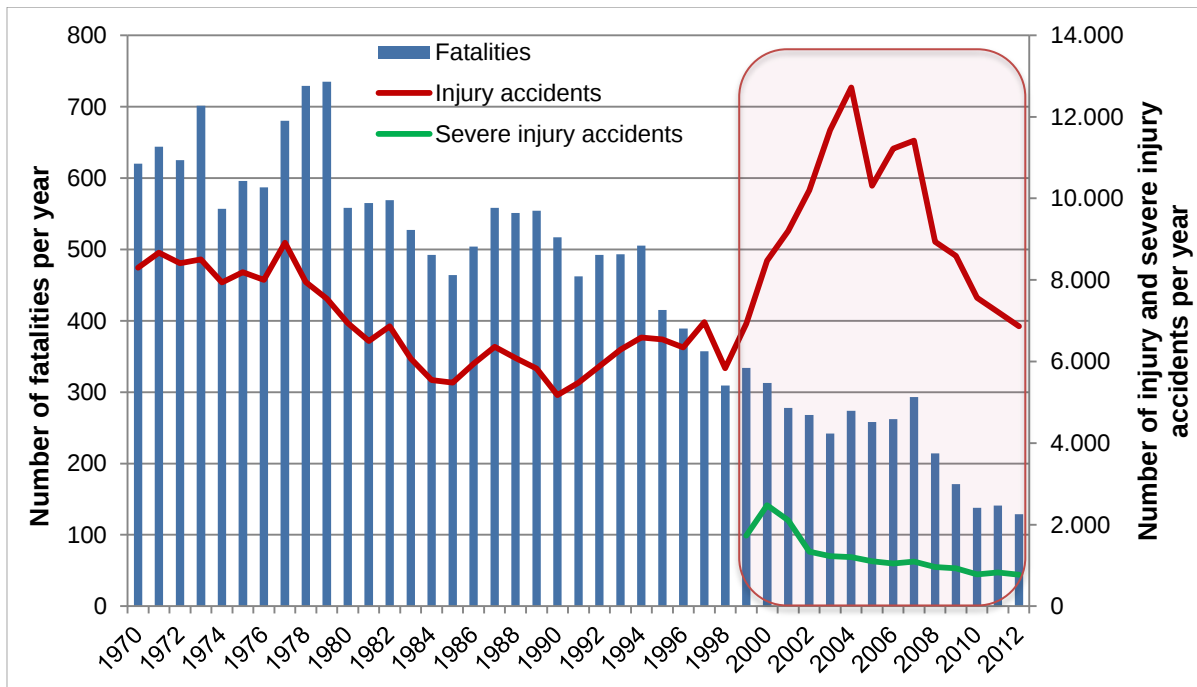


Figure 1. Basic indicators of road traffic safety in Slovenia in the period from 1970 to 2012 with the emphasis on the period from 1999 to 2012

Source: Authors, based on [10; 11]

The calculation of AAGR and CAGR on number of accidents per year show slight improvement in traffic safety in the period from 1999 to 2012; the number of accidents compared to the previous year was actually increasing in most of the analysed period, however a great decline in number of accidents occurred in the period from 2007 to 2009, with number of accidents dropping by almost one third in 2008 in comparison to 2007 and more than 20% in the following year.

Greater improvement is evidenced in the number of fatalities as can be seen from Table 1. The greatest improvement was recorded in the period from 2008 to 2010, when the number of fatalities halved in comparison to the year 2007.

Table 1. AAGR and CAGR for number of all accidents, fatal accidents and fatalities on Slovenian roads in the period from 1999 to 2012

AAGR (all accidents)	-0.9%
CAGRS (all accidents)	-1.9%
AAGR (fatal accidents)	-6.1%
CAGR (fatal accidents)	-6.9%

AAGR (fatalities)	-6.5%
CAGR (fatalities)	-7.2%

Source: Authors based on [11]

The calculation of AAGR on monthly data does not yield any constructive results due to the meaningful seasonality of traffic safety data.

The application of APW method gives similar results; if AAGR is calculated for the APW values we get an average overall road traffic safety improvement of 2% per year, while CAGR indicates an improvement of 2.5% per year.

Table 2. APW method assessment of road safety in Slovenia

	Property damage	Injury			Number of accidents	Value	Difference
		Severe	Light	Fatal			
1999	33,678	1,734	4,968	307	40,687	17,754	
2000	30,828	2,473	5,707	289	39,297	19,884	12.00%
2001	30,387	2,107	6,985	243	39,722	19,444	-2.21%
2002	29,428	1,340	8,725	240	39,733	18,325	-5.75%
2003	29,504	1,228	10,367	220	41,319	19,198	4.76%
2004	30,193	1,204	11,506	253	43,156	20,373	6.12%
2005	43,853	1,103	8,976	230	54,162	20,640	1.31%
2006	44,320	1,050	9,940	233	55,543	21,364	3.51%
2007	39,531	1,093	10,058	263	50,945	20,809	-2.60%
2008	25,876	958	8,029	200	35,063	15,672	-24.69%
2009	18,232	928	7,509	154	26,823	13,361	-14.74%
2010	20,950	778	6,655	127	28,510	12,610	-5.63%
2011	24,083	831	6,258	129	31,301	13,090	3.81%
2012	24,829	774	5,968	122	31,693	12,794	-2.26%

Source: Authors, based on [11]

Anyhow, the basic statistics shows that the goal of 210 victims on Slovenian roads in the year 2005 was not reached; there were 259 victims recorded by the official statics which is 23.3% above the expected level. Similar situation occurred in 2011; the goal was to have a maximum of 124 victims on Slovenian roads, but the official statistics says that there were 141 victims so the expected number was surpassed by 13.7% which is still a progress in regards to 2005.

Traffic safety is closely related to traffic flows. In fact, there is high and statistically significant correlation between the volume of traffic flows and the number accidents on Slovenian state roads. We found out that the growth of AADT on state roads by 10% results in growth in the number of traffic accidents by about 11.2% or between 8.7 and 13.8% with a confidence interval of 95%, while the same growth of AADT on motorways leads to smaller growth in the number of accidents; the growth is around 7.5% or between 6.5 and 8.5% at a confidence interval of 95%.

As the motorways started to accommodate majority of traffic work in Slovenia is it quite expectable that traffic safety deteriorates on motorways and increases on roads of lower category as can be seen in Table 3.

Table 3. APW coefficient for different state road categories in Slovenia

Year	Motorways	Main roads	Regional roads
1999	593.6	3,100.0	3,954.4
2000	741.8	3,575.6	4,363.2
2001	706.6	2,983.0	4,262.0
2002	710.6	2,892.0	3,829.2

2003	924.6	2,626.4	4,252.0
2004	981.8	2,727.0	4,421.6
2005	1,437.0	3,206.8	5,335.0
2006	1,550.8	3,700.6	6,015.0
2007	1,428.8	3,369.0	5,535.0
2008	1,087.8	2,409.8	3,644.4
2009	1,019.0	1,658.4	2,583.0
2010	1,309.2	1,300.8	2,416.0
2011	1,191.2	1,414.0	2,933.8
2012	951.2	1,033.4	2,383.6

Source: Authors, based on [11]

Proportion of the number of people killed on the motorways is growing; in 2001 the share of fatalities on motorways represented only 7% of all fatalities, while in 2010 this share was more than 13%. However it should be noted that back in 2001 motorways accommodated barely 21% of all traffic flows in Slovenia, while in 2011 more than 44% of transport work flows was done on motorways. With other words this means, the traffic volume on Slovenian motorways almost tripled in the analysed period. So, in 2001 there were 9.11 fatalities per billion vehicle kilometres done on motorways and in 2010 this number dropped to 3.40 fatalities per billion of vehicle kilometres on motorways. This is actually according to the theory which says that the increased volume of traffic flows on a limited transport infrastructure results in lower traffic speeds which consequently result in less severe accidents (see e.g. [3]).

According to the transport work done, we can see that the motorways are still about 3.3 times safer than the main roads, and as such represent the safest roads in Slovenia, which is again consistent with the theory [see e.g. 6].

We have created an ARIMA model to forecast the number of fatalities on Slovenian roads for the period from 2013 to 2015. Forecasting into further future would make no sense due to the short original time series.

By using SPSS, we found that the number of fatalities on Slovenian roads is best described by ARIMA (0,0,0),(0,1,1)₁₂ with a constant¹. We first eliminated the non-stationarity of original time series by using natural logarithm function. Afterwards we checked the normality of the distribution of residuals. The introduction of regressors (changes in legislation, the introduction of vignette tolling system for vehicles with the mass of up to 3.5 tons etc.) could potentially improve the level of suitability of the model, but we left them out for two reasons; they would make the model more difficult to understand and we cannot tell how long the currently valid legislation and procedure will last. The ARIMA model parameters are presented in Table 4.

Table 4. ARIMA model parameters to model the number of fatalities on Slovenian roads

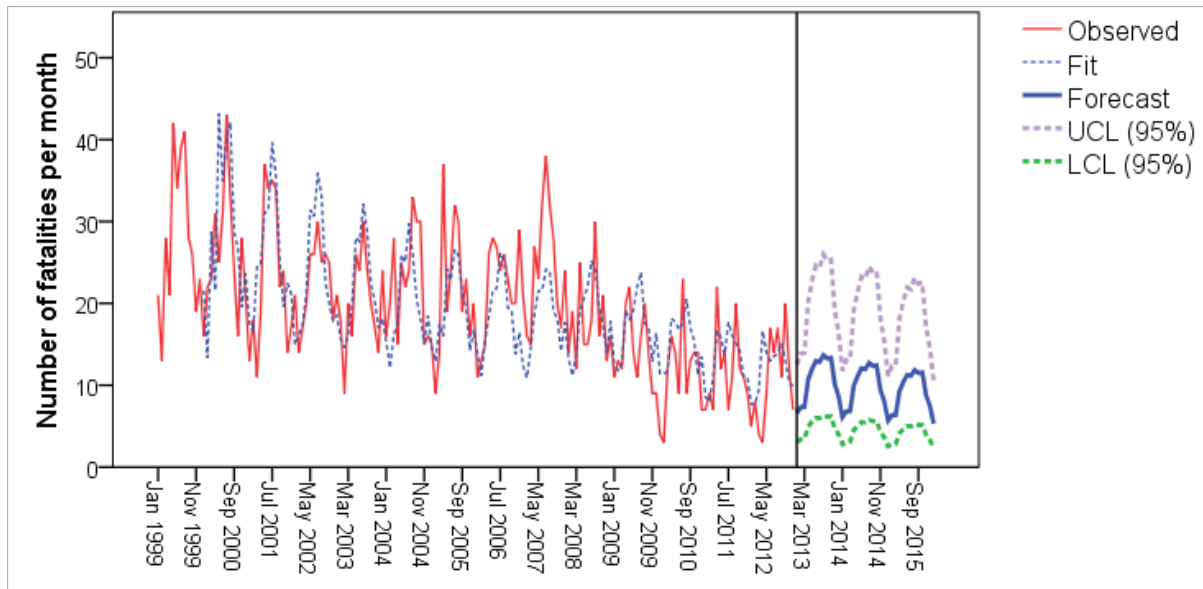
	Estimate	SE	t	Sig.
Fatalities- Model_1	-0.075	0.010	-7.702	0.000
Fatalities	1			
Natural Log				
Constant				
Seasonal Difference				
MA, Lag 1	0.779	0.083	9.372	0.000
Seasonal				

The expected number of fatalities is shown in Table 5 and the model is graphically presented in Figure 2.

¹ Better fit was achieved by the ARIMA(0,1,1)(0,1,1)₁₂ model, however the residuals from this model were auto-correlated.

Table 5. The forecast of the number of fatalities for 2013-2015 by ARIMA (0,0,0)(0,1,1)₁₂

	2013	2014	2015
Forecast	129	120	112
Upper confidence limit (UCL 95%)	244	231	218
Lower confidence limit (LCL 95%)	60	55	50

**Figure 2. The forecast of the number of fatalities until January 2016 ARIMA (0,0,0)(0,1,1)₁₂**

We tested the model with the data on number of fatalities in the first five months of 2013. The results are pretty satisfactory as can be seen from Table 6.

Table 6. Forecasted and actual number of fatalities in the period from January to May 2013

	Forecasted	UCL (95%)	LCL (95%)	Reported
January 2013	6.58	12.48	3.05	7
February 2013	7.31	13.88	3.39	6
March 2013	7.34	13.93	3.41	11
April 2013	10.73	20.36	4.98	7
May 2013	11.96	22.70	5.55	12

4. CONCLUSIONS

Traffic safety is one of the basic qualities of the transport system. The improvements in traffic safety can be achieved only if all elements of transport system, that is transport environment, vehicle and persons act in accordance.

In this paper we have not analysed transport policy measures to improve road traffic safety. Instead, we analysed only the results of taken measures by applying different statistical methods.

There is progress, but figures from the national program have not been achieved in the expected time. Furthermore, significant negative deviation from the set goals occurred in the period between 2004 and 2008.

Current Road Safety Programme emphasis the need to reduce the number of fatalities by six per year in the period from 2011 to 2015, and by five per year in the period from 2015 to

2021. This would be sufficient if in the base year, that is 2011 the goal of maximum 124 fatalities was achieved. But in 2011 there were 141 fatalities on Slovenian roads, which makes the goal of 70 victims in 2021 even more challenging.

The difference in actual and forecasted number of victims is only one in the period from January to May 2013 (if forecasted number is rounded to full number) and if we thus trust the proposed model there should 129 fatalities in 2013, which is two more than in 2012, but afterwards the number of fatalities should decrease significantly. Notwithstanding this, the delay from planned target is present, and the plan for 2013 would be reached in 2015. This means that from 2015 onwards the number of deaths per year, should be on average, reduced by seven per year.

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POSSIBLE APPLICATION OF HARMONIC NUMBERS IN ERGONOMIC ASSESSMENT OF MALE TRUCK AND VAN DRIVERS WORKING ENVIRONMENT

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ABSTRACT

Factors of working environment from cab in interacting with anthropometric measures of truck and van drivers in the static sitting position affect the task difficulty, according to TCI Fuller dynamic model. Anthropometric measures were taken from a random and sufficient sample of $n = 50$ truck and van drivers from company Tisak d.d., for Rijeka and Grad Zagreb with their surroundings. It was determined 95 percentil for all investigated anthropometric measures. Harmonic numbers i.e. mean values of ratios of characteristic anthropometric measures in relation to the standing height were calculated, for static sitting position. Linearity of functional dependencies between the studied anthropometric measures and standing height were evaluated according to value of correlation coefficient R . Some of the calculated harmonic numbers and functional dependencies (for $R > 0.6$) should be used in the future for simplified quick calculations based on the knowledge of the standing height for 95 centile of respondents, during defining of user requirements for the design of cab working environment in the new vehicles adapted to the target population of drivers.

KEY WORDS

task difficulty, human factor, 95th percentile, harmonic numbers, cab design

MOGUĆA PRIMJENA HARMONIJSKIH BROJEVA U ERGONOMSKOJ PROSUDBI RADNOG OKOLIŠA MUŠKIH VOZAČA KAMIONA I KOMBIJA

SAŽETAK

Čimbenici radnog okoliša upravljačnice u interakciji s antropomjerama vozača kamiona i kombi vozila u sjedećem statičkom radnom položaju, utječu na težinu zadaće vožnje prema dinamičkom TCI Fullerovom modelu. Snimljene su antropometrijske mjere za slučajni i dovoljni uzorak od $n = 50$ vozača kamiona i kombi vozila iz kompanije Tisak d.d., za gradove Rijeka i Grad Zagreb s njihovim okolicama. Određen je 95 centil za sve istraživane antropometrijske mjere. Izračunati su harmonijski brojevi tj. srednje vrijednosti omjera karakterističnih antropometrijskih veličina u odnosu na stojeću visinu, a za sjedeći statički položaj. Linearnosti funkcijskih ovisnosti između istraživanih antropomjera i stojeće visine vrednovala se pomoću iznosa koeficijenta korelacije R . Pojedine od izračunatih harmonijskih brojeva i funkcijskih ovisnosti (za $R > 0,6$) treba u budućnosti koristiti za pojednostavljene brze izračune na temelju poznavanja stojeće visine za 95 centil ispitanika, a tijekom definiranja korisničkih zahtjeva za dizajn radnog prostora upravljačnice u novim vozilima prilagođenog ciljanoj populaciji vozača.

KLJUČNE RIJEČI

težina zadaće, ljudski faktor, 95 percentil, harmonijski brojevi, dizajn upravljačnice

1. INTRODUCTION

Factor anthropometric unconformity of cab workspace in relation to anthropometric measures of drivers may be an important factor of subjective disturbance from cognitive

perceptions of drivers, increasing the workload of drivers during driving, and reducing the reliability and safety of the driver.

According to Fuller TCI dynamic model, "the ability of drivers - demand tasks" [1] for evaluation of weight functions, the driver capability is predominantly determined by factors from the group of "human factor", and factors of the "human factor", by selecting the speed of traffic, significantly affect the "tasks demand". Factors of the "human factor" are, among other things, factors that result from the physical appearance of men, and they include the characteristic anthropological measures investigated in this paper, from a sufficient and random sample of $n = 50$ truck and van drivers from the city of Rijeka and the City of Zagreb with their surroundings, from the entire population of $N = 312$ truck and van drivers from the company Tisak d.d. in all Croatia.

Authors' own measurements conducted during the year 2013 in Croatia on truck and van male drivers in Tisak d.d. further confirm the findings from the scientific literature according to which the static anthropomeasures are relatively increased over the years, considering the mean value of body height, if comparing the results of measurements of anthropomeasures from Rudan from the 1980s [2] according to Table 1, with the results of measurements from Ujević et al. from years 2005 and 2006 [3] from all Croatia according to Figure 1 and the results of measurements for several final populations of N male drivers in Croatia and Bosnia during the years 2012 and 2013 [4, 5, 6] shown in Table 2.

Table 1. Anthropometric results for men in Croatia

Variable (mm)	Percentiles				
	5 %	25 %	50 %	70 %	95 %
Body height	1592	1620	1648	1724	1801
Sitting height	820	848	882	908	941
Upper arm length	288	303	316	326	341
Lower arm length	241	260	270	278	298
Arm length	708	743	759	784	821
Upper leg length	474	502	523	540	570
Lower leg length	333	362	376	390	414
Leg length	881	935	965	996	1045
Biochromial range	358	377	393	404	432
Pelvis width	269	283	293	302	318
Body mass (kg)	56.5	64.9	71.5	80.2	95

Source: Taken from Rudan, P. et al. 1979 [2]

It is widely known that different people from different nations with different genotypes have significantly different standing heights at the same time, so that for example, trucks and vans with cab space produced for the Asian market cannot be ordered for the Central European market.

According to Figure 1 [3] the estimate of body height in Croatian men was $\bar{h} = 175.8$ cm, for the measurements in the Republic of Croatia which were being carried out by Ujević, D. et al. during 2005 and 2006.

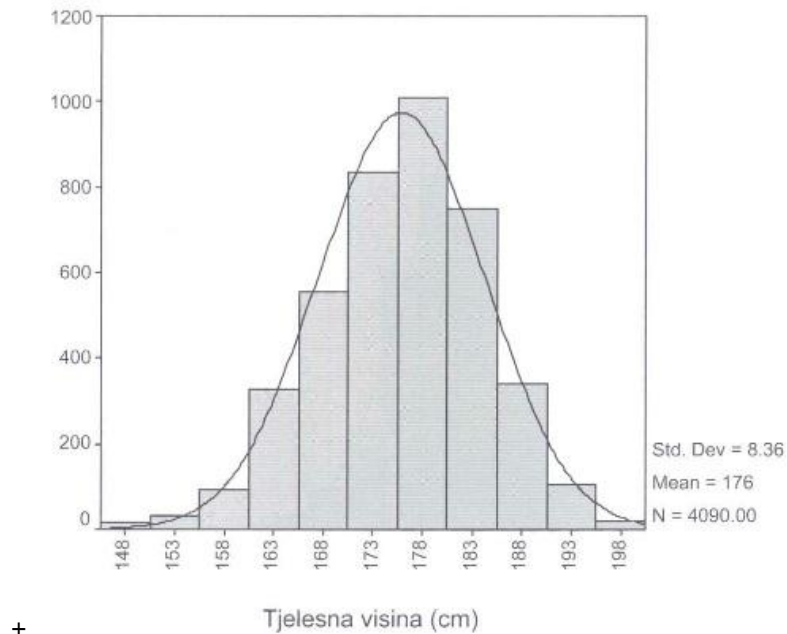


Figure 1. Distribution of body height in adult men in Croatia

Source: Taken from Ujević, D. et al., 2009 [3]

Table 2. Comparison of the mean amount ratio arm's length and standing height for the citizens of the Republic of Croatia and Bosnia and Herzegovina

Male subjects:	Tram drivers in Zagreb	Tram drivers in Sarajevo (BiH)	Locomotive engineers from all over Croatia	Truck drivers in company Tisak d.d. from Rijeka and City of Zagreb
The total number of subjects n in the random and sufficient sample	52	64	50	50
Total population N	573	132	1410	312
Age range (years)	29÷64	26÷54	28÷53	20÷57
The average attainment of the age (years)	47.2	35.3	44.9	38.4
Mean height value $\bar{h}$ (cm)	181.0	180.2	180.4	180.1
Standard deviation σ_h (cm)	6.1	6.6	6.2	7.3
A range of sample height Δh (cm)	168÷192	164÷195	165÷194	167÷200
Calculated height range for the central 90% - $\Delta h_{90\%}$ (cm)	170.9÷191.0	169.3÷191.1	170.2÷190.6	168.2÷192.1
Mean value of ratio of maximal arm's reach and standing height h_{MAR}/h	0.42	0.42	0.42	0.42
Correlation coefficient R for evaluating of linear function $h_{MAR} = h_{MAR}(h)$	0.63	0.62	0.69	0.76
Year of measurement	2013	2013	2012	2013

Source: 2013 authors' complemented own research and results of past research taken from 2013 [4, 5] and 2012 [6]

Numerous anthropometric studies show the differences that result from the constitutional differences between people, both regarding gender, age and weight [7, 8], and regarding the different types of human body constitution or human body variations in different canons of the head height [9]. Also, phenotype variations in anthropometric measures of human body

during the years can be result of different ecological actions and different genetic histories [9]. For these reasons, it is always necessary to use the latest available measurement results from the latest scientific literature, or make your own measurements in the target population.

For humans standing height Muftić chose a diameter of the Zederbauer circle $2R_k$. The diameter of the Zederbauer circle was associated with the canon network of eight head heights h_g by Muftić, O. et al. [7, 8], and a connection between harmonic numbers and anthropological measures was established according to expression (1).

$$2 \cdot R_k = h = 8 \cdot h_g \quad (1)$$

From the Zederbauer and Muftić harmonic circle [7, 8] the following sizes are called harmonic numbers, according to Table 3. Harmonic analysis of human body by Muftić and Zederbauer showed that the function of anthropological measures, i.e. segmental length depends dominantly on the standing height h , in most of young people of normal body constitution.

Table 3. Man anthropometric size as function of his standing height h according to canon $h = 8 \cdot h_g$

Length of body segment	Symbol for length	Function	Length of body segment	Symbol for length	Function
Length of arm	h_r	$= 25/64 \cdot h$	Length of upper arm	h_6	$= 5/32 \cdot h$
Length of forearm	h_5	$= h/8$	Length of hand	h_H	$= 7/64 \cdot h$
Length of legs	h_n	$= 17/32 \cdot h$	Length of upper leg	h_3	$= 9/32 \cdot h$
Length of tibia (lower leg)	h_2	$= 7/32 \cdot h$	Length of feet	h_1	$= h/8$

Source: Taken from Muftić, O. et al., 2001 [7], Muftić, O. et al., 2001 [8]

According to Table 2 male drivers from the company Tisak d.d. are in the range between 20 and 57 years of age, the average attainment of their age is 38.4 years, and it is possible that the harmonic relations for the studied anthropometric measures in relation to the standing height are not perfect. Therefore, the authors conducted their own measurements.

2. MEASUREMENT RESULTS AND HARMONIC RELATIONS

Measurements of anthropometric measures for respondents from the city of Rijeka and the City of Zagreb with their surroundings were measured at the same time of day, for the body's segments to the left side of the human body. The results are rounded to integers in centimetres. According to the instructions provided by Kroemer and Grandjean [10] 5% of the tallest and 5% of the smallest individuals of the entire population of investigated truck and van drivers should be excluded (in the physical dimension to which the analysis applies), hereinafter referred to as the central 90% of randomly selected and sufficient sample. If we ignored minor mistakes produced by folds of the skin and possible smaller extension in joints during the work and/or measurements, we can consider equal static anthropometric measure length of arm h_r from Table 3 and dynamic anthropometric measure maximal arm reach h_{MAR} (length of reach) from Table 4 measured from shoulder joint to the tip of the longest finger.

Figure 2 shows typical static anthropometric measures in the sagittal plane with labels by Kroemer and Muftić [7].

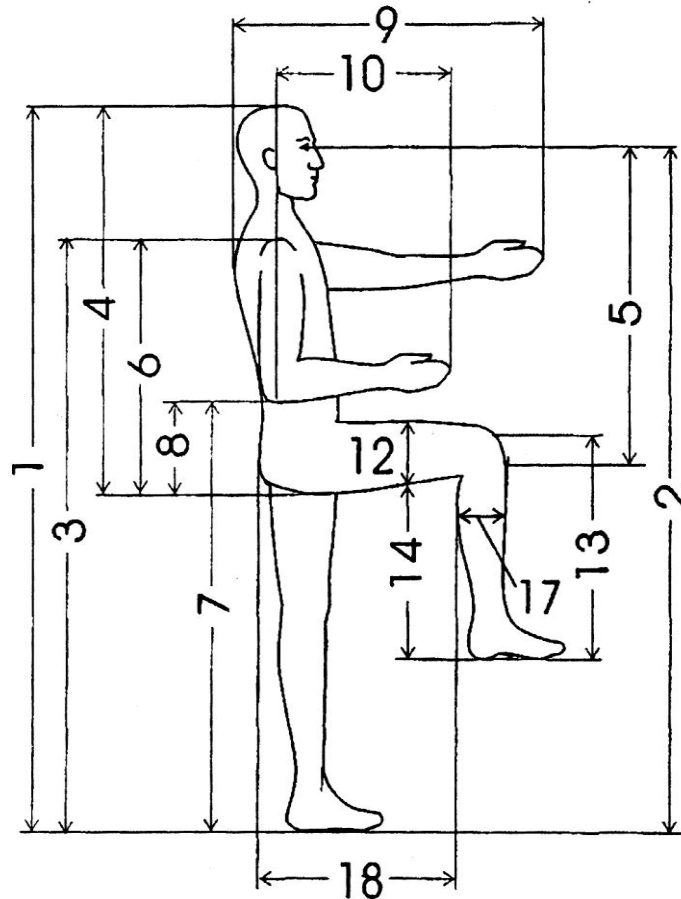


Figure 2. Showing typical static anthropometric measures in the sagittal plane by Kroemer

Source: Taken from Muftić, O., Milčić, D. 2001 [7]

According to Kovač-Striko et al. [11] a sufficiently large sample is $n > 30$ from any basic set of the expected mean μ and standard deviation σ_{h_n} . Shown deviations σ_{h_n} in Table 4 of all mean value anthropomeasures $\bar{h}_n$ for the sample $n = 50$ truck and van drivers from the city of Rijeka and the City of Zagreb in relation to the expected mean anthropomeasures μ on the basic set of the entire population of $N = 312$ drivers from all Croatia are acceptable. If we know the arithmetic mean $\bar{h}_n$ and sample standard deviation σ_{h_n} , we can calculate 5 centile and 95 centile for all anthropometric measures, according to expressions (2) and (3) taken from Kroemer and Grandjean [10].

$$5,0 \cdot c = \bar{h}_n - 1,65 \cdot \sigma_{h_n} \quad (2)$$

$$95,0 \cdot c = \bar{h}_n + 1,65 \cdot \sigma_{h_n} \quad (3)$$

Table 4. Comparison of measurement results on a sample of $n=50$ employees from Tisak d.d. with the results of Kroemer and Muffić

Part of body	Label by Kroemer and Muffić (Fig. 2)	Kroemer		Muftić amount	Symbol	$\bar{h}_n$ (cm)	Δh (cm)	σ_{h_n} (cm)	$\sigma_{\bar{h}_n}$ (cm)	Percentiles		Ratio (harmonic number) hi/h	Expression hi=hi(h)	Coefficient R for hi=hi(h)
		amount (cm)	variations (cm)							5 %	95 %			
										(cm)	(cm)			
Body height	1	172	160÷184	175	h	180	167÷200	7.3	0.9	168	192	/	/	/
Eye height in sitting position	5	79	73÷85	80.5	h_e	82	73÷91	4.3	0.6	75	89	0.45	=0.4067h+ 8.5591	0.69
Shoulder height in sitting position	6	59	54÷64	59.5	h_s	63	55÷72	3.8	0.5	57	70	0.35	=0.3272h+ 4.4317	0.63
Elbow height in sitting position	8	24	20÷28	25	h_{el}	28	23÷34	3.3	0.4	22	33	0.15	=0.0934h+ 10.884	0.21
Horizontal reach of extended arm	9	82	75÷87	83	h_{HREA}	91	76÷101	4.8	0.6	83	98	0.50	=0.4793h+ 4.1291	0.72
Normal hand reach or working distance (from elbow to the tip of the longest finger)	10	47	45÷51	45	h_{NHR}	47	39÷55	2.8	0.4	42	51	0.26	=0.2709h- 2.0712	0.71
Maximal arm reach or length of reach (from shoulder joint to the tip of the longest finger)		/	/	/	h_{MAR}	76	61÷88	5.0	0.7	68	84	0.42	=0.5205h- 17.858	0.76
Hand length		/	/	/	h_H	21	18÷24	1.3	0.2	19	23	0.11	=0.1055h+ 1.6625	0.59
Height below the knee of the foot	14	45	42÷48	43	h_{BKF}	51	47÷55	1.9	0.2	48	54	0.28	=0.1403h+ 25.934	0.55
Shoulder width (biacromial range)	15	45	41÷49	46	h_{br}	48	42÷57	3.5	0.5	43	54	0.27	=0.2419h+ 4.7951	0.51
Length of buttocks to lower leg	18	50	46÷54	50	h_{bl}	61	52÷71	3.5	0.5	55	67	0.34	=0.3841h- 8.1198	0.80

Source: 2013 authors' measurement results compared with the results of Kroemer and Muffić from the 1980s [7]

While defining the users' demands of the operator company towards vehicle manufacturer, for the design of the driver's workspace (in a cabin) in new vehicles adjusted to the targeted drivers population, in the future the calculated mean values of ratios, i.e. harmonic numbers hi/h or those functional dependencies $hi=hi(h)$ from Table 4 should be used, for which the amount of the correlation coefficient is $R > 0.6$, because then the deviation of the calculated anthropometric measures hi using mean values of ratios, i.e. harmonic numbers hi/h or function $hi=hi(h)$ is acceptable, compared to the measured amount of actual hi . Using the mean values of ratios hi/h and the functional dependencies $hi=hi(h)$ from Table 4 for calculation of anthropometric value hi only from the standing height h , amounts for 95 centile of other anthropometric measures hi can be easily and quickly calculated only based on the knowledge of the amount of standing height h for 95 centile from random and sufficient sample of the entire population of respondents. For those anthropometric measures hi in Table 4, for which functional dependencies $hi=hi(h)$ are determined with correlation coefficient $R < 0.6$, it is necessary to determinate the amounts for 95 centile based on measurements of individual anthropometric measures hi from random and sufficient sample, and based on those amounts make orders for cabins in new delivery trucks and vans. It is necessary to prove the credibility of the mean value of harmonic ratio hi/h with comparable measurements and calculations on more finite populations of male drivers in Croatia, on the random and sufficient samples. According to Table 2, the mean value of ratio of maximal arm's reach and standing height h_{MAR}/h is always $h_{MAR}/h = 0.42$ for all male respondents from Croatia, and can be considered credible.

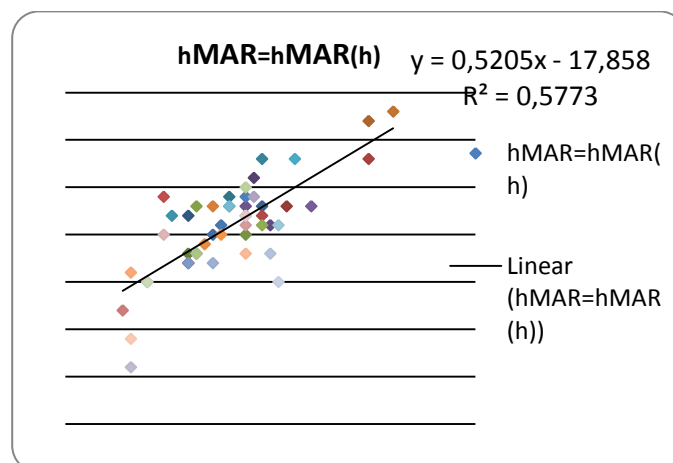


Figure 3. Mean value of ratio of maximal arm's reach and standing height h_{MAR}/h for truck and van drivers from the company Tisak d.d.

3. CONCLUSION

Based on the acceptable deviations $\sigma_{\bar{h}_i}$ of mean arithmetic values of individual anthropometric measures h_i in the sample in relation to the expected mean values μ for all investigated anthropometric measures from Table 4 in the entire population, it has been proven that the random sample of $n = 50$ from the city of Rijeka and the City of Zagreb with their surroundings is sufficient, so that the presented ones refer to the central 90% of the entire population of truck and van drivers from the company Tisak d.d. in Croatia. Mathematically considered, the sample of drivers from this study is sufficient ($n > 30$), but for the final results before ordering vehicles the sample should be extended to men from other places in other counties except the city of Rijeka and the City of Zagreb, due to the possible impact of different genotypes. During defining the users demands of the operator company towards vehicle manufacturer for the purchase of new vehicles, it is possible to use, for different anthropomeasures hi amounts for 95 centile calculated from the standing height

value of 95 centile, using the mean value of the ratio, i.e. the harmonic number of h_i / h or functional dependence $h = h(h)$, if the amount of the correlation coefficient $R > 0.6$ for the researched functional dependence $h_i = h_i(h)$. Generally considering, during the ordering process and the design of new vehicles for the Croatian market, in the circumstances with a proven relative slight increase in static anthropometric measures for men from Croatia over the years, a critical amount of all characteristic anthropomeasures is for 95 centile on random and sufficient sample of drivers from the whole final population of truck and van drivers in the company Tisak d.d. Thus one should avoid non-ergonomic working postures for a part of the drivers distributors with anthropomeasures close to 95 centil, such as: too spread legs, insufficient space for the knees, inability to lay his head to the neck support, ducking his head while driving due to lack of height in the cabin, and the inability to achieve a satisfactory overview of the current traffic situation through windshield.

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GREEN TRANSPORT CLUSTERING

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ABSTRACT

The aim of this paper is to give an overview of current situation in the SEE region and green freight clustering approaches. Since the main aim of the GIFT project is to map, analyze and evaluate the status of the transport sector in the SEE and to propose new policies and strategies in infrastructure, processes, assets, ICT, legislation, norms and harmonization/ standardization issues, in order to promote innovative green intermodal freight transport corridors, this paper presents results which indicate the importance of clusters formation.

KEYWORDS

GIFT, clusters, green transport, intermodal freight transport

KLASTER ZELENOG TRANSPORTA

SAŽETAK

Cilj rada je dati pregled trenutnog stanja u regiji Jugoistočne Europe, kao i pregled metodologije za formiranje klastera. S obzirom da je glavni cilj projekta GIFT mapirati, analizirati i ocijeniti stanje prometnog sektora u regijama jugoistočne Europe, predložiti nove politike i strategije u infrastrukturi kao i procese, sredstva, ICT, zakonodavstvo, norme i pitanja harmonizacije / standardizacije, s ciljem promocije inovativnih zelenih intermodalnih koridora za transport, ovaj rad prezentira rezultate koji pokazuju važnost formiranja klastera.

KLJUČNE RIJEČI

GIFT, klaster, zeleni transport, intermodalni prijevoz tereta

1. INTRODUCTION

Intermodal freight transport means movement of goods in an intermodal transport unit (ITU), using two or more modes of transport without handling the goods themselves when changing modes. In recent years, the East-West trade in Europe is growing rapidly. Eastern Europe's transport infrastructure often does not meet Western standards. The combination of rapid growth and insufficient infrastructure has created fears of increased traffic congestion, logistic bottlenecks and environmental problems. GIFT project is focused on development of green intermodal freight transport in the South East Europe (SEE), especially in the GIFT project partner countries (Bulgaria, Croatia, Greece, Italy, Romania, Serbia, Slovenia, Slovakia and Hungary). The main aim of the GIFT project is to map, analyze and evaluate the status of the transport sector in the SEE and to propose new policies and strategies in infrastructure, processes, assets, ICT, legislation, norms and harmonization/ standardization



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issues, in order to promote innovative green intermodal freight transport corridors. One of the important issues are clustering organization and operation methodology, presented in this paper.

2. PROBLEM DESCRIPTION

Road freight transport is the dominant mode of goods movement across the EU (with a share of 49%) as it represents a cost effective and flexible mode. Its dominance in SEE countries may also be contributed to the lower requirements for infrastructure, standards, and legal framework. However, road transport exhibits significant weaknesses contributing to considerable CO₂ emissions, accidents, increased noise level, road congestion and wear. Looking 40 years ahead, it is clear that transport cannot develop along the same path. If we stick to the business as usual approach, according to the EC White paper [1], CO₂ emissions from transport would remain one third higher than their 1990 level by 2050. Congestion costs will increase by about 50% by 2050. It is evident that in order to relieve the pressure on the roads, transport modes have to be combined so as to reduce congestion, environmental impact, improve safety, reduce economic impact (due to fatalities and environmental harm), while at the same time meet modern demands for reliability, speed and safety. Figure 1 shows energy consumption rates in GIFT countries (based on Eurostat data).

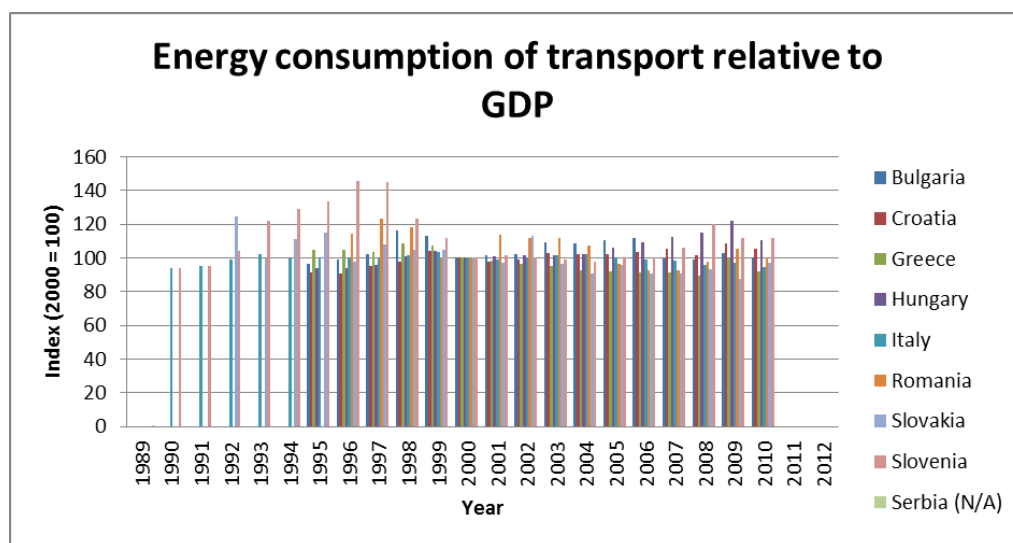


Figure 1. Energy consumption of transport relative to GDP

When compared to year 2000 it is visible that energy consumption is slightly decreasing in most of the countries, but not a close enough to meet goals defined by countries' and EC strategies. Trucks' efficiency has improved in the last decades but not enough when compared to the improvements in the private cars' sector. Therefore, approach of combining freight transport modes is suggestible whenever possible and justifiable to reduce congestion, environmental impact, improve safety, reduce economic impact (due to fatalities and environmental harm), while at the same time meet modern demands for reliability, speed and safety.



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In order to make transport more greener beside other measures very important is to include all relevant stakeholders connected with freight/intermodal transport in cluster organisation such as national public administration, railway transport operators, combined transport operators, terminal operators, port operators, railway infrastructure managers, motorway operators, IWW transport operators, road transport operators, freight forwarders, 3PL, 4PL and shippers. Basically cluster organisations are defined as organisations that aim to enhance the strength of their stakeholders. By definition, cluster organisations capture more than one sector. Besides cluster organisations that provide a platform for all companies in sectors that are related to each other, sector associations link all companies and/or organisations within a specific sector. Clustering is not a goal in itself, but may be beneficial because of its link with economic prosperity. Regions with a higher rate of employment in industries that belong to strong clusters appear generally more prosperous (higher GDP per capita).

3. CLUSTERING APPROACHES

There are different definitions of clusters. Various forms of networking are however often identified with clusters, and the most important are the content and level of their development. Clusters differ by:

- The type of products and services they produce,
- Dynamics and level of development,
- Business environment.

The European Commission in the field of regional policy popularises the use of "best practices". European trend of comparison leads to the best results in the establishment of regional policies with similar objectives, instruments and concepts of politics. It is the development of policy innovation particularly important for the development of the cluster. Innovative clusters launches successful interaction between companies, academia and the public administration – interactions between these subjects is covered by the term "triple helix". In Croatia, the initial impetus for the development of clusters in was set by the Croatian Employers' Association by establishing the National Centre for Clusters in 2005. Croatian Government in its document "Strategical development framework 2006 - 2013" has also highlighted the importance of the development of clusters and cluster policies as instruments to strengthen competitiveness and innovation. During the 2007 the inaugural meeting of Cluster community was held at the Croatian Chamber of Commerce. The most important objectives stated was the support to existing and new clusters through education and other activities, cooperation with the institutions in order to establish good relations as much intense connecting with scientific institutions as possible. In 2011 "Cluster Development Strategy in the Republic of Croatia 2011 - 2020" was adopted.

Potential constrains in the cluster establishment can be divided in several groups:

- Lack of awareness of clusters and its potential benefits;
- Insufficient training of public administration in regional planning and evaluation of development programs;
- Lack of coordination in the process of cluster development.

The GIFT project recognized the importance of establishing a mega and micro-clusters in the segment of cargo transport, with special emphasis on the coordination of activities in the process of creating clusters and information of all relevant stakeholders. It is essential that all



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participants develop coordinated policies cluster because it can contribute to the development of clusters and enable increased competitiveness.

There are basically two possible approaches for cluster organisations as to the initiative to establish a cluster. This initiative can be categorised in government-induced organisations (top-down) and cluster organisations induced by leader firms and/or sector associations (bottom-up). Top-down approach is government induced and supported focused on long-term strategy and policy. Main focus is economy, education and recruitment, research, development and innovation and common interest such as environmental impact and safety of transport. Bottom-up approach is induced and supported by strong leader firms or sector associations and focused on short-term benefits. Main focus is regulation, tax regime, labour market and job promotion, innovation project support and export support that are mainly operational problems. Regardless the organisation the main goal in establishing cluster organisations is the installation of a structure that provides clear solutions for cluster issues.

The main issues in project GIFT at the basis of the establishment of cluster organisation are to increase competitiveness, to promote and to improve coordination in SEE region regarding intermodal freight transport.

Mega and micro cluster organisations cooperate with the same parties, i.e. private companies, sector associations, government and research institutions. In order to be more efficient clusters have to be statistically monitored in terms of economic significance. The main theoretic benefits of cluster organisation activities are increase in efficiency and a higher level of innovation.

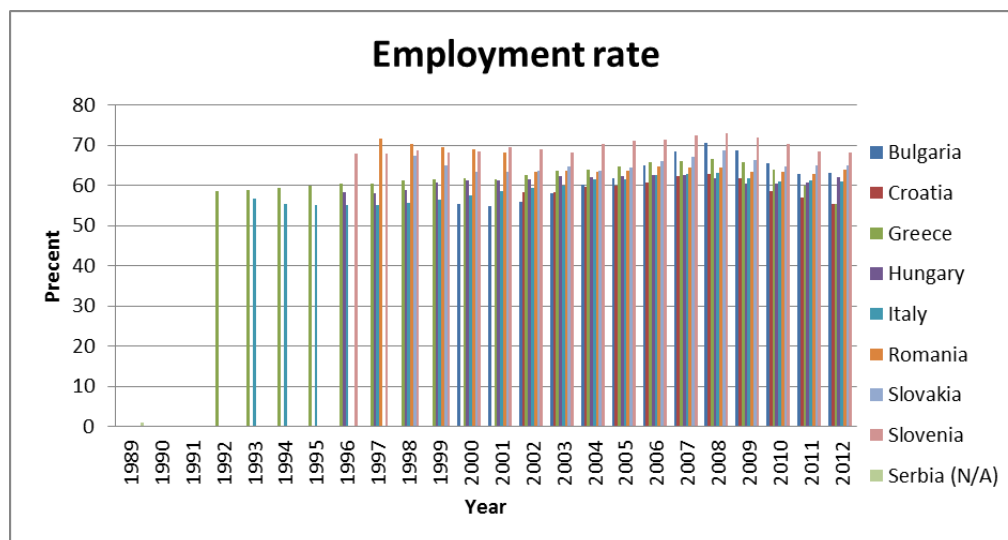


Figure 2. Employment rate

The global map of intermodal freight transport is increasingly dominated by geographically concentrated groups of companies and related economic actors and institutions. Interactions between companies, knowledge institutions and the public sector contribute to job creation, higher wages and surplus. Figure 2 and 3 represent an employment rate and dispersion of the GDP per inhabitant in GIFT countries. A range of international studies have presented results which indicate that formation of clusters have a positive impact on innovation and economic growth. In light of this knowledge, GIFT countries and regions have embraced the concept of clusters and work to develop clusters



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through initiatives, programs or cluster-specific innovation policy. This complies with GIFT project goals.

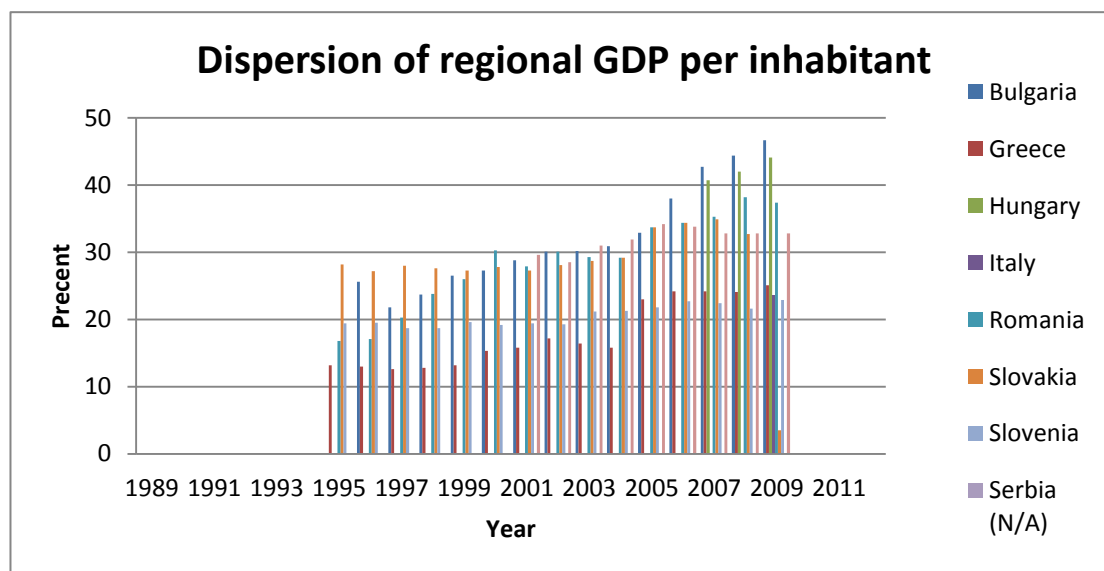


Figure 3. Dispersion of regional GDP per inhabitant

4. CLUSTERING METHODOLOGY

One of the weaknesses of mega cluster organisations are the difficulties they experience in defining to which cluster a sector belongs¹. With the involvement of all relevant stakeholders in the GIFT project, this disadvantage is eliminated. In order to realise these goals, it is necessary to conduct an analysis of existing sectors and clusters connected to cargo transportation. Information of experience within the different sector/cluster organisations in addition to a clear mapping of stakeholders within the framework, it will become easier to work out relevant future policy initiatives. Information include when, whom, organisation (top-down, bottom-up), why, mission, type of activities, formal structures, cooperation, SWOT, financing and main results of sector/cluster organisations connected with freight transport.

Utilization of cluster mapping to identify local and regional competitive advantage as clusters are a useful tool to benchmark and identify trends for policy making. Competitiveness and innovation as cluster participants enables to cope with the pressures associated with international competition. Micro clustering encourages local development and strengthening of small and medium enterprises (SME). It can be used to achieve a wide range of local development goals, such as SME support, job creation and skills upgrading that are important locally and translate into welfare gains at the regional and national levels.

By identifying and building on local competitive advantage, SEE can also make a profit from clusters in transport sector.

Another step in methodology is definition of roles of cluster such as networking, knowledge base, innovation, raising awareness, marketing & branding, representations including lobbying, skills and investment proposals promotion.

¹ For example ports belong to the logistics cluster and to the maritime cluster.



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In order to improve cluster performances there is a need for systematic understanding of the factors (performance indicators) that contribute to the creation and development of clusters, inter relations over time and operation. There are many different methods and techniques for cluster analyzing in the literature; no standardized approach has emerged in the area of freight transport clustering.

Two possible concepts for factors identification are connected with (current) conditions and (current) performances. Factors affecting performance are significance (number and size of cluster firms, structure, export orientation), interaction (internal awareness, external recognition, linkages) and dynamism (innovation and growth). The factors (indicators) must be properly interpreted to obtain value.

Last step in proposed methodology are proposals for environment, monitoring, decision making process, financial aspect, cooperation and promotion of green intermodal freight transport.

Freight cluster program design should grasp the importance of sustainability (cluster policies need to be designed with a long time horizon in mind). Support should be based on clear criteria conditional upon top-down and bottom-up entrepreneur-led initiatives with a proven potential for self-sustainability. Public-private partnerships are important to develop a constructive dialogue to identify local development needs (networking of local stakeholders is crucial to moving forward localities economically and socially). Exchanges between entrepreneurs, civil society and public authorities can help to dynamise local economies. Special attention needs to be paid to building social capital among cluster participants. Policies should advance regional development, to strengthen SMEs and to increase innovation need to be carefully coordinated to achieve synergies. Evaluation is very important and policies and programs in place need to be continuously monitored and evaluated. Cluster mapping needs to be undertaken on a regular basis as an instrument to benchmark industries/sectors and to identify industry/freight transport trends.

Green intermodal freight transport cluster management and operation methodology has an important role as it builds up a critical mass of information, knowledge, skills and technology to allow groups of companies to seize new organizational models and technologies as viable transport opportunities. Productivity can be increased through joint communication and information links, specific education and training programs and local supply chains. Joint research and development and outsourcing of research and development increase innovation. Enhancing openness by enabling new members to bring in new knowledge, resources, technology and experience and by encouraging linkages with international network structures is also very important

5. CONCLUSION

The main issues at the basis of the establishment of cluster organisation are to increase competitiveness, to promote sectors, and to improve coordination within the cluster. Formation of clusters has a positive impact on innovation and economic growth so countries that are partners in GIFT project have accepted the concept of clusters. Main reasons to establish the transport cluster is to increase the competitiveness, promotion and coordination activities with aim to make transport greener. Green transport cluster organisation can optimise cluster benefits through organisational structure. In order to make transport more efficient and to reach a higher level of innovation organisational structure should include all stakeholders which are linked with freight transport with proper methodology of organization and operation.



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APPLICATION OF THE EUROPEAN TRANSPORT POLICY IN BULGARIAN LEGISLATION

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ABSTRACT

This paper provides an overview on the integration of the European and national transport policy rules for development of different modes of transport as well as the intermodal facilities in Bulgaria and of the environmental performance of the transport to improve the overall efficiency of the GIFT area corridors. The favorable geographical position of Bulgaria is evident in view of the five Pan-European Transport Corridors - IV, VII, VIII, IX and X, passing through its territory. This supposes a lot of challenges and requires huge investments - first for improvement and maintenance of the existing infrastructure, then for building the missing one.

KEYWORDS

Pan-European Corridors, transport, regulation, Bulgaria

APPLICATION OF THE EUROPEAN TRANSPORT POLICY IN BULGARIAN LEGISLATION

ABSTRACT

This paper provides an overview on the integration of the European and national transport policy rules for development of different modes of transport as well as the intermodal facilities in Bulgaria and of the environmental performance of the transport to improve the overall efficiency of the GIFT area corridors. The favorable geographical position of Bulgaria is evident in view of the five Pan-European Transport Corridors - IV, VII, VIII, IX and X, passing through its territory. This supposes a lot of challenges and requires huge investments - first for improvement and maintenance of the existing infrastructure, then for building the missing one.

KEYWORDS

Pan-European Corridors, transport, regulation, Bulgaria

1. INTRODUCTION

The Executive agency “Maritime administration” participates as a partner in the implementation of “Green intermodal freight transport” project co-funded by the South East Europe Transnational Cooperation Programme 2007-2013.

Activity 3.2 form WP3 – (Mapping of current EU & SEE Regional policies) of the project stipulates the EAMA to provide information on the integration of the European and national transport policy rules for development of different modes of transport as well as the intermodal facilities in the country, the environmental performance of the transport to improve the overall efficiency of the GIFT area corridors.



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Main policy data:

- CO2 emissions;
- Sustainable ecological transport development;
- Promotion of rail, sea and inland waterway;
- Combining different services suppliers to form effective logistics associations;
- Promotion of competitiveness;
- Encouraging the development of new technologies;
- Infrastructure development through EU and national funding.

2. TRANSPORT – GENERAL

Republic of Bulgaria is a cross point between Europe and Asia, a chain-bridge between East and West. Another well-developed transit destination is the North- South, connecting the Baltic Sea and the Mediterranean.

The favorable geographical position of Bulgaria is evident in view of the five Pan-European Transport Corridors - IV, VII, VIII, IX and X, passing through its territory. This supposes a lot of challenges and requires huge investments - first for improvement and maintenance of the existing infrastructure, then for building the missing one.

Bulgaria provides free access for all transport operators to various types of transport infrastructure. Railway freight transport is visibly lagging behind other transport modes although the introduction of the EU road transport rules (limits on driving time, freight limits) increase the attractiveness of railways. The requirements for protecting the environment are very strict in Bulgaria, which also increase the attractiveness for the railway transport.

Growth of container cargo is expected in regions with good existing infrastructure and some new intermodal terminals are to be in use in the near future. Container traffic may increase significantly after 2016 as a result of the commissioning of new container terminals at the ports of Burgas and Varna.

Key strategic policies for freight transport are:

- Strategy for development of the transport system of Republic of Bulgaria till 2020 - The Ministry of Transport, Information Technology and Communications elaborated Strategy for the development of the transport system of the Republic of Bulgaria till 2020, adopted by the Council of the Ministers of the Republic of Bulgaria on 7 April 2010. The Strategy's goals are: Economy efficiency; Sustainable transport sector; Regional and social cohesion improvement.
- Strategy for development of the transport infrastructure of Republic of Bulgaria by 2015 - The main goal is providing an efficient and reliable transportation. The trend is for improving and developing the majority of the ports, airports and highways by concessioning.

3. TRANSPORT - CO2 EMISSIONS

Priority "Reduction of the transport sector negative impact on the environment and human health for the period till 2020" was identified on the basis of the formulated mission, vision and strategic objectives of Bulgaria's transport sector, and accounting the role of the state, the institutional framework, the development trends and the SWOT analysis.



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3.1. Reduction and targets

Reduction of the transport sector negative impact on the environment and human health:

- Measure 1 Limiting harmful emissions and pollution and the negative impact on climate caused by the transport sector.
- Measure 2 Creation of a favorable environment and conditions for a substantial growth of intermodal transport.

3.2. Vehicle technologies

Limiting the harmful effect of transport on the environment, climate and quality of life requires the introduction of, and incentives for using fuels and energy from alternative and renewable sources, as well as the development and increased share of environmentally compatible transport modes. The development of transport vehicles powered by accumulator batteries and the mass production of electric cars (hybrid and fully electric) will also contribute to limiting the harmful impact on environment.

The introduction of European standards for light and heavy trucks in terms of particulate matter and nitrogen oxide emission, the introduction of environmental requirements and tax relief for the acquisition of vehicles for public transport purposes as incentives for the market of environmentally compliant and energy efficient vehicles, as well as increasing the market share of bio-fuels used in transport to 5.75% by 2010, and to minimum 10% by 2020, and devising strategic noise maps along major roads, railway lines and airports will all contribute to decreasing the harmful effects of transport on the environment and public health.

The implementation of the “Single European Sky” (SES) project by 2020 will substantially reduce the negative impact of air transport on climate by optimizing the scheme for managing air traffic in Europe.

4. TRANSPORT – SUSTAINABILITY

Policies and strategies in national, cross-national and EU-wide transport network planning are:

- National regional development strategy of the Republic of Bulgaria till 2015;
- Strategy for the development of the transport infrastructure of the Republic of Bulgaria by 2015;
- National strategic reference framework 2007 – 2013;
- Operational Programme on Transport 2007 – 2013;
- Operational Programme Regional development 2007 – 2013;
- National programme for the development of public ports by 2015 (draft);
- National strategy for sustainable development (draft);
- National long-term programme for energy efficiency until 2015;
- National long-term programme to encourage the use of biofuels in the transport sector 2008 – 2020;
- National strategy for sustainable development of tourism in the Republic of Bulgaria 2009 – 2013;
- National strategy for the environment 2009 – 2018;
- Programme of the Government of European development of Bulgaria;
- General Transport Master Plan for Bulgaria.



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European strategies are:

- White paper 2011 - Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport system
- The Greening Transport Package
- Railway transport - “Towards a European rail network for competitive freight”, followed in 2008 by a Proposal for a Regulation of the European Parliament and of the Council concerning a European rail network for competitive freight.
- Road transport and intelligent transport systems - Action plan for the deployment of Intelligent Transport Systems in Europe.
- Waterborne transport – “Strategic goals and recommendations for the EU’s maritime transport policy until 2018”
- Air transport - The EU Air Transport Policy “Flying Together” highlights the aspects and the development objectives of air transport.
- Intermodal transport - “Freight Transport Logistics Action Plan”
- Green paper on the development of TEN-T. Green Paper TEN-T: “A policy review – Towards a better integrated trans-European transport network at the service of the common transport policy”.

Action plan for the deployment of Intelligent Transport Systems in Europe- The objective of the Report on Intelligent Transport Systems in Bulgaria to the European Commission in accordance with Paragraph 1 of Article 17 of Directive 2010/40/EU, which requires Member States (MS) to submit to the Commission by 27 August 2011, is to report their national activities and projects regarding the priority areas in the ITS Directive is to provide for a coordinated introduction of ITS applications and harmonized trans-border services regarding data on road traffic and on traffic management.

5. TRANSPORT – SUSTAINABILITY

KPIs - Key Performance Indicators to facilitate sustainability and improvement actions

According to the strategic vision for the development of the country, as defined in the National Strategic Reference Framework, Bulgaria is facing the challenge to achieve a sustainable genuine convergence through high economic growth rates based on investments, a substantial increase of productivity and improvement of competitiveness.

Achieving these objectives can be perceived as indicators performing sustainability:

- To achieve and maintain a high economic growth rate by a dynamic economy in compliance with the principles of sustainable development
- To improve the quality of the human factor and reach employment, income and social integration levels, which would assure a high living standard.

By 2020, Bulgaria should have a modern, safe and reliable transport system in order to satisfy the demand for high-quality transport services and to provide better opportunities for its citizens and business.

6. TRANSPORT-PROMOTION OF RAIL, SEA AND INLAND WATERWAY

The objective of the activities outlined in the “Freight Transport Logistics Action Plan” is to assist the logistics sector of freight transport in order to achieve a long-term efficiency and



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growth by solving such problems as bottlenecks, pollution and noise, carbon dioxide emissions and the dependence on fossil fuels, which – in the absence of solutions – will expose the efficiency objective to a risk.

The Marco Polo Programme is one of the major European Commission initiatives in support of intermodal transport. It is iredted to reducing traffic congestions, avoiding freight traffic on roads or reassigning freight from road transport to other transport modes, which are more environment-friendly and have unused capacities, for instance short distance short-sea shipping, railway transport and inland waterways.

6.1. Incentives: Sea and inland waterway transport

Waterborne transport offers substantial opportunities to increase efficiency and improve environmental performance.

The European Commission published:

- in early 2009 the document titled “Strategic goals and recommendations for the EU’s maritime transport policy until 2018”
- in January 2009 the “Communication and action plan with a view to establishing a European maritime transport space without barriers”.
- in January 2006 the “Communication on the Promotion of Inland Waterway Transport “NAIADES” an Integrated European Action Programme for Inland Waterway Transport”
- The European Council assigned to the European Commission on June 19, 2009 the task to draft the “EU Strategy for the Danube Region, which is already a fact.

6.2. Incentives: Railway transport

The European Commission launched a series of initiatives in 2007 with the objective to achieve a higher efficiency in freight transport within the Community. This new package of measures included also the Communication of the Commission titled “Towards a European rail network for competitive freight” , followed in 2008 by a Proposal for a Regulation of the European Parliament and of the Council concerning a European rail network for competitive freight.

The Proposal for a Regulation contains provisions, covering the international management of the railway infrastructures, which otherwise could not be implemented individually by the member states.

The introduction of the EU road transport rules, for instance limits on driving time and freight limits, also may increase the attractiveness of railways, as freight operations by road will become more expensive if performed legally.

The requirements for protecting the environment will also become very important for Bulgaria; as a result, railways will become even more attractive. The volume of freight transported by railways will increase by 0.025 percent because of the higher environmental requirements. The results from the research on the options to change the transport mode used for freight, and the expected increase of the prices of fuels, electricity and labour define a future increase of road transport operating costs, compared to rail transport, and create conditions for changes when choosing the transport mode, especially for the purposes of long-term planning.



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7. INCENTIVES FOR SPARKING GROWTH AND FOR MOVING INTO NEW TECHNOLOGIES

Incentives for sparking growth and for moving into new technologies are:

- Institutional - Current legislative framework, its efficiency and effectiveness to spark growth and move economy into new technologies.
- Organizational - Regulatory and operational instruments (i.e. traffic management, control and information).
- Financial - Tools (i.e. taxation, pricing and licensing) and instruments (i.e. grants and subsidies).

The regulatory base in the field of the transport in the Republic of Bulgaria consists of the following laws and regulations:

- Railway Transport Act
- Roads Act
- Road Traffic Act
- Act on Maritime Space, Internal Waterways and the Ports in the Republic of Bulgaria
- Commercial Shipping Code
- Civil Aviation Act.

Harmonization of Bulgaria's legislation with the EU acquis was the main prerequisite for Bulgaria's accession and gaining a status of a full EU member state.

This transport policy align is the basic facilitating factor for developing the modern transport in Bulgaria in terms of new "green" freight transport corridors.

8. CONCLUSION

The favorable geographical position of Bulgaria is evident in view of the five Pan-European Transport Corridors - IV, VII, VIII, IX and X, passing through its territory. Bulgaria provides free access for all transport operators to various types of transport infrastructure. Railway freight transport is visibly lagging behind other transport modes although the introduction of the EU road transport rules (limits on driving time, freight limits) increase the attractiveness of railways. The requirements for protecting the environment are very strict in Bulgaria, which also increase the attractiveness for the railway transport.

Goals identified in two key strategic policies for freight transport in Bulgaria are economy efficiency, sustainable transport sector and regional and social cohesion improvement, i.e. providing an efficient and reliable transportation. The trend is for improving and developing the majority of the ports, airports and highways by concession.

Within priority "Reduction of the transport sector negative impact on the environment and human health" two measures are identified: Measure 1 Limiting harmful emissions and pollution and the negative impact on climate caused by the transport sector and Measure 2 Creation of a favorable environment and conditions for a substantial growth of intermodal transport.

Harmonization of Bulgaria's legislation with the EU acquis was the main prerequisite for Bulgaria's accession and gaining a status of a full EU member state.



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CONTAINERIZED CARGO FLOW ANALYSIS OF BRANCH B CORRIDOR V

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ABSTRACT

Traffic and geographical position of Croatia as Central European, Danube and Adriatic country, represents a significant potential for the development of transport and transformation of transport system. Due to its favorable geographical position Republic of Croatia should have a much greater and more important role in the transport of goods.

Planning and development of environmentally sustainable transport system requires development of new technologies that will have the greatest positive economic and social impact, and that will also minimize negative impact on the environment.

KEYWORDS

Transport system, cargo flows, planning

ANALIZA KONTEJNERSKIH ROBNIH TOKOVA NA KORIDORU VB

SAŽETAK

Prometni i zemljopisni položaj Republike Hrvatske kao srednjoeuropske, podunavske i jadranske zemlje, predstavlja značajan potencijal za razvoj prijevoza i transformaciju prometnog sustava. Zbog svog povoljnog geoprometnog položaja Republika Hrvatska bi trebala imati daleko veću i značajniju ulogu u prijevozu robe.

Planiranje i razvoj ekološki održivog prometnog sustava zahtjeva razvoj takvih novih tehnologija koje će imati najveći pozitivan ekonomski i socijalni učinak, a koje će istovremeno imati što manji negativni utjecaj na okoliš.

KLJUČNE RIJEČI

Transportni sustav, robni tokovi, planiranje

1. INTRODUCTION

Traffic and geographical position of Croatia as Central European, Danube and Adriatic country, represents a significant potential for the development of transport and transformation of transport system. Due to its favorable geographical position Republic of Croatia should have a much greater and more important role in the transport of goods.

Recently, volume of container transport has increased from three to four times. Today, more than 70% of goods are transported by containers, and the rest makes other goods.

Intermodal transport combines the best of all forms of transport, in the way that for long distances transport primarily uses means of transport which consume less energy per mass



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of freight and are thus cheaper (maritime and rail transport), while less energy-efficient and more expensive road transport is used only at short distances, on the initial and final stages of "door to door" transport system. Intermodal transport includes highly sophisticated transportation planning process and enables avoiding of empty ride and for that reasons intermodal transport imposes itself as one of the solutions for sustainable transport planning that will have the least negative impact on the environment and climate change.

2. ANALYSIS OF CARGO FLOW ON CORRIDOR V B

Basic framework of Croatian potential consisting of major international transport corridors which pass through Croatia and integrate Croatian transport network in Pan European Corridor Network and the European transport system. One of the corridors, which in this context is of vital importance to Croatia, is the Pan-European Corridor Vb on relation Rijeka-Zagreb-Budapest. Pan-European Corridor Vb relation Rijeka-Zagreb-Budapest is a transverse axis which links Central European area with the Adriatic and in the broader sense with the Mediterranean area, including the port of Rijeka as a referent transit point of corridors and road and rail communications in its land connections with Central European transit hinterland.

Despite above mentioned, Pan-European Corridor Vb to date has not been fully valorized and represents Croatian unused traffic and economic system capital. Pan-European Corridor Vb with scientifically based valuation of its benefits and the appropriate strategic direction for achieving greater efficiency and higher quality of transport services has potential for even greater competitiveness in the European market of transport services. Corridor Vb would increase numerous economic and traffic impacts for all Croatian participants in northern Adriatic transport linking with central Europe.

Table 1. Container flows on Vb corridor in Croatia

Transport Link	Ro - La	Length (km)	Time (h)
Rijeka - Zagreb	/	166	2, 37
Rijeka - Kotoriba	/	284	4

Source: made by authors

By analyzing transport time, the most important was the time achieved by road transport, because the rail transport transports significantly smaller number of containers.

Port of Rijeka is the largest port in Croatia, which in the Croatian port system does not have pronounced competition and is also a strategic transit point for Corridor Vb.

The most important transport routes for the port of Rijeka are Pan-European Corridors V and his branch b. The traffic direction to which the Hungarian, Czech, Slovak and the South Polish market are gravitating has largely been focused on the road Rijeka - Zagreb - Budapest on Corridor Vb. For this relation of 504 km by road it takes less than 6 hours thanks to a newly built highway. For the same relation train will travel about 24 hours and it will travel for 592 km.

According to available statistics shown in Table 2, in the last five years the Rijeka - Zagreb highway has seen a decline in number of freight vehicles, with the exception of the 2011 when the number was increased. Thus, in the 2012 number of freight vehicles on the part of the Corridor Vb from Zagreb to Rijeka was around 32% smaller compared to year 2008.



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Table 2. Average annual daily traffic of freight vehicles (AADT) on the highway Rijeka – Zagreb

daily traffic of freight vehicles (AADT)	2008	2009	2010	2011	2012
Zagreb-Rijeka	1101	1050	1005	1105	749

Source: made by authors

Table 3. Port of Rijeka distances in relations with cities on Vb corridor

CITY	ROAD DISTANCE (km)	RAIL DISTANCE (km)
ZAGREB	145	228
BUDAPEST	504	592

Source: made by authors

For the purpose of analysis of container traffic on Corridor Vb it is necessary to analyze logistics hubs and their capacities.

Table 4. HUB logistics nodes on corridor Vb in Republic of Croatia

Hub Name	Area (m ²)	TEU capacity	Roofed warehouse (m ²)	ICT services/description	Additional services/description
Rijeka	150 000	250 000	14 826	Navis system, TOS Terminal Operating System	Load and unloading CT, storage of container
Zagreb	41 000	30 000	550	IS Cargo	Load and unloading CT, storage of container
Kotoriba	33 500	10 000	3 500	In house solution (in Exel)	Load and unloading CT, storage of container

Source: made by author

Table 5. Port of Rijeka realized container traffic

Period of observation (year)	Container (TEU)
2008	168 761
2009	130 740
2010	137 048
2011	150 670

Source: made by authors

Only 15% of containerized cargo is transported by rail and the rest by road. It is an indicator of poor transport system because rail transport is the most efficient and environmentally friendliest mode of transport and is a key link in intermodal transport chain.



3. STAKEHOLDER ANALYSIS IN TRANSPORT PROCESSES

Table 6. Individual stakeholders in transport processes on the corridor Vb

COMPANY NAME	TYPE	SERVICES	WAREHOUSE	MODE OF TRANSPORTATION
JADRANSKA VRATA d. d. Adriatic Gate Container Terminal	Terminal	Load/unload, warehousing	135 505 m ² , 14 826 m ² of closed area	road, railway, sea, combined transport
HŽ Cargo d.o.o.	Railway transport	Transport of goods by rail	–	railway, combined transport
AGIT d.o.o., Zagreb	Intermodal transport	Intermodal transport	4 500 m ² , 850 m ² of closed area	road, railway, combined transport
Kuehne + Nagel Croatia d.o.o.	Logistics services	All transport and logistics means	16 000 m ² of closed area	road, railway, sea, combined transport
Cargo-Partner d.o.o.	Logistics services	All transport and logistics means	–	road, railway, sea, combined transport

Source: made by authors

Jadranska Vrata Corporation / AGCT are part of international corporations ICTSI from Manille / Philippines which is part of the industry acquisitions, development, management and operations at container ports and terminals worldwide. Jadranska vrata are a subsidiary of Port of Rijeka Corporation, which are concessionaire of container and Ro-Ro terminal in the Port of Rijeka. Annual capacity amounts more than 250,000 TEU and single capacity is 6,500 TEU.

Croatian railways HŽ Cargo perform public cargo transport in domestic and international rail and combined transport and all other support activities for transportation. HŽ Cargo has full ownership of AGIT Company which is engaged in organization of rail and road transportation, customs brokerage and providing freight forwarding services to domestic and international markets. AGIT Company is established in 1993. The reason is separation freight transport activity from the structure of Croatian Railways with the aim of improving transport and logistics services.

Kuehne + Nagel Croatia corporation has achieved its strong position in the market with jobs in maritime, air and road transportation and contract logistics, with a clear focus on providing services in value chain by using modern information technologies. The Kuehne + Nagel company was the first foreign freight forwarder company that has entered at Croatian market after thorough political transformation of the country.

Cargo-Partner corporation is a medium sized company with a constant growth specializing in transport with particular emphasis on maritime transport.

Port of Rijeka is the shortest land and sea link of Central and Central Eastern Europe with overseas destinations.

Table 7. Container traffic in Port of Rijeka

Year	Number of containers			TEU		Tones of goods in containers
	Total	Full	Empty	Full	Empty	
2009	84 334	51 173	33 161	75 552	47 821	876 836
2010	81 577	53 183	28 394	79 928	41 169	892 816
2011	87 290	57 521	29 769	86 155	42 233	980 577

Source: made by authors



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Table 8. Statistics of Jadranska Vrata Company

		Volume of container transport (TEU)	Number of regular weekly services	Share of lost cargo	Share of damaged cargo	Accidents	
						Major	Small
JADRANSKA VRATA COMPANY	2008	168 761	7	0.5 %	4 %	0 %	15 %
	2009	130 740					
	2010	137 048					
	2011	150 677					

Source: made by authors

Table 9. Statistics of HŽ Cargo Company

		Volume of container transport (TEU)	Number of regular weekly services (road)	Share of lost cargo	Share of damaged cargo	Accidents		Transport costs – intermodal transport (EUR)
						Serious	without consequence	
HŽ CARGO d.o.o.	2008	42 485	7	1 %	5 %	1%	25%	134 (20t)
	2009	30 803						
	2010	32 110						
	2011	27 594						

Source: made by authors

Table 10. Statistics of AGIT Company, Zagreb

	Average transport time (h/km)			Number of regular weekly services	Share of lost cargo	Share of damaged cargo	Accidents		Transport costs – intermodal transport (EUR)
	road	rail	Intermodal transport				Serious	without consequence	
AGIT company , Zagreb	0.014	0.05	0.05	7	1 %	5 %	1%	25%	230(20t)

Source: made by authors

Table 11. Statistics of Kuehne + Nagel Croatia, Zagreb

		Volume of container transport (TEU)	Total transport of goods (t)	Transport costs – road transport (EUR)	Transport costs – rail transport (EUR)	Average transport time by road (h/km)	Average transport time by road (h/km)	Average transport time by combined transport (h/km)
Kuehne + Nagel Croatia	2008	7500	51 700	107 (20t)	126 (20t)	0.014	0.05	0.05
	2009	4500	32 900					
	2010	5000	35 100					
	2011	5500	42 600					

Source: made by authors



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Based on interviews with logistics operators who are dissatisfied with the HŽ Cargo and 99% of container traffic performed by road transport, we got the results which highlight the most common problems that logistics operators meet. They proposed improvements through future directions for the development of transport HŽ system.

Development guidelines:

- Ordering wagons in the morning until 10 am for same day when container dispatch
- The existence of tariffs on container terminal Zagreb and quick and efficient process performance
- A sufficient number of available rolling stock
- Shipments should not be separated (if sender sent 12 containers all 12 must arrive to him in the same time)
- Agreed train composition should not be changed
- Cost of railway transportation, including price of truck manipulation and delivery from railway terminal to the final destination (doors), must be competitive with direct road transport

4. FUTURE DEVELOPMENT STRATEGY FOR THE SUSTAINABLE DEVELOPMENT

Vision and goals for the development of the transport system of the Republic of Croatia are incorporated in the Transport Development Strategy, which was ratified by the Croatian Parliament in 1999. As this strategy does not match current conditions, currently a new strategy is being prepared.

In March of 2011 the European Commission adopted a new package of measures with aim to improve competitiveness and efficiency of the European transport system. White Paper of the Single European transport area (White Paper: Roadmap to a Single European Transport Area) provides a variety of measures intended to improve the mobility of goods and passenger transport, reduce the burden on Europe's key transport hubs and increase the employment rate in the transport and related sectors.

With regard to transport, the emphasis is primarily placed on the improvement of the railway traffic, while emphasizing investment in medium-range routs (up to 300 km), and a threefold increase infrastructure for high speed trains. This continues a strategy to promote greater use of rail transport. Furthermore, according to a reconstruction plan of transportation the allocation of excise taxes among transport infrastructure users (for example, predicts the establishment of a European system of electronic toll collection, with a unique method and conditions of payment of tolls for all users of the road infrastructure), which would attempt to a certain extent harmonize excise tax on traffic infrastructure throughout the Union.

Promoting the principles of intermodality, EU seeks to integrate various modes of transport in the effective logistic chains in order of optimal usage of some transport sectors and to minimize traffic delays.

So it is necessary to shift 30% of road freight transport at distances longer than 300 km to other modes of transport such as rail and water transport by the year 2030 and by the year 2050 more than 50%, which should facilitate the establishment of efficient and green freight corridors. To achieve this goal, it will also be necessary to develop adequate infrastructure.

In road transport, for long distances, reduced carbon emissions are more limited, and it is necessary to make multimodal freight transport economically viable. An effective combination of different modes of transportation is needed. EU needs specially developed freight



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corridors, where energy efficiency is brought to the highest possible level, where the exhaust gases and the effect of transport on the environment are reduced to a minimum and are also attractive because of its reliability, restrictions of traffic congestion and low operating and administrative costs.

Railways are sometimes considered unattractive mode of transport in the Republic of Croatia, especially for freight. However, the examples in some Member States show that rail can offer a quality service. Offering structural changes to ensure the competitiveness of railways to take over substantial part of the transport on medium and long-distance (including passengers) is a challenge. It will require significant investments to expand and modernize the capacity of the rail network.

On the coast, it takes more efficient entry points to the European market, which will avoid unnecessary traffic across Europe. Seaports play an important role as logistics centers and their connections with the inland must be effective. Their development is the key to a successful response to the increased volume of cargo, both short-sea traffic connections which are transported within the EU, as well as those that are transported between the EU and the rest of the world. Inland waterways, which are not used, must play a greater role, especially in inland cargo transport and in European seas linking.

City of Zagreb is ideally positioned at the interface of trans-European routes TEN-T network -European Corridor X, Xa, Vb. Prerequisites for the real evaluation of this position is to build a high-speed railway line Rijeka-Zagreb - border, construction of the logistics distribution center and intermodal terminals in Zagreb. Better rail links with Central Europe, City of Zagreb will achieve with the construction of the so called Krapina railways.

Measures of development in intermodal transport:

- special act must declare reloading of equipment and means of transport in the intermodal transport system as equipment that favors environmental protection, which opens the possibility of using (customs and tax) easement;
- allocation of transport permits in international road transport should be made conditional with the use of RO-RO, RO-LA and Piggy-BACK technology in intermodal transport, as well as the establishment of cross-border companies to provide services in intermodal transport;
- lift the ban of road vehicles operation during the tourist season, in cases when the goods are transported in a system of intermodal transport;
- by state guarantees, HBOR affordable loans, the customs and tax incentives should allow companies easier procurement of equipment for intermodal transport;
- reduce the income rate tax earned on income in intermodal transport;
- subsidize fuel for ships and railways in the same amount that is set aside for road construction

5. CONCLUSION

Planning and development of environmentally sustainable transport system requires development of new technologies that will have the greatest positive economic and social impact, and that will also minimize negative impact on the environment.

After inland waterway transport, rail is the most efficient and environmentally friendly mode of transport and is a key link in the chain of intermodal transport. Unfortunately, in last twenty years development of railways in Croatia has not been a priority of Croatian government and circumstances are not good for the development of intermodal systems.



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Railway infrastructure is not equipped to take over the key role in intermodal transport, which would allow Croatian competitive and economical transportation system.

Today, the share of Croatia railways in total freight transport is around 15%, which is significantly lower than the European average. For using only road infrastructure to deliver cargo, Croatian logistics companies justify with the speed as a key factor in relation to other traffic solutions, because currently only the road infrastructure is at a satisfactory level of development.

As for container transport by rail HŽ Cargo is the only carrier, but there is still huge space for improvement. Kuehne + Nagel Croatia and Cargo Partner are leading operators in container traffic.

Unsatisfactory state of the transport system needs to be transformed into an efficient and competitive and fuel-efficient transportation system in the interest of the Croatian economy and implementation of European transport policy that is defined in the White Paper of the 2011.

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INNOVATIVE INFORMATION AND COMMUNICATION SERVICES FOR GREENER FREIGHT TRANSPORT

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ABSTRACT

Information and communication technologies and services represent one of the major factors of success in the development of greener freight transport. The success is particularly reflected through innovative information and communication services whose implementation in freight transport acts preventively on the eco system. Numerous information and communication solutions require adjustment and harmonization in order to improve the transport along certain traffic corridors. Most of the national documents for the traffic network development of the European Union member states have set the main goals of improving the current situation by implementing modern technologies. For this purpose it is necessary to allow the application of new technologies through the following services: development of route planners of freight movement, real-time information of stakeholders during transport, monitoring and tracking of freight, measuring and monitoring of the ecological impacts (consequences), integration with ERTMS system, integration with the administration systems of ports that have container terminals, maintenance of business processes, comprehensive knowledge bases about ICT tools, and development of green ICT strategy for short- and long-term goals in meeting the quality of service (QoS). The mentioned services can be unified and conceptualized by the application of new paradigm based on the cloud computing concept.

KEYWORDS

Information and communication services, green freight transport, cloud computing, XaaS models.

INOVATIVNE INFORMACIJSKO-KOMUNIKACIJSKE USLUGE ZA ZELENIJI TERETNI TRANSPORT

SAŽETAK

Informacijsko-komunikacijske tehnologije i usluge predstavljaju jedan od značajnih činitelja uspješnosti razvoja zelenog teretnog transporta. Uspješnost se posebno ogleda kroz inovativne informacijsko-komunikacijske usluge koje svojom primjenom na teretni prijevoz djeluju preventivno na eko-sustav. Brojna informacijsko-komunikacijska rješenja zahtijevaju prilagodbu i harmonizaciju u cilju poboljšanja transporta određenim prometnim koridorom. Većina nacionalnih dokumenata za razvoj prometne mreže država članica Europske Unije imaju za postavljene glavne ciljeve unaprijediti postojeće stanje primjenom suvremenih tehnologija. U tu svrhu potrebno je omogućiti primjenu novih tehnologija kroz slijedeće usluge: razvoj planera ruta kretanja tereta, stvarnovremensko informiranje dionika tijekom transporta, praćenja i nadzor tereta, mjerenja i praćenja ekoloških utjecaja (posljedica), integracija sa ERTMS sustavom, integracija sa sustavima lučkih uprava koje imaju kontejnerske terminale, održavanja poslovnih procesa, opsežne baze znanja o ICT alatima te izrada green ICT strategije za kratkoročne i dugoročne ciljeve u postizanju zadovoljavanja kvalitete usluge (QoS). Navedene usluge moguće je objediniti i konceptualizirati primjenom nove paradigme zasnovane na konceptu računalstva u oblaku.

KLJUČNE RIJEČI

Informacijsko-komunikacijske usluge, zeleni teretni transport, računalstvo u oblaku, XaaS models.



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1. INTRODUCTION

The intensity of the development of the traffic system in general, as well as the intensity of the development of intermodal freight transport require increased implementation of modified information and communication services. Using the information and communication services allows more efficient and optimal usage of the existing capacities, i.e. transport entities such as trucks, trains, barges, ships, and ports, intermodal centres, etc. In spite of the identified possibilities, the information and communication services are still insufficiently applied for freight transport requirements. There are numerous possibilities of the development and implementation, and these are reflected through different phases of the transport process. This is particularly seen in the inadequate correlation of different subsystems of freight transport as well as intermodal centres and ports from the aspect of communication and provision of the necessary information to all the stakeholders in real time. The information can be used before and during the transport having at disposal the services of pre-trip and on-trip information (via Internet network, GSM/GPRS/UMTS networks of mobile telephony, etc.) with the possibility of adaptive traffic management from the control centre. Relevant information can influence and/or improve the modal shift of freight transport, coordination between the transport modalities, allow better integration and act positively on the environment. One of the modern integrative approaches from the information and communication domain is the implementation of the cloud computing concept which ensures flexibility regarding the location of accessing computer resources. The paper proposes a concept of applying cloud computing for the stakeholders of freight transport that would allow omnipresent and adequate on-demand network access for sharing configurable computer resources, such as the network, servers, data storages, applications and services. The applicability is closely related to the interaction of the freight transport stakeholders and service providers and with the selection of the appropriate level of cloud computing services.

2. INFORMATION AND COMMUNICATION INFRASTRUCTURE AS FREIGHT TRANSPORT DEVELOPMENT FACTOR

By studying the trends of freight transport on the traffic corridors of the Republic of Croatia and the examples of good practice from the European Union, the key factors of sustainable development have been identified. The factors are reflected through the development proposals of Transport Infrastructure, Transport Services, Information & Communication Technologies and Services, Transport Market – Private sector and Environment [1]. For the development and establishment of a more efficient freight transport the application of information and communication technologies and services is a necessity. This necessity is reflected in all the phases of transport, and especially in planning and organizing where the stakeholders need reliable, accurate and timely information about the traffic system situation. Transportation supply chains involve hundreds of economic agents, and the freight transport stakeholders as potential users of information and communication services are national public administrations, railway transport operators, combined transport operators, terminal operators, port operators, railway infrastructure managers, motorway operators, IWW¹ transport operators, road transport operators, freight forwarders, 3PL, 4PL, shippers, etc.

¹ Inland Waterways



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Realization wide spectrum of services in ITS mean implementation of modern computers, sensors and communication systems. Therefore is especially important telecommunication infrastructure which is responsible for ensurance of maximum distributed backbone for interconnection of terminal equipment, signaling and sensor equipment in buildings, controll and information spots, as well as mobile terminals in vechicles and users in movement [2]. The information and communication infrastructure has to allow the accessibility of services the purpose of which is to inform the stakeholders about the route of movement of the traffic entity, real-time information of the stakeholders during transport, tracking and monitoring of freight, measuring and tracking of environmental impacts and possible consequences, integration with ERTMS – European Rail Traffic Management System, integration with systems of port administrations that have container terminals, maintenance of business processes, monitoring of the results of measuring CO₂ by means of ICT tools, etc. The research done in the international project GIFT2 [1] has consolidated the proposals that refer to the application of information and communication technologies and services on Corridor V (through the Republic of Croatia), and that are related to the road, rail, and maritime freight transport mode:

- Development / integration of telematic platforms for freight transport and logistics;
- Introduction of ITS (Intelligent Transport Systems) to streamline the logistic operations;
- Real time information system during the journey;
- Monitoring and cargo control;
- Monitoring and measuring of environmental impacts.

Construction and implementation of the integrated information and communication system inside subsystems freight transport contributes to:

- Faster and more efficient information exchange, briefing and remote access;
- Company's centralized database, security, archiving, surveillance and management system;
- Efficiency of entire business system by using: Business Intelligence (BI), Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM) systems;
- Integration, coordination and supervision of larger number of users, processes, flows and activities;
- Transfer of information from sensors that are placed on roads towards central office;
- Web access, video and IP telephony services [3].

3. CLOUD COMPUTING IN THE FUNCTION OF GREENER FREIGHT TRANSPORT

The information and communication technologies supporting the transport should be observed on the basis of the ICT infrastructure available to all stakeholders. Studying the freight transport issues and the possibilities of the implementation of different information and communication services, the need has been noted to have a unique platform that would have integration, financial and ecological effect. The mentioned synergic group of effects can be realized by the application of the cloud computing concept thus achieving rationalization at all levels of the application of the information and communication services. Cloud computing

² Green Intermodal Freight Transport in South East Europe region



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represents an aspect of computing where the scalable information and communication capacities and their possibilities are offered in the form of service with the usage of internet technologies to a large number of external users. The service users i.e. freight transport stakeholders need only to take care about what this service can do for them, and not how it is implemented. In order to monitor and identify freight in intermodal transport it is necessary to connect the systems based on GIS, GPS and GPRS technologies in combination with Cloud services. Figure 1 shows the cloud computing architecture and different transport process participants from the domain of freight transport, who, by means of wireless technologies, access the information and communication service by using adequate client. The application is accessed by means of different devices and interfaces (web browser).

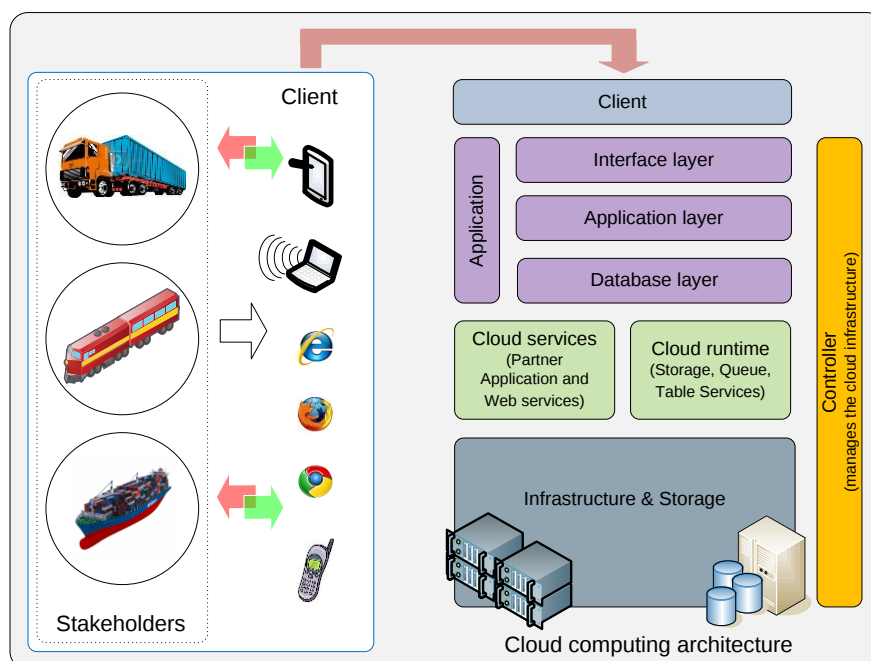


Figure 1. Cloud computing architecture

Source: Created by authors

There are four different models of cloud computing implementation and depending on the needs they are designed in four different ways: Public Cloud, Private Cloud, Community Cloud and Hybrid Cloud [4], [5]. Each of the mentioned methods has a different function, structure and control method, and they are interconnected by standardized or proper technologies that allow efficient transfer of data or applications [6], [7]. According to the classification of the National Institute of Standards and Technology (NIST) three basic services are known and they are designated as SPI model (*Software - SaaS, Platform - PaaS and Infrastructure - IaaS*) [8].

Figure 2 shows the stakeholders of freight transport and different levels of cloud computing that are based on the application, platform, infrastructure and possible sources of traffic data on a certain observed corridor or road.



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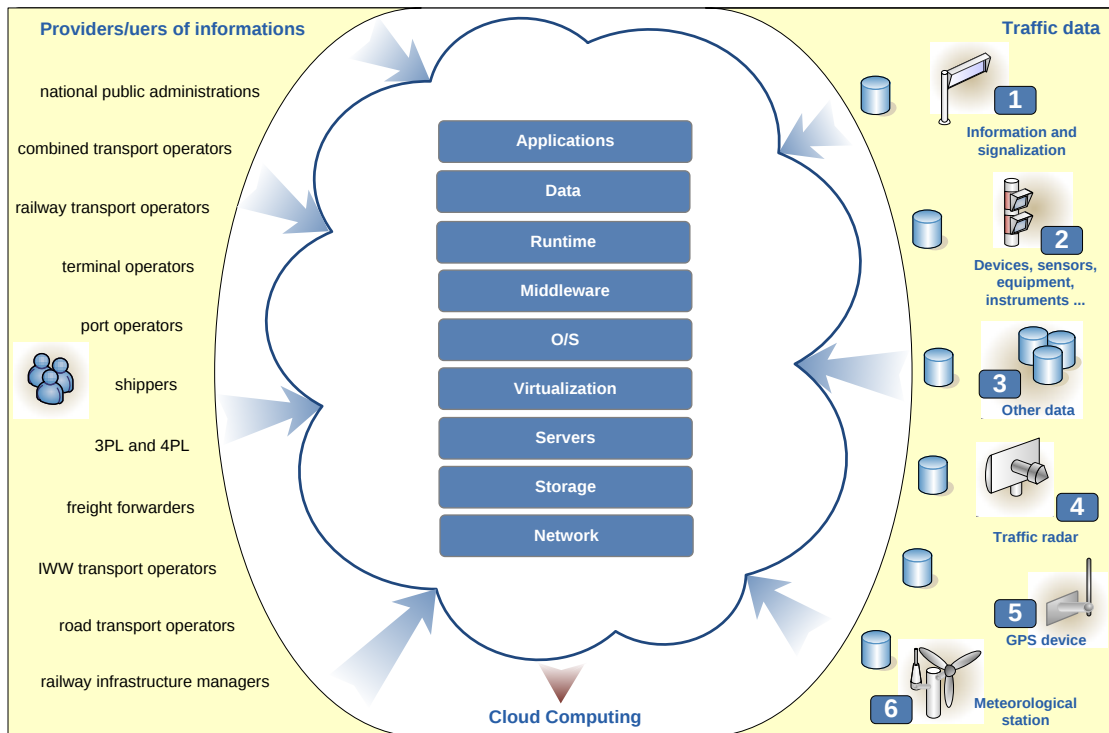


Figure 2. Freight transport stakeholders and different levels of cloud computing

Source: Created by authors

One of the most abundant is GIS CLOUD system whose operation is based on the mentioned technologies. Among others, one of the main advantages are daily updates and the ability to adapt to the system user requirements. Services based on Cloud principles could provide:

- Lower maintenance costs and system upgrades;
- Availability of data at any time;
- Data security, and
- Large number of users, etc.

Implementation of Track & Trace system could provide real-time information with the ability to define points of interest (POI) and use of SMS or email to obtain relevant information. The function of route planner's freight movement system is to monitor and route freight from one mode of transport (e.g. road) to another (e.g. rail) using RFID (Radio Frequency IDentification) and NFC (Near Field Communication) technologies. The obtained real-time information enables a more efficient transport system. Information and communication services and applications in freight transport represent a significant development and impact on the ecosystem:

- they can be used to facilitate the exchange of crucial business information on international scale;
- to realise the proactivity of the users and integral improvement of capacities;
- availability of real-time information, decision-makers do not have to wait long for the research results and changes in the transportation method of certain goods;



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- simpler collection of data using unique databases;
- simpler establishment and maintenance of contacts with the target groups;
- tracking and communication with the performers of certain transport processes;
- connecting of ports and intermodal centres with the environment (business partners/operators, other intermodal centres, regional scientific and research&development institutions, etc.) in the form known as “virtual organisation”;
- possibility of planning certain intermodal delivery (from – to), based on the valid data of different operators.

Further in the text the XaaS models (X as a Service) are explained as a platform for the delivery of information and communication services of freight transport stakeholders.

4. XAAS MODELS AS PLATFORM FOR THE DELIVERY OF INFORMATION AND COMMUNICATION SERVICES

The implementation of the model based on XaaS would allow the users to use the services of adjustment and usage of applications which can be found on the service provider's infrastructure. The service provider provides the application required by the user as well as the required hardware (servers, memories, processors, etc.). XaaS key characteristics include: high scalability, multi-tenancy, online and automated provisioning, device independence that (in many cases) enables users to access software regardless of what device they are using, location independence, term-based billing or pay-as-you-go models, etc. XaaS models for greener freight transport presented in Figure 3.

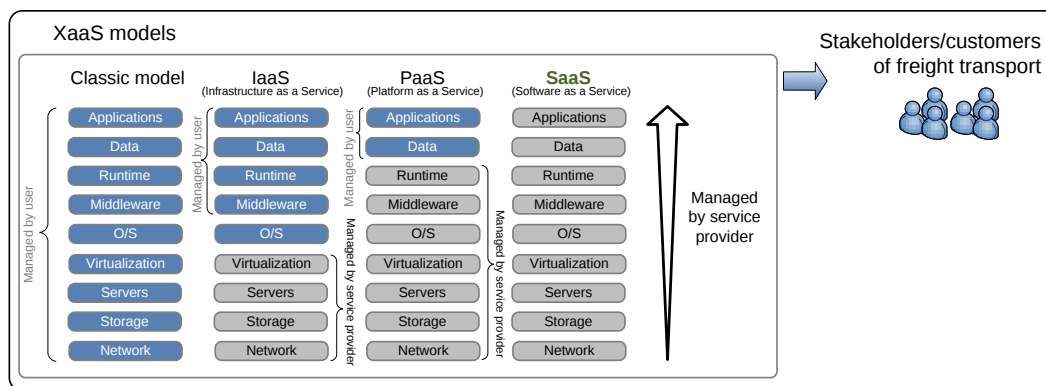


Figure 3. XaaS models for greener freight transport

Source: Created by authors

The concept of the PaaS (Platform-as-a-service) and SaaS (Software-as-a-service) models is reflected in service providers offering their customers complete services, both software and hardware platforms and the necessary user equipment “packaged” and offered on the market as a certain service. Besides many other mentioned advantages, a positive impact on environmental protection is achieved. The positive impact is expressed in the optimization of costs (the emphasis is on the fact that there is no need any more for CAPEX costs) and services of freight transport stakeholders for each single freight delivery, electronic connection of different groups of shipments, provision of unique digital identity of



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stakeholders, locations and products with individual access to different levels managed by the service provider.

5. CONCLUSION

The research has shown that XaaS is a very suitable platform, both for private companies and corporations in the domain of freight transport, and for the managers of the transport infrastructure. The study of XaaS platform has shown that the PaaS service model has the best predispositions for the implementation in case of intermodal freight transport. The implementation of the principles and services based on PaaS, minimal cost would be realized, and safe and reliable access to Cloud in the function of electronic data exchange that would make it possible for the freight transport, regardless of the transport mode, to be more efficient at all levels of activity. The efficiency of the freight transport affects directly the realization of the tendency to achieve sustainable and greener freight transport.

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DEA FOR GREEN INTERMODAL FREIGHT TRANSPORT EFFICIENCY EVALUATION: THE CASE OF SOUTH EAST EUROPE CORRIDORS

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ABSTRACT

DEA (data envelopment analysis) is a non-parametric linear programming method for determining the relative efficiencies of a set of decision making units (e.g. public transport companies) with multi-inputs and multi-outputs. The advantage of using DEA is that it does not require any assumption on the shape of the frontier surface and it makes no assumptions concerning the internal operations of a DMU. It is very often used in the transport sector for estimating the efficiency of airports, ports, railways and public transport companies. In order to make better assessment of green intermodal freight transportation, the aim of this paper is to applied DEA method to evaluate the relative efficiency of two green intermodal freight transport (GIFT) corridors (IV,V) of South East Europe. Input variables considered in this DEA problem are relative unit cost, transport time, delay risk, CO₂ and SO₂ emissions. Frequency of regular service is output variable. The application of this method aims at the identification of strengths and weaknesses of each GIFT Corridor and will pinpoints the actions that should be taken in order to improve their operational status and their transformation to Green Corridors.

KEYWORDS

Data Envelopment Analysis, corridor efficiency, green intermodal freight transport, South East Europe

DEA PER LA VALUTAZIONE DELL'EFFICIENZA DEL TRASPORTO MERCI INTERMODALE VERDE: IL CASO DEI CORRIDOI DEL SUD EST EUROPA

ABSTRACT

DEA (data envelopment analysis) è un metodo di programmazione lineare non parametrico per la determinazione delle efficienze relative di una serie di unità operative (ad esempio, le società di trasporto pubblico) aventi multi-input e multi-output. Il vantaggio di utilizzare la DEA è che non richiede alcuna assunzione sulla forma della superficie frontiera e non fa alcuna ipotesi riguardanti le operazioni interne di una DMU. E' molto spesso utilizzata nel settore trasporti per stimare l'efficienza di



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aeroporti, porti, ferrovie e aziende di trasporto pubblico. Al fine di effettuare una migliore valutazione del trasporto merci intermodale verde, l'obiettivo di questo lavoro, è quello di applicare la DEA per valutare l'efficienza di due corridoi (IV, V) del Sud Est Europa. Gli input considerati sono il costo unitario, il tempo di trasporto, il rischio di ritardo, le emissioni di CO₂ e SO₂. La frequenza del servizio è l'output. L'applicazione di tale metodo mira all'identificazione dei punti di forza e di debolezza di ogni corridoio e individua le azioni che dovrebbero essere adottate al fine di migliorare il loro stato operativo e la loro trasformazione in corridoi verdi.

KEYWORDS

Data Envelopment Analysis, efficienza dei corridoi, trasporto merci intermodale verde, Sud Est Europa

1. INTRODUCTION

Transportation accounts for 20% of all European Greenhouse Gas emissions (GHG) while freight transportation is responsible approximately for one third of the total transport GHG emissions according to Cefic & ECTA [1]. Furthermore, road freight transportation is the dominant mode of goods movement across the EU with a share of 76.4% as it represents a cost effective and flexible mode of cargo movement, while railway transportation has the second highest amount of inland freight transport¹ with a share of 17.1% in 2010, according to Eurostat [2]. Lastly, inland waterway transportation (IWW) was responsible for the 6.5% of total cargo movement in 2010, marking an increase of 0.5 % when compared to 2009 results (Eurostat [2]).

According to the European Environmental Authority (EEA), the share of road freight transport usage in the South East Europe (SEE) area exceeds the average percentage of road transportation in the EU27. This dominance, in SEE countries, may result due to poor infrastructure, delays in borders crossing, as well as lack of standards, and legal framework. However, road transport has a negative impact to the environment as it contributes with a share of 25.1% in the total GHG emissions of the EU27 according to Lammgard [3]. Furthermore, it is responsible for accident fatalities, increased noise level, and road congestion.

The main aim of the EU is to achieve a European transport system, which will address the current economic, social and environmental needs with a sustainable manner. Regarding transport industry, the European Union promotes various eco-friendly policies and strategies resulting from the White Paper, the Green Paper, Transport in 2050 and from the Euro vignette directive. In this framework, it is worth noting that the European Union, mainly under the TEN-T program, supports actions that promote modal shift and green transport.

To this end, the “Green Intermodal Freight Transport (GIFT)” project aims at enhancing green intermodality by focusing on the PEN Corridors IV, V and VII². The challenges to be addressed are as follows:

- In order to be a major player in global market, the SEE counties need to enhance their connectivity, especially with the emerging countries. Multimodal transport is an essential factor in this.

¹ Inland freight transport includes road, rail and inland waterways.

² Corridor IV is addressing routes similar to TEN-T corridor 7 (Motorway Axis Igoumenitsa/Patra-Athina-Sofia-Budapest) as well as TEN-T corridor 22 (Railway axis Athina-Sofia-Budapest-Wien-Praha-Number/Dresden)

Corridor V is addressing is addressing routes similar to TEN-T corridor 6 (Railway Axis Lyon-Trieste-Divaca/Koper-Ljubljana- Budapest-Ukraine border

Corridor VII is addressing routes almost identical to TEN-T corridor 18 (Rhine/Meuse-Main-Danube Inland waterway axis).



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- The excellence of infrastructure, ICT systems and operations of freight transport can address significant current issues such as environmental impact, cost and speed of freight transport in the region.

In this context, the main objectives of the project are as follows:

1. Identify the current status (census of existing network) of the GIFT freight transport network (e.g. infrastructure, assets, processes, ICT, industry, legislation, norms) and review policies and strategies in traffic decongestion, noise reduction and green transport
2. Support discussion platforms (public consultations) for communication and co-ordination between regional authorities and private service providers and their collective associations in order to assess current status of the GIFT transport corridors and suggest methods, techniques and tools to transform them into more efficient and environmental friendly (green corridors transformation)
3. Develop concrete proposals to enhance accessibility of freight in terms of speed, reliability, cost effectiveness, and promote regional/transnational sustainable and green development
4. Improve interoperability and intermodality of freight transport on land, IWW, and sea including harmonization across national borders and along key corridors in order to connect ports to landlocked countries
5. Promote green corridors in the GIFT network by promoting technical innovation in interoperability and multimodality, and a shift towards the least polluting and most efficient modes of transport
6. Develop an ICT tool for CO₂ footprint monitoring that will support the minimization of environmental impact
7. Develop transnational agreements, common measures and Memoranda of Understanding (MoUs) on multi-modal connections especially among agglomerations.

In order to support trade oriented economic development and to promote regional/transnational sustainable and green development, GIFT project has increasingly been under pressure to improve corridors efficiency by ensuring that corridor services are provided on an internationally competitive basis. Corridors form a vital link in the overall trading chain and, consequently, corridor efficiency is an important contributor to a nation's international competitiveness. Thus, monitoring and comparing one's corridor with other corridors in terms of overall efficiency has become an essential part of many countries' microeconomic reform programs.

This study hopes to contribute to this important task by applying an innovative approach to corridors efficiency ratings covering a selected sample of GIFT corridors based on DEA model.

Over the past three decades Data Envelopment Analysis (DEA) has emerged as a useful tool for business entities and organizations to evaluate their activities. Mathematically, DEA is a linear programming-based methodology for evaluating the relative efficiency of a set of decision making units (DMUs) with multi-inputs and multi-outputs. DEA evaluates the efficiency of each DMU relative to an estimated production possibility frontier determined by all DMUs. The advantage of using DEA is that it does not require any assumption on the shape of the frontier surface and it makes no assumptions concerning the internal operations of a DMU.



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In this study we have measured efficiency of two GIFT selected corridors of South East Europe, corridors IV, V, considering five inputs (relative unit cost, transport time, delay risk, CO₂ and SO₂ emissions) and one output (frequency of regular service).

The rest of the paper is organized as follows. Section 2 gives a brief review of related studies which have used DEA techniques in transport field. Section 3 introduces DEA model. Section 4 presents the results of empirical study conducted on two green intermodal freight transport corridors (IV, V) of South East Europe. Conclusions are reported in the final section.

2. LITERATURE REVIEW ON DEA IN TRANSPORT PLANNING

Many application of DEA can be found in literature. This method has been used in several contexts including education systems, health care units, agricultural production, and military logistics.

DEA has also been applied in various transport systems. A briefly literature review on studies that have applied DEA method to analyze transport systems efficiency is proposed, with particular attention to freight transport efficiency.

Chu et al., [4] use DEA to measure efficiency of selected bus transit systems in the united states. Roll and Hayuth [5] first tried to use DEA model in analyzing the efficiency of container ports. They evaluated the efficiency of 20 virtual ports through DEA with 3 inputs and 4 outputs. Martinez-Budria et al. [6] classified 26 container ports in Spain into three groups according to the level of complexity based on data from 1993 to 1997 and then evaluated the efficiency of those ports through DEA-BCC model with 3 inputs and 1 outputs.

Tongzon [7] uses DEA to measure efficiency of four Australian and twelve international ports. Valentine and Gray [8] also applied the DEA model with 2 inputs and 2 outputs to examine the efficiency of 31 container ports out of the world's top 100 container ports in 1998. Boile [9] extends previous work by considering variable returns to scale. She uses DEA to measure efficiency of 23 bus transit systems. Park and De [10] evaluated the efficiency of 11 Korean container ports with 2 inputs and 4 outputs.

Park [11] performed DEA/window analysis on 11 Korean container terminals during the five years from 1999 to 2002. Song and Sin [12] also evaluated the efficiency of 53 international major container ports using DEA based on data from 1995 and 2001.

Cullinane and Wang [13] use DEA for measuring the efficiency of 69 container terminals in Europe. Pjevcevic and Vukadinovic [14] measured efficiency of bulk cargo handling at river port.

3. FORMULATION OF THE PROPOSED METHODOLOGY

In this section we investigate the DEA model that we have applied for the study of corridors efficiency.

DEA is a linear programming (LP) based deterministic and non-parametric method for measuring the relative efficiency of DMUs (Decision Making Units) with multiple inputs and outputs. The DEA models most widely used in practice is the CCR. The CCR model assumes constant returns to scale (CRS). DEA models can be distinguished according to whether they are input-oriented or output-oriented (i.e. either minimizing inputs for a given level of output, or maximizing output for a given level of input).



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Charnes, Cooper and Rhodes [15] extended Farrell's [16] work in the measurement of technical efficiency and first introduced the term data envelopment analysis, known as the CCR model. Here we give the formulation of the model.

More formally, assume that there are n DMUs to be evaluated. Each DMU consumes varying amounts of m different inputs to produce s different outputs. Specifically, DMU j consumes amounts $X_j = [x_{ij}]$ of inputs ($i = 1; \dots; m$) and produces amounts $Y_j = [y_{ri}]$ of outputs ($r = 1; \dots; s$). The $s \times n$ matrix of output measures is denoted by Y , and the $m \times n$ matrix of input measures is denoted by X . Also, assume that $x_{ij} > 0$ and $y_{ri} > 0$.

Consider the problem of evaluating the relative efficiency for any one of the n DMUs, which will be identified as DMU0. Relative efficiency for DMU0 is calculated by forming the ratio of a weighted sum of outputs to a weighted sum of inputs, subject to the constraint that no DMU can have a relative efficiency score greater than unity. Symbolically:

Input-oriented CCR model

$$\max_{u,v} \frac{\sum_r u_r y_{r0}}{\sum_i v_i x_{i0}} \quad (1)$$

Subject to

$$\frac{\sum_r u_r y_{rj}}{\sum_i v_i x_{ij}} \leq 1$$

$$u_r, v_i \geq 0 \quad \text{for } j = 1, 2, \dots, n; \quad r = 1, 2, \dots, s; \quad \text{and } i = 1, 2, \dots, m$$

where u_r and v_i are weights assigned to output r and input i , respectively.

This fractional programming problem can be easily transformed into the following equivalent linear programming problem:

$$\max_{u,v} \sum_r u_r y_{r0} \quad (2)$$

Subject to

$$\sum_i v_i x_{i0} = 1$$

$$\sum_r u_r y_{rj} - \sum_i v_i x_{ij} \leq 0$$

$$u_r, v_i \geq 0$$

Alternatively, the same solution can be obtained by solving the dual problem of formula (2). The dual problem to the above multiplier form is the envelopment form, which can be written in the following vector-matrix form:

$$\min \theta \quad (3)$$



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Subject to

$$\theta x_0 - X \lambda \geq 0$$

$$Y \lambda \geq y_0$$

$$\lambda \geq 0$$

where θ is a scalar representing the efficiency score of the DMU₀ and λ is a $n \times 1$ vector of constants.

Similarly, the output-oriented CCR model can be written as follows:

$$\min_{u,v} \sum_i v_i x_{i0} \quad (4)$$

Subject to

$$\sum_r u_r y_{r0} = 1$$

$$\sum_i v_i x_{ij} - \sum_r u_r y_{rj} \geq 0$$

$$u_r, v_i \geq 0$$

also in this case, the same solution can be obtained by solving the dual problem of formula (4). The dual can be written in the following vector-matrix form:

$$\max \theta \quad (5)$$

Subject to

$$x_0 \geq X \lambda$$

$$\theta y_0 - Y \lambda \leq 0$$

$$\lambda \geq 0$$

Input-oriented efficiency scores range between 0 and 1.0, and whereas output-oriented efficiency scores range from 1.0 to infinity, in both cases 1.0 is efficient.

For the output-oriented model, we define the efficiency score as the inverse of the estimated score (i.e. θ^{-1}). If a DMU has efficiency score smaller than 1 then it is inefficient.

Inefficient DMUs can improve their performance to reach the efficient frontier by either increasing their current output levels or decreasing their current input levels. However, both desirable (good) and undesirable (bad) inputs or outputs may be present. For example, if inefficiency exists in production processes where final products are manufactured with a production of wastes and pollutants, the outputs of wastes and pollutants are undesirable and should be reduced to improve the performance. There are indeed at least four possibilities for dealing with undesirable outputs in the DEA-CCR framework. The first



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possibility is just simply to ignore the undesirable outputs. The second is to treat the undesirable outputs with a non-linear DEA model according to Fare et al [17]. The third is to treat the undesirable ones as outputs and to adjust the distance measurement in order to restrict the expansion of the undesirable outputs. The fourth is to treat the undesirable outputs as inputs.

Using the last method, we show that the standard DEA-CCR input oriented model can be used to improve the performance via decreasing the undesirable outputs. The method can also be applied to situations when some inputs need to be increased to improve the performance. In the next section we can see the application of DEA-CCR input oriented model to evaluate the efficiency of two selected GIFT corridors (IV,V) considering five inputs (relative unit cost, transport time, delay risk, CO₂ and SO₂ emissions) and one output (frequency of regular service). As we can see, we have treated the undesirable output (CO₂ and SO₂ emissions) as inputs in our model in order to obtain the efficiency measure of the two corridors and to observe how the emissions can be reduced in order to improve the efficiency of the corridor which results inefficient and to improve the transformation to Green Corridor.

4. CASE OF STUDY

The information obtained from GIFT project was analysed and gathered in order to prepare for an internal consolidation and selection process, which objective was to select two specific corridors, corridor IV and corridor V, which contain important data, especially KPIs data, for the evaluation of their relative efficiency with the application of DEA. This analysis involved two initial criteria, namely the available data on certain KPIs, such as relative transport cost, transport time, delay risk, frequency of regular service, as well as green indicators (CO₂ emissions, SO₂ emissions), and involving specific modes of transport like road and rail for each corridor.

Ranking of efficiency of GIFT corridors, that is obtained with the application of DEA model, is going to comply with the benchmarking methodology developed in Deliverable 3.3.1 Benchmarking of freight transport corridor [18] where a set of key performance indicators have been developed in order to identify key performance indicators (KPIs) of the two GIFT corridors (IV, V). The identified KPIs have been used as inputs and outputs in the DEA-CCR input oriented model for the selected corridors.

The measure of relative efficiency of each corridor will assess the level of performance of GIFT corridors in terms of green transport objectives achieved through sustainable transport based on cleaner fuels, tax incentives, good infrastructure and organisation.

Specifically, eighteen KPI-s divided in 4 categories (Service Efficiency, Service Quality, Infrastructure and Transport Business Players) have been elaborated during GIFT project.

For the purpose of efficiency measure based on DEA only the KPIs related to *transport operations* were used, and they have been estimated for each specific mode of transport (road, rail) for each corridor (IV, V), as we can see below:

1. Relative unit cost (cost of goods transported per ton-km)
2. Transport time (average transport time from node to node)
3. Delay risk (amount of serious disruptions like cancellations, strikes, etc.)
4. Frequency of regular service (number of service per week)
5. CO₂ emissions (total grams per ton-km that are emitted by transport activity)
6. SO₂ emissions (total grams per ton-km that are emitted by transport activity).



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In this numerical application is used the DEA-CCR input oriented empirical analysis for two GIF corridors (IV, V). The selected KPIs have been divided in five inputs and one output. The output measure used is one: frequency of regular service. The inputs measures used are five: relative unit cost, transport time, delay risk, CO₂ and SO₂ emissions. The data are listed in Tables 1 and 2 for each mode of transport.

Table 1. Values of the selected KPIs, divided in five inputs and one output per road mode on Corridor IV and V

Gift corridors	Mode	Relative cost unit (€/ton-km)	Transport time (h/100km)	Delay risk (min/100km)	Polluters CO ₂ (g/ton-km)	Polluters SO ₂ (g/ton-km)	Frequency of regular service (number of service/week)
Corridor IV	Road	0,04	1,49	20,28	72,76	0,09	14,00
Corridor V	Road	0,05	1,40	10,48	68,64	0,09	2,25

Table 2. Values of the selected KPIs, divided in five inputs and one output per rail mode on Corridor IV and V

Gift corridors	Mode	Relative cost unit (€/ton-km)	Transport time (h/100km)	Delay risk (min/100km)	Polluters CO ₂ (g/ton-km)	Polluters SO ₂ (g/ton-km)	Frequency of regular service (number of service/week)
Corridor IV	Rail	0,03	1,51	25,82	19,66	0,06	9,00
Corridor V	Rail	0,03	1,83	50,31	17,65	0,09	104,73

Source: SEE-GIFT Project

After applying CCR input oriented model to the selected inputs and outputs, the results of efficiency analysis on the two selected corridors are shown in Tables 3 and 4 for road and rail mode. To practically improve the efficiency of corridors, decreasing the given inputs may be more appropriate than increasing changeable outputs. Therefore, this study selected the input-oriented CCR model to measure technical efficiency. DEA Excel Solver, the widely used DEA software, is used for the analysis. As shown in Table 3, the efficiency index of Corridor IV is equal to 1 (100%) while Corridor V has an efficiency index smaller than 1 (31%). In Table 4 the efficiency index of corridor IV is smaller than 1 (17%) while corridor V has an efficiency index equal to 1 (100%).

Table 3. Relative efficiency measures using DEA (CCR input oriented) per road mode for Corridor IV and V

DEA-CCR input-oriented	Mode	Efficiency (%)
Corridor IV	Road	100%
Corridor V	Road	31%



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Table 4. Relative efficiency measures using DEA (CCR input oriented) per rail mode for Corridor IV and V

DEA-CCR input-oriented	Mode	Efficiency (%)
Corridor IV	Rail	17%
Corridor V	Rail	100%

As shown in Tables 5 and 6, the corridors that are inefficient (Corridors V for road mode and Corridors IV for rail mode) can increase their efficiency score decreasing properly their input values. In fact the application of DEA-CCR input oriented model allows to determine, for a given value of output, the optimal reduction of inputs in order to reach the corridors the efficiency of 100%. In the first row of Tables 5 and 6 are reported the original values of the inputs, in the second row are reported the values of the inputs properly reduced by the application of DEA to increase the efficiency score of corridors IV and V.

Table 5. Potential improvment of Corridor V through the reduction of inputs by DEA

Gift Corridor	Mode	Relative cost unit (€/ton-km)	Transport time (h/100km)	Delay risk (min/100km)	Polluters CO ₂ (g/ton-km)	Polluters SO ₂ (g/ton-km)
Corridor V	Road	0,05	1,40	10,48	68,64	0,09
		0,01	0,44	3,26	21,35	0,03

Table 6. Potential improvement of Corridor IV through the reduction of inputs by DEA

Gift Corridor	Mode	Relative cost unit (€/ton-km)	Transport time (h/100km)	Delay risk (min/100km)	Polluters co ₂ (g/ton-km)	Polluters so ₂ (g/ton-km)
Corridor IV	Rail	0,03	1,51	25,82	19,66	0,06
		0,01	0,25	4,32	3,29	0,01

Obviously, corridor IV in road mode and corridor V in rail mode will not change in anyway their inputs values because they are already operating in their optimal condition.

We conclude by highlighting that the reduction of the input values for inefficient corridors will also lead to an increase in performance in terms of green transport objectives achieved through sustainable transport based on cleaner fuels which will reduce emissions of pollutants, tax incentives, good infrastructure and organisation etc.

5. CONCLUSIONS

This study is an attempt to provide a satisfactory answer to the problem of making efficiency comparisons across corridors of South East Europe by applying the DEA analysis to a sample of GIFT corridors (IV, V) for which relevant data are available. DEA has recently been successfully applied to a number of different economic efficiency measurement situations.



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The technique offers a significant alternative to classical econometric approaches to extracting efficiency information from sample observations, such as the use of stochastic frontier production functions.

Important features of DEA are that the technique is non-parametric and that more than one input and output measure can be specified. In the case of corridor efficiency, the ability to handle more than one output is particularly appealing because a number of different measures of corridor output are available, depending on which features of corridor operation are being evaluated.

This study has shown the suitability of DEA for GIFT corridor efficiency evaluation and produced useful findings for certain corridors. Further methodological issues will be investigated in order to take into account in the DEA method also imprecise or approximate data. As we mentioned, DEA models allow us to evaluate the current level of efficiency of each GIFT corridor and to identify the strength and weakness of each corridor and eventually to suggest an efficient way of benchmarking to inefficient corridors. Despite of the above implication, we still need to conduct further studies as follows.

Firstly, we just used 5 inputs and 1 output in our DEA model to measure the technical efficiency of corridors IV and V using two different transport modes: road and rail. This is a very restrictive model and it is therefore required to conduct various studies for models with various and different inputs and outputs. Secondly, it is also required to perform DEA/Window analysis with time-series data in order to see how the efficiency for corridors will change in the future periods of time. Ranking of efficiency of GIFT corridors IV and V applying DEA-CCR input oriented model was based on certain properly selected key performance indicators (SEE-GIFT project).

The results clearly show lowest performance level of GIFT corridor V compared gift corridor IV (road mode) while, for rail mode, gift corridor IV is inefficient compared to corridor V.

Through DEA-CCR input oriented analysis we can reduce the inputs values of inefficient corridors to increase efficiency score and, contemporary, to improve their operational status and their transformation to Green Corridors.

Promotion of intermodality, purchase of new trucks, and use of high quality fuels, along with better road conditions (especially on corridor V), may contribute to reduction of CO₂ pollution emitted by road transport. Far more extensive measures should be taken in railway transport to complete electrification of railway corridor and replace old diesel traction units as well as to solve insufficient railway capacities entailing bad transport optimisation and resulting in higher CO₂ emissions (especially on corridor IV).

However, we can consider the road and railway results very reliable.

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OVERVIEW OF TRANSPORT REGULATIONS IN CROATIA: BASIS FOR DEVELOPMENT OF GREEN TRANSPORT

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ABSTRACT

This paper reviews strategy documents and policy statements as well as regulations and identifies the key objectives and strategic orientations of these documents. Policy objectives and actions laid down in these documents have an objective to enhance mutual integration and interconnection of all Croatian transport systems for better access to European transport corridors and better integration with transport network of the neighbouring countries, while respecting environmental protection criteria.

KEYWORDS

regulation, green transport, combined transport, transport planning

PREGLED PROMETNE REGULATIVE U REPUBLICI HRVATSKOJ: PODLOGA ZA RAZVOJ ZELENOG PROMETA

SAŽETAK

U radu je dan pregled strateških dokumenata kao i propisa, te su identificirani glavni ciljevi i strateške smjernice navedenih dokumenata. Ciljevi i aktivnosti propisani u ovim dokumentima imaju cilj unaprijediti međusobnu integraciju i povezati hrvatski prometnih sustava u jednu cjelinu u svrhu bolje povezanosti s europskim prometnim koridorima i boljom integriranosti s prometnom mrežom susjednih zemalja poštujući pritom kriterije zaštite okoliša.

KLJUČNE RIJEČI

propisi, zeleni promet, kombinirani promet, planiranje prometa

1. INTRODUCTION

For planning of green transport networks a clear development conception at the national and international level of the whole transport system is needed. In achieving this goal as one of the main problems fragmented development of different transport sectors is recognized together with lack of consideration of real conditions and an exclusive emphasis on the financial resources of the public sector. Basis for the planning and development of transport system is laid down in different strategy documents and policy statements.

A number of policy documents, both national and international, determine the orientations of Croatian transport system. In the following chapters the review of existing Croatian strategy documents and policy statements as well as regulations related to planning and development of green transport network is given.



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2. STRATEGY DOCUMENTS AND POLICY STATEMENTS

Importance of transport has been identified in different strategy documents and policy statements in Croatia. Enhancing mutual integration and interconnection of all internal transport systems for better access to European transport corridors and better integration with transport network of the neighbouring countries, while respecting environmental protection criteria, is one of the measures set by the *Strategy for sustainable development of the Republic of Croatia* (OG¹ 30/09). The policy objectives and actions are laid down particularly in the following documents:

- Transport development strategy of the Republic of Croatia, (OG 139/99)
- Transport development strategy "Croatia in 21st century" (CG, 2002)
- National railway infrastructure programme for the period 2008-2012 (OG 31/08)
- River transport development strategy of the Republic of Croatia, 2008-2018 (OG 65/08)
- Mid-term plan for development of inland waterways and inland ports in the Republic of Croatia, 2009-2016 (MPPI, 2008)
- Pre-accession maritime strategy of the Republic of Croatia (MPPI², 2005)
- Physical planning strategy of the Republic of Croatia (1997, amendments OG 76/13)
- Physical planning programme of the Republic of Croatia (OG 50/99, 84/13)
- Strategic development framework 2006-2013 (CODEF,³2006)
- Strategic coherence framework 2007-2013 (CODEF, 2007)
- Program for the construction and maintenance of public roads 2009-2012 (CG,⁴ 2009)
- Strategy for sustainable development of the Republic of Croatia (OG 30/09)
- Strategy plan of Ministry of economy 2013-2015 (MINGO,⁵ 2012)
- Strategic framework for the development of the public private partnerships (Croatian Ministry of the economy, labour and entrepreneurship, 2008)
- Strategy of Government programmes 2013-2015, (MFIN,⁶ 2012)
- Regional development strategy of the Republic of Croatia 2011 – 2013, (Croatian Ministry of regional development, forestry and water management, 2010)
- Strategic plan of the Ministry of maritime affairs, transport and infrastructure 2013-2015 (MPPI, 2013)

New National transport development strategy is currently in the process of drafting, and it is expected that it will be constituted as part of the single transport market of the EU.

¹ OG – Official Gazette of Republic of Croatia

² MPPI – hrv. *Ministarstvo Pomorstva, Prometa i Infrastrukture*, eng. Ministry of maritime affairs, transport and infrastructure

³ CODEF - Central Office for Development Strategy and Coordination of EU Funds, now Croatian Ministry of regional development and EU funds

⁴ CG – Government of the Republic of Croatia)

⁵ MINGO – hrv. *MINistarstvo GOspodarstva Republike Hrvatske*, eng. Ministry of the economy Republic of Croatia

⁶ MFIN – hrv. *Ministarstvo FINancija Republike Hrvatske*, eng. Ministry of finance of the Republic of Croatia



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2.1. Strategy for sustainable development of the Republic of Croatia (OG 30/09)

The Strategy for Sustainable Development is a crucial document that directs long-term economic and social development as well as environmental protection towards the sustainable development of the ROC. The strategy integrates different development policies into the components of sustainable development: economic, social and environmental; and establishes the fundamental principles and guidelines for determining the objectives and priorities in considering the long-term transformation towards sustainable development of the country. The Strategy also indicates the method and responsibility for monitoring implementation.

Analysing *Strategy for sustainable development of the Republic of Croatia (OG 30/09)* and *Croatian Strategy of Government programmes for period 2012-2014*⁷ where one of the general objectives for achievement of strategic objective⁸ is balanced regional development (general objective 3), under which specific objectives are identified, transport system development being one of them, the following key performance indicators that facilitate sustainability and action improvement are identified:

- *Transport infrastructure.* Main national transport terminals are currently in the process of surface area enlargement/optimisation which correlates with the capacity and realized transshipment volumes, i.e. the larger the surface is, the higher the capacity and realized volumes generally are. Also, one of the objectives is also improvement of roads, rail gauges, and inland waterways which will enhance terminal connections.
- *Time.* Except investments in transport infrastructure there are also investments in transport suprastructure (ship, cranes, trains), which reflects in optimisation of average time for loading/unloading from ship/truck/train, average dwelling time per transport unit in the terminal, turnaround time, total waiting time, total time, average transshipment time, etc. Also, improvement in quality and quantity of roads, rail gauges, and inland waterways will ensure shorter travel time.
- *Accessibility / connection.* Maintaining and increasing the frequency of existing services and introduction of new lines ensures better mobility of the population, faster and more economical cargo transport, uniform development of regions, the association of different types of traffic, i.e. intermodal transport and encourages tourism development.
- *Transport fleet size and average age.* To enhance service quality, of passenger and freight transport, measures are adopted to help operator, by subsidising, to construct and to modernize transport fleet (e.g. in the maritime sector around 10 passengers ships were constructed, on rivers vessels on the ferry crossings (areas without bridges) are being modernized and maintained, construction of tourist boat on the River Danube), and to improve economic activity by renewing transport fleet.
- *Safety and security.* Implementation of different system to manage and control traffic is in the process of establishment or is already functioning (e.g VTMIS, RIS, tachograph, etc.), system informatization. In order to increase the competitiveness of

⁷ Strategy of Government programmes for period 2012-2014 is a document composed by the Croatian Ministry of finance on the basis of Strategic plans of different ministries; all Croatian ministries are obligated to construct Strategic plans according to the Budget Act (OG 87/08, 136/12). Strategy is available at: public.mzos.hr/fgs.axd?id=18603, 06.02.2013.

⁸ Strategic objective set by the Strategy is: Growth and employment in a competitive market economy that operates in the European welfare state of 21 century.



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domestic (road) carriers and to prevent illegal performing public road transport, in the coming period is planned to create single register of the carrier, which will consolidate all the data on the number and quality of licensed carriers.

- *Energy efficiency.* There are several approaches to change transport dependence on oil, to reduce local, regional and global pollution, and to decrease energy consumption, defined by the Croatian National energy efficiency program 2008-2016. Croatia has already adopted Biofuels Act (OG 65/09) and subordinate regulations, it is necessary also to provide the infrastructure for the use of alternative fuels (electric vehicles liquefied petroleum and compressed natural gas). One of the approaches for energy efficiency stated is also traffic congestion taxation at the local level. Intensive public awareness campaign on the promotion of the use of energy-saving vehicles, energy-efficient driving, and using public transportation and promoting the use of different modes of transportation can be introduced is needed. Also, at the local level to encourage sustainable planning transport systems, which includes increasing the number of bike trails and improving public transport infrastructure. Through sector policy MPPI is responsible body for enforcement of energy efficiency in the transport sector and the use of biofuels in transport.
- *Transport emissions of greenhouse gases.* Reduction of emissions gasses, especially CO₂ and NO_x as well as other pollutants, by redirect traffic from road to more energy efficient and environmentally friendly transport modes (inland waterways, railways, MoS)
- *Intellectual capital.* Encouraging education and specialist training of sufficient personnel in transport, by awarding scholarship, the required level of knowledge and skills is achieved, to provide quality of transport services. Since 2006 scholarships and fellowships are awarded to scholars of secondary schools and students of maritime faculties, and this practice is going to continue. Also, MPPI will help in provision of necessary equipment to maritime schools and faculties, according to new international standards.
- *Sustainability.* Protection of the environment from pollution, e. g by establishing a sustainable system of oily water, sewage water and waste from ships and equip all ports for public transport and nautical port with appropriate devices and equipment for such acceptance, and moderate use of natural resources.
- *Networking and cooperation with international organizations.*
- *Integrated transport development.* Development of transport sector as a whole, using integrated approach through territorial cohesion, to enhance accessibility and connectivity by exploiting the inherent characteristics of different developmental areas.

2.2. Transport development strategy of the Republic of Croatia, (OG 139/99)

The Transport development strategy was the first long-term transport system development study for enactment in the independent and sovereign state of Croatia. This strategy planned investments of up to 5% of GDP in the transport sector for the period 1999-2010, 25% of which would be devoted to maritime and river transport and 10% to multimodal transport. The main strategic goals put forward by this strategy are: (i) the appropriate evaluation of the advantages of the Croatian geopolitical position as a part of the European network of major transport routes, (ii) the interconnection of Croatian regions, particularly its coastal and continental parts, (iii) the integration of the Croatian economy into the



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international division of labour, (iv) the creation of enabling environment for investment of foreign capital and for credit support of international finance institutions (IFIs) for the development of transport infrastructure, (v) the restructuring of large state-owned companies by applying market principles in their business operations, and (vi) the administration organisation, construction and usage of transport infrastructure facilities particularly those considered as or located on a public property.

New National transport development strategy is currently in the process of drafting, and it is expected that it will be constituted as part of the single transport market of the EU.

2.3. Transport development strategy "Croatia in 21st century" (CG, 2002)

This strategy defines the general framework and guidelines for the overall development and the transport sector in Croatia. The main objectives highlighted in this strategy are: (i) better integration in the trans-European transport network, (ii) fair pricing in transport, (iii) environmental protection, (iv) transport safety, (v) social cohesion, (vi) internal market growth, (vii) growth of the external market dimension, and (viii) a justified deregulation of the transport market. The long-term objective is to improve the competitiveness and efficiency of the transport sector on both international and domestic markets, including the restructuring of state enterprises in transport and infrastructure.

2.4. National railway infrastructure programme for the period 2008-2012 (OG 31/08)

National railway infrastructure programme defines priorities for the development, construction, modernization, renovation and maintenance of railway infrastructure system functionality and determine plans for the construction of new and modernization and maintenance of the existing rail network, sets priorities and their implementation schedule and the amount and sources of the required funds.

Programme defines eight objectives: (i) technological improvement and harmonisation of rail infrastructure on railway lines for international traffic in accordance with the demands set for the trans-European conventional rail network, (ii) technical and technological harmonisation of railways of regional and local importance and their capacity in accordance with actual needs, (iii) harmonisation of entire national transport sector by coordinating development of the railway infrastructure, maritime and river ports and combined transport (iv) to increase the role of railways in the suburban and urban traffic of large cities, (v) to increase the volume and efficiency of railway transportation by construction, modernization and reconstruction of railway infrastructure, (vi) to provide an adequate level of maintenance of functional and security infrastructure subsystems and timely renovation and modernization of old and obsolete railway lines and facilities, (vii) complete and functional computerization of railway infrastructure system and increase the efficiency and quality of service, (viii) to create a sustainable and stable system of financing the construction, modernization, renovation and maintenance of the railway infrastructure.

Due to the inadequacy, deterioration, outdated and long-term dilapidation of rail infrastructure the Programme highlights that in order to achieve these objectives considerable financial resources are require and predicts at least three to four mid-term planning periods for its achievement,



2.5. River transport development strategy of the Republic of Croatia, 2008-2018 (OG 65/08)

Main functionality problem of river transport defined in this Strategy and in the Transport development strategy of the Republic of Croatia from 1999 is disintegrated network. As a result a long-term development plan of network integration within the combined river-maritime Danube-Adriatic corridor is set.

European Action Programme for Inland Waterway Transport (NAIADES⁹) which sets the frame for a comprehensive inland waterway transport (IWT) policy by focusing on five strategic interdependent areas: (i) markets, (ii) fleet, (iii) jobs and skills, (iv) image and (v) infrastructure is integrated into the Croatian River transport development strategy from 2008 through six areas: (i) safety of navigation and environmental protection, (ii) markets, (iii) infrastructure, (iv) shipping, (v) employment and education, (vi) administrative capacity.

2.6. Mid-term plan for development of inland waterways and inland ports in the Republic of Croatia, 2009-2016 (MPPI, 2008)

For the purpose of the implementation of the above described River transport development strategy Mid-term plan for development of inland waterways and inland ports in the Republic of Croatia was passed in December of 2008. It represents national action plan on the level of infrastructure of inland waterways water and inland ports providing an overview of all activities on the inland waterways network and in the inland ports and harbors of the state and regional importance. Plans can be divided into two main directions: (i) achieving a higher level of competition and quality of the existing network of inland waterways (improving maintenance, removal of bottlenecks and technological modernization of the marking system and navigational signals system, and (ii) achieving faster and more harmonious construction of inland waterways of European standard, within TEN-T network, in accordance with the principles of the European transport policy.

2.7. Pre-accession maritime strategy of the Republic of Croatia (MPPI, 2005)

This Strategy derives from the Transport development strategy of 1999 described above, taking into account the then present status (2006), the foreseeable overall development strategy of the ROC, as well as EU's opinion and related decisions on the principles, priorities and conditions contained in the European partnership with, and future accession of, Croatia. The strategy highlighted several goals and related measures across four areas:

- *Maritime safety, security and environmental protection:* (i) increase of the level of safety on board Croatian-flagged ships and their inclusion in the Paris MoU white list, (ii) Recognition of the CRS, (iii) Introduction of the vessel traffic monitoring and information system (VTMIS), (iv) Environmental protection in the Adriatic sea and in ports, (v) Harmonisation of maritime legislation in line with the EU's legislation, and (vi) Strengthening of administrative capabilities.
- *Seafarers:* (i) maintaining high standards in maritime education and training (MET) and certification of seafarers, (ii) Keeping an appropriate record of employment of seafarers and inclusion of seafarers engaged in international trade on board Croatian ships into the system of health and social insurance, (iii) Improvement of standards

⁹ NAIADDES - Navigation and Inland Waterway Action and Development in Europe.



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and safety of work on board Croatian ships, (iv) Environmental protection in the Adriatic sea and in ports, and (iv) incentivising and motivating students towards the choice of seafaring professions.

- *Shipping*: (i) Increasing the frequency, reliability and quality of shipping services between the mainland and the Islands, (ii) Establishing public service contracts and a related procurement framework for those services, (iii) Renewal and modernisation of the Croatian fleet, (iv) Reflagging of Croatian-owned ships back to the Croatian flag, and (iv) Adjusting the Croatian shipping legislation to relevant EU legislation and programmes.
- *Ports*: (i) Modernising the port of Rijeka towards increasing transit and containerised cargo traffic, (ii) Building of the new passenger and RoRo terminal in the port of Zadar, (iii) Building of supplementary seasonal (summer) berths in the port of Split, (iv) Modernizing and reconstruction of the passenger terminal in the port of Dubrovnik, (v) Encouraging the introduction of new cross-Adriatic shipping lines between the ports in the region, (vi) Installation of appropriate port reception facilities, and (vii) Harmonising the Croatian port's legislation to relevant EU legislation.

2.8. Physical planning strategy of the Republic of Croatia (1997, amendments OG 76/13)

Physical Planning Strategy of 1997 with amendments of 2013¹⁰ sets out long-term objectives of spatial development and physical planning in conformity with the overall economic, social and cultural development of the country. The strategy defines the basic objectives and entities in charge for spatial development planning and outlines the essential elements for the harmonization and organisation of physical planning documents. It represents a basis for decision making considering interventions in the environment and physical planning of smaller units and plans at local levels.

2.9. Physical planning programme of the Republic of Croatia (OG 50/99, 84/13)

For the purpose of the implementation of the above described Strategy in 1999 The Physical Planning Programme was passed and in 2013 it was amended¹¹. The program sets more closely main objectives, criteria and guidelines for spatial and other units planning, it also proposes priorities for achieving spatial planning objectives. It provides a basis for the organization, protection, land use and planning, the system of central places, system of developed national infrastructure, and measures and guidelines for environmental protection and promotion.

2.10. Strategic development framework 2006-2013 (CODEF, 2006)

The Strategic Development Framework (SDC) for 2006-2013, which was approved by the GOC in 2006, defines national economic goals and instruments for their implementation with the overall aim of achieving economic growth through competitiveness and employment. Goals and instruments defined in the document are drafted in accordance with the determination of Croatia to become a full member of the EU and its obligations arising from

¹⁰ Decision on Amendments to the Physical Planning Strategy (OG 76/2013)

¹¹ Decision on Amendments to the Physical Planning Programme (OG 84/2013)



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this process. The main point of the SDC for 2006-2013 is that Government's driven growth is not sustainable in the long run, and that the private sector should become the main driver of the future economic growth. To this end, simultaneous and coordinated actions are required in 10 strategic areas (entrepreneurial climate; efficient labour and education; science and ICT; transport and energy infrastructure; spatial planning, protection of nature and environment, regional development, and social cohesion and justice), seven of which are directly relevant for the SCF and more specifically components III and IV of the IPA programme.

2.11. Strategic coherence framework 2007-2013 (CODEF, 2007)

The Strategic Coherence Framework (SCF) represents one of the programming documents that serve as a reference point for the use of EU assistance in Croatia. SCF represents an umbrella strategic document that regulates the priorities within components III and IV of the Instrument for Pre-accession Assistance (IPA) programme, i.e. in the areas of infrastructure investment in environmental protection and transport, economic development and enhancing competitiveness, and employment and education. Priorities are further elaborated in sectoral implementation documents: the Environmental Protection Operational Programme, the Regional Competitiveness Operational Programme, the Transport Operational Programme and the Human Resource Development Operational Programme. Individual administration bodies are responsible for the preparation of these programmes within the scope of their sectoral responsibilities and according to EU strategic guidelines. As far as the maritime sector is concerned, the reference documents under the SCF are the IPA Transport Operational Programme of 2007-2009 and the draft IPA Transport Operational Programme of 2007-2013, although the focus of both documents is on railway and inland waterway developments.

2.12. Program for the construction and maintenance of public roads 2009-2012 (CG, 2009)

Program for the construction and maintenance of public roads is a four-year program adopted by the Croatian Government on the proposal of the Ministry of Maritime Affairs, Transport and Infrastructure. According to the Public Roads Act (OG 84/11, 22/13, 54/13) Programme presents a mid-term plan for development (planning, construction and maintenance) of public roads, while long-term plan is defined by the Strategy of public roads development passed by Croatian Parliament. Short-term plans (annual plans) are defined by the Plans of construction and maintenance prepared by Hrvatske ceste d.o.o for state roads and Hrvatske autoceste d.o.o. for motorways.

2.13. Strategy plan of Ministry of economy 2013-2015 (MINGO, 2012)

This strategy plan was delivered in 2012 and lays down several objectives for the development of the Croatian economy most notably (i) the development of the economy through the promotion of industrial competitiveness, (ii) the strengthening of the energy system and the management of mineral resources, (ii) the strengthening of a competitive and dynamic knowledge-based economy, and (iii) the development and standardization of trade and internal markets.



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2.14. Strategic framework for the development of the public private partnerships (Croatian Ministry of the economy, labour and entrepreneurship, 2008)

The Strategic Framework represents the initial fundamental document for ministries and public bodies at all levels, and primarily for the Directorate for the System of Public Procurement, the Agency for PPPs and the Ministry of Finance as the competent authorities for the establishment, evaluation and appraisal of proposed PPPs, the approval of the application of the PPP models and the development of potential PPPs, as well as the monitoring of the implementation of PPP contracts, in line with the strategic development priorities of the Republic of Croatia. PPPs have the potential to play a key role in the achievement of the abovementioned goals set by Strategic Development Framework 2006-2013, especially in terms of the accelerated construction of strategic national and urban infrastructure.¹²

2.15. Strategy of Government programmes 2013-2015, (MFIN, 2012)

Strategy of Government programmes for a three year period identifies priorities and objectives for the rapid recovery of the economy and society of the consequences of the economic crisis. Strategy defines twelve general objectives. For each general objective a set of specific objectives are defined with measures and means for achieving this objectives as well as performance indicators to measure level of achievement. Transport is an important part of two general objectives, objective number three *Balanced regional development* with specific objective: Sustainable development of the transport system and objective number eleven *Maintenance of public and national security at the highest level*.

2.16. Regional development strategy of the Republic of Croatia 2011-2013, (Croatian Ministry of regional development, forestry and water management, 2010)

Regional development strategy defines objectives for balanced development of the country. To achieve these objectives three main strategic objectives are defined: (i) development of counties and statistical regions (ii) development of aided (deprived) areas, (iii) development of border regions.

2.17. Strategic plan of the Ministry of maritime affairs, transport and infrastructure 2013-2015 (MPPI, 2013)

Strategic plan¹³ provides vision, mission and main objectives of the Ministry. Vision is to develop high, efficient, safe, environmentally friendly and modern transport and communication system, fully integrated into the network of major international traffic directions, which exploits the most Croatian transport and geographical position and meets the needs of freight and passenger transport.

The mission of the Ministry is to create conditions and build capacity to ensure the development of quality laws and regulations and their enforcement for the protection of the

¹² <http://www.ajpp.hr/media/5108/stratframe.pdf>, 19.09.2013

¹³ Available at: http://www.mppi.hr/UserDocsImages/065-STRATESKI%20PLAN%20MPPI%202013-2015%205_12.pdf, 19.09.2013



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sea, maritime domain and inland waterways, providing transport links between the islands and the mainland, to achieve a high level of development of electronic communications and postal services market, to organize the development of strategic infrastructure projects and investment programs of special importance for Croatia, organize work on the construction of modern transport infrastructure, which will connect all regions and develop all transport modes with a high degree of professionalism and safety in provision of transport services and undertaking all measures to protect the environment during transport.

Two main objectives are defined

1. Sustainable development of the transport system, which consists of four sub-objectives (i) balanced development of transport infrastructure, (ii) high quality traffic and developed market for transport services, (iii) high levels of traffic safety and (iv) environmental protection in transit
2. The development of the electronic communications and postal services, consists of two sub-objectives: (i) high and uniform development of broadband Internet access and (ii) high quality and developed market of the postal services

2.18. Transportation Operational Programme 2007-2013 (MPPI, 2012)¹⁴

Transportation Operational Programme represents a programme document which defines strategic areas for financing through EU Structural Funds (SF), namely the European Regional Development Fund (ERDF) and Cohesion Fund (CF), for the implementation of the EU cohesion policy in the transport sector in Croatia for period from 2007 to 2013.

As part of the Programme the following 3 priority axes are implemented:

- Priority Axis 1: Modernisation of TEN-T railway infrastructure (IPA/Cohesion Fund) - The axis aims at upgrading Croatian railway network on TEN-T corridors, especially sections of TEN-T corridors Vb and X located within Croatia.
- Priority Axis 2: Upgrading Croatia's inland waterway system (IPA/ERDF) - The axis aims at Upgrading Croatia's inland waterway system by establishing conditions for safe and reliable inland navigation and ensuring that the waterways meet minimal navigation requirements and improvement of ports.
- Priority Axis 3: Technical Assistance (IPA/ERDF) – The axis aim is to ensure the full, efficient and effective use of the funds allocated to the Transportation Operational Programme in accordance with the relevant rules and procedures.

3. REGULATIONS WITH INCENTIVES FOR DEVELOPMENT OF GREEN TRANSPORT

In this chapter is given an overview of national regulations with incentives for green transport development.

3.1. Act on combined (intermodal) transport (OG 124/09)

Act on combined (intermodal) transport (OG 124/09, Article 2) stipulates that the Strategy for the development of combined (intermodal) transport in the Republic of Croatia will be

¹⁴ Available at: [http://www.mppi.hr/UserDocImages/SF%20TOP%2007-13%20v3_21122011%20\(2\).pdf](http://www.mppi.hr/UserDocImages/SF%20TOP%2007-13%20v3_21122011%20(2).pdf), 19.09.2013.



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adopted/made for the purpose of long-term and coordinated development of the combined (intermodal) transport and for encouragement of logistics in the Republic of Croatia.

Incentives defined by the Act on combined (intermodal) transport (OG 124/09), Section IV are:

- The release of the annual fee for the use of public roads (Article 7)

(1) Owners or operators of motor vehicles and trailers registered in the Republic of Croatia, which, during the 12 months of the date of the last certification of roadworthiness performed at least 80 prior or subsequent transportation to and from the railway terminal for intermodal transport or unloading station, shall be exempt from obligation to pay the annual fee for the use of public roads to be paid at the registration of motor vehicles and trailers, and that is determined by a special regulation.

(2) The minister responsible for traffic regulation shall establish procedures and method of proving the use of vehicles for the previous and subsequent transport from the first paragraph this article and entitlement to an exemption from paying the annual fee for the use of public roads to be paid at the registration of motor vehicles and trailers.

(3) County road managements and Governing Body of the City of Zagreb will be allocated from the state budget to cover the amount of the annual fee for the use of public roads that have not been achieved due to the application of Article 7 Paragraph 1 and 2 this Act.

- Exemption from quotas and licenses (Article 8)

Minister responsible for transport regulation stated in Article 5 of this Act shall define also road route on which the previous and subsequent transportation is exempt from all quotas and permits that are set out in international multilateral and bilateral agreements.

- Exemption from restrictions on the Road (Article 9)

On the previous and subsequent transportation the injunctions defined by other special rules do not apply.

3.2. Order on the traffic restrictions on roads (OG 64/09)

This order restricts/prohibits transport of cargo vehicles, with or without a trailer, having a maximum mass exceeding 7.5 tonnes, vehicles that are with or without a trailer longer than 14 m, also it restricts transport of tractors, horse-drawn vehicles, work vehicles and other machinery and vehicles that on the straight road cannot achieve speed greater than 40 km/h, vehicles of driving school (when the training is carried out), in the state ferry ports of Split and Zadar, and on defined state roads, in defined periods. These periods are:

- between June, 15 to September, 15 on Saturdays from 4:00 to 14:00 and Sunday from 12:00 to 23:00 h.
- On Good Friday and on the days prior to the Croatian feast days from 15:00 to 23:00 h, and on the last day of the feast from 14:00 23:00 h. If the holiday, or the last day of the holiday season, is on Friday or Saturday, the ban applies also on Sundays from 12:00 to 23:00 h. If the feast is on Sunday or Monday, the ban applies also on Fridays prior to the feast from 15:00 to 23:00 h.

During the validity of the ban, vehicles registered in the Republic to which this Order applies, shall be permitted to enter Republic of Croatia through border crossing defined by this Order, and movement to the nearest customs office or customs terminal, provided that there is a space for parking vehicles.



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3.3. Ordinance on technical requirements for vehicles in road traffic (OG 51/10, 84/10, 145/11)

This Ordinance stipulates deviations in terms of vehicles weight involved in combined (intermodal) transport, where in the Article 10 it is stated that maximum permissible weight for triaxial haulier with twin or triaxial trailer, when transporting 40 TEU ISO container as a combined (intermodal) transport operation (unit), can be up to 44 tons, while for the haulier in non-intermodal transport the limit is 40 tonnes.

3.4. Railway Act (OG 123/03, 194/03, 30/04, 79/07, 75/09)

This Act defines services provided in combined (intermodal) transport as services of special national interest (Article 39) and provides possibility of cost reimbursement for rail carriers involved in intermodal transport from the State budget where cost generated by the transport cannot cover the revenues.

There are no special tax relief for road vehicles involved in intermodal transport, except in the part that is arranged by bilateral treaties on international transport with other countries.

4. CONCLUSION

Documents analyzed in previous chapters define priorities of transport policy in Croatia. Analysing these documents the following priorities of the transport sector, to enhance the level of the whole transport system, can be extracted: restructuring of unprofitable state-owned enterprises in the transport sector, rational management of transport infrastructure, the equality of market operation for all sectors of transport, traffic management, inducing demand for non-road traffic modes and public transport, increase participation of intermodal transport in transport system, integration of national network into the European network and networks of surrounding countries, improvement of traffic safety, environmental protection, reduction of external costs and the use of new technologies.

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HYBRID APPROACH FOR DEVELOPMENT OF RECOMMENDER SYSTEM FOR TEXTUAL E-LEARNING MATERIALS IN AREA OF TRAFFIC AND TRANSPORT TECHNOLOGY

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ABSTRACT

This paper presents a description of applied procedures and methods, the way of making a model of recommendations system for textual e-learning materials in area of Traffic and Transport Technology and testing the applicability of developed recommendations model. Documents are pre-processed including procedures of dimensionality reduction, selection of stop-words and creation of document-term matrix. For the text classification, combination of v -fold cross validation and kNN (k - nearest neighbors) method is used. Within the matrix the criterion and predictor variables are defined and used so kNN algorithm could successfully perform the classification of database of derived keywords. This way 'optimal' value of k is firstly analyzed, and results of v -fold cross validation are applied for the selection of value k . Results are given in the form of classification error analysis. Future research and implementation aims for developed recommender system are described.

KEYWORDS

Text mining; recommender system; k -nearest neighbor; document-term matrix

HIBRIDNI PRISTUP U RAZVOJU SUSTAVA PREPORUKA ZA TEKSTUALNE NASTAVNE DATOTEKE IZ PODRUČJA TEHNOLOGIJE PROMETA I TRANSPORTA

SAŽETAK

Ovim radom opisane su primijenjene procedure i metode kao i način izrade modela sustava preporuka za tekstualne nastavne datoteke iz područja tehnologije prometa i transporta te testiranje primjenjivosti razvijenog modela. Dokumenti su prethodno obrađeni primjenom postupka redukcije dimenzionalnosti, uklanjanja stop riječi te kreiranja dokument-pojam matrice. Za potrebe klasifikacije teksta korištena je kombinacija međuvaidacijske metode i kNN (*k-najbližih susjeda*) algoritma. Unutar kreirane dokument-pojam matrice definirane su kriterijske i prediktorske varijable na temelju kojih kNN algoritam vrši klasifikaciju izvedenih ključnih riječi unutar baze podataka. Rezultati međuvaidacijske metode primijenjeni su u svrhu odabira vrijednosti parametra k . Rezultati su prikazani u obliku analize klasifikacijskih pogrešaka. Radom su opisana i daljnja istraživanja kao i mogućnosti implementacije razvijenog sustava preporuka.

KLJUČNE RIJEČI

Rudarenje podataka; sustavi preporuka; k -najbližih susjeda, dokument-pojam matrica

1. INTRODUCTION

In the modern world overrun by computers, areas of high capacity storage and globally available Internet access, access to information has reached a very high level. Proportionally increasing capacity of storage has increased and the amount of data stored on them, and the rapid development and lower prices of computer equipment and the development of broadband Internet access has resulted in increasing the number of users accessing the data available. Of the total number of stored data accessible through the Internet large

proportion of files are written in text format, stored in various formats (XML, HTML, PDF, DOC, TXT, etc.). The downside of a big problem of a large set of stored text files is their efficient, reliable and fast retrieval by the user at any given moment.

This paper focuses on development of classification based recommender system for graduated students in Traffic and Transport Technology to aid their learning process by suggesting teaching materials based on a prediction of students' interests and past studying history. This problem is much highlighted in multidisciplinary studding areas where students came with different levels of knowledge and different study background.

2. RECOMMENDER SYSTEMS

The problem of classification of text documents written in natural language is the subject of the study in the past few decades with the fact that more attention is paid to this issue after the early - 1990s. The reason for this is the rapid advancement of information and communication technologies. In the sixties and seventies of the last century it was possible to store and effectively use a very limited amount of data, so the most essential data that will be stored and processed were carefully selected (a side effect of this approach is the Y2K problem). Eighties and nineties of past century, computing resources cease to be an issue which allowed the storage of large amounts of data and use of relational database models. Large amounts of data storing has resulted with a problem of analysis and rapid access and retrieval of information causing evolution of, among other things, the automatic document classification.

Recommender systems for text documents written in natural language have become the subject of research for the past few decades. In literature [1] [2] examples of automatic classification of documents where web documents or articles are classified by Naive Bayes algorithm can be found. Other techniques are also applied for classification of textual documents. Description of library documents classification based on k - nearest neighbors (kNN) algorithm can be found in [3]. Text mining-based recommendation system that assist customer decision making in online product customization, where customers describe their interests in textual format, and based on captured customers' preferences recommendations are generated is described in [4] and other examples in [5] [6] [7] [8].

When modeling recommendation systems for text documents written in natural language it is important to carry out pre-processing procedure in order to provide good output results. Text documents considered in this recommendation system are multidisciplinary lectures material in area of Traffic and Transport Technology.

3. PRE-PROCESSING OF TEXT DOCUMENTS

Firstly, it was needed to represent text documents (strings) in a format suitable for text classification. For this purpose a vector space model is used (Figure 1).

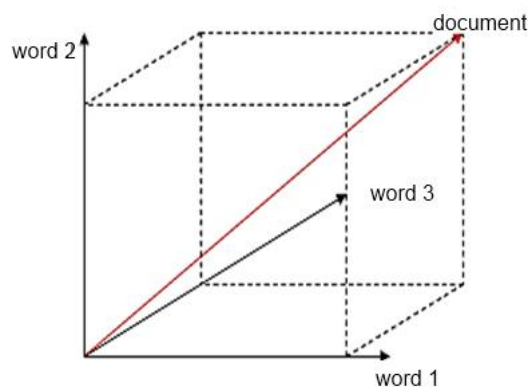


Figure 1. Text documents vector space

In this model, each text document is displayed as a vector of words. So a document-term matrix or term-document matrix is created (Figure 2).

$$A = \begin{bmatrix} a_{11} & \dots & a_{1n} \\ \dots & a_{ij} & \dots \\ a_{m1} & \dots & a_{mn} \end{bmatrix} \begin{matrix} w_1 \\ \dots \\ w_i \\ \dots \\ w_m \end{matrix}$$

$$d_1 \quad \dots \quad d_j \quad \dots \quad d_n$$

Figure 2. Document-term matrix

This is a mathematical matrix that describes the frequency of terms that occur in a collection of documents. In a document-term matrix, rows correspond to documents in the collection and columns correspond to terms. For example, $A = (a_{ij})$, where a_{ij} is a weight of word in the document j . There are several ways of determining the weight a_{ij} . Let f_{ij} represents the frequency of words in the document j , N is the number of documents in the learning set, M is the number of different words, and n_i the total number of times a word appears in the learning set. The simplest approach for determining the weight is the binary weights approach, where a_{ij} is set to be 1 if the word appeared in the document, otherwise it is equal to 0. Another simple method uses the frequency of occurrences of words in a document as a weight, ie $a_{ij} = f_{ij}$. The most popular way of determining the weight is TF- IDF (Term frequency - inverse document frequency) method of determining the weight where the weights are defined as:

$$a_{ij} = f_{ij} \times \log \left(\frac{N}{n_i} \right) \quad (1)$$

If text documents with various lengths are considered, the adopted (1) looks like this:

$$a_{ij} = \frac{f_{ij}}{\sqrt{\sum_{i=1}^M f_{ij}^2}} \times \log \left(\frac{N}{n_i} \right) \quad (2)$$

Since for the matrix A the number of rows is determined by the number of different words in a text documents. Given that there may be plenty of different words, including all the words in the language, plus the results of conjugation, and also, gender iterations (as in Croatian different words represent different genders) etc., it was necessary to determine key words.

For this purpose next steps were taken:

- Removing the stop – words;
- Tokenization;
- Lemmatization;
- Stemming;
- Synonyms;
- Group of words;
- Word cleansing.

A. Stop – words

Any group of words can be chosen as the stop - words for a given purpose. They can be defined as words that don't have a relevant meaning for the observed subject. Very often list of stop- words includes conjunctions, but in some other cases it depends of document context. List of stop - words varies depending on the morphological characteristics of the

language so that the list for Croatian language consists of approximately 2000 words and for English; the number is approximately 600 words [9].

B. Tokenization

Tokenization is the process of breaking a stream of text up into words, phrases, symbols, or other meaningful elements called tokens. A token is an instance of a sequence of characters in some particular document that are grouped together as a useful semantic unit for processing. Tokenization is a very important step in pre-processing documents written morphologically rich languages like Croatian due to the fact that it allows dimensionality reduction of the input data [10].

C. Lemmatization

Lemmatization in linguistics is the process of grouping together the different inflected forms of a word so they can be analyzed as a single item. Lemmatization is a form of morphological normalization or procedure that finds the linguistically correct canonical form of a word.

D. Stemming

Stemming is the process for reducing inflected (or sometimes derived) words to their stem, base or root form, generally, a written word form. The stem need not be identical to the morphological root of the word; it is usually sufficient that related words are mapped to the same stem, even if this stem is not in itself a valid root. This type of morphological normalization is less accurate than lemmatization, because root of the word does not necessarily have to be a meaningful word [11].

E. Synonyms

Synonyms or synonymous words indicate that they have the same meaning. Their identification has a great impact in getting relevant results at the end of text analysis. Same as for the stop – words, for the synonyms, the list is created.

F. Group of words

Term group of words represents a problem when a group of individual words, when written together, denote one meaning. For this purpose we can use two approaches:

- Phrase list - combines word groups that represent common phrases in the language,
- Statistics - monitor the occurrence of two or more words together in the document.

Group is defined as group of words if it appeared together more than a predefined threshold. In order to increase the quality of the text that is the subject of analysis, such a group of words should be represented by one token.

G. Word cleansing

Word cleansing process is the last step in the pre-processing procedure. It includes removal of words that appear less frequently. Words that appear less than 1% times are usually the result of a typo error and the omission of such words reduces the noise of the document. Same goes for the words that appear in the document more than 20% times.

As an input for document-term matrix creation 54 text documents in area of Traffic and Transport Technology. Used documents are in pdf (Portable Document Format) format and selected from teaching materials written in Croatian. Main motivation for selecting these text documents was familiarity with content of these documents and their availability, as well as copy right issues. Based on the results key words have been extracted for the word set representing each text document. This was done in two phases, manually and automatically. Based on steps defined in this chapter overall of 984 key words have been identified. These words were used for definition of document-term matrix.

4. TEXT CLASSIFICATION

For text classification weighted kNN method is used. When classifying a new document, kNN algorithm needs to determinate closest neighbour by calculating the distance vectors between text documents [12]. Based on the *k* most similar neighbor class of considered

document is decided. Similarity is determined by the Euclidean distance between vectors of documents or cosine value between two vectors of documents. Cosine value is defined as:

$$\text{sim}(X, D_j) = \frac{\sum_{t_j \in (X \cap D_j)} x_i \times d_{ij}}{\|X\|_2 \times \|D_j\|_2} \quad (3)$$

Where X is the vector of classifying document. D_j is the j -th document from the learning set, t_j is a word that exists in X and D_j , x is the weight of those words in the document D_j , $\|X\| = \sqrt{x_1^2 + x_2^2 + x_3^2 + \dots}$ is a normal vector X , and respectively $\|D_j\|$ is the normal vector D_j .

To determine optimal size of neighborhood v -fold cross-validation method was applied. Meaning that for a fixed value of k , we apply the kNN model to make predictions on the v -th segment and to evaluate the error. The choice for this error is defined as the accuracy (the percentage of correctly classified cases). This process is then successively applied to all possible choices of v . At the end of the v folds (cycles), the computed errors are averaged to yield a measure of the stability of the model (how well the model predicts query points). The above steps are then repeated for various k and the value achieving the highest classification accuracy is then selected as the value for the k . Results of v -fold cross-validation in Statsoft Statistica tool are shown in Figure 3.

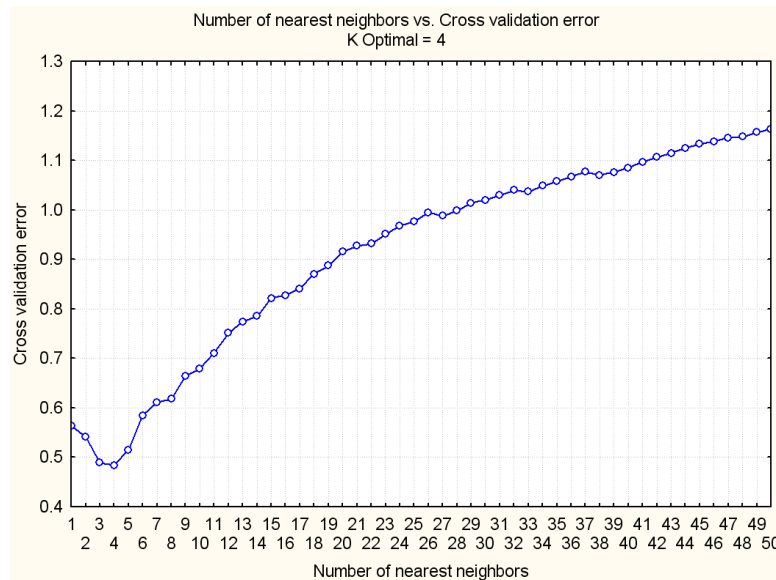


Figure 3. v -fold crossvalidation result

Based on the v -fold cross-validation results the value of the parameter k was set to be 4 (the lowest cross-validation error is 0.48429 %). For the k values that are higher than 4, continuous growth of classification errors is recorded. Figure 4 represents classification error where, in multidimensional space, classification error for 10 cases is represented by dots. As visible, most results are in 'yellow' area meaning that the value of the error was close to 0. Just one value is in 'red' area, meaning that error was in the interval between 3 - 5 %.

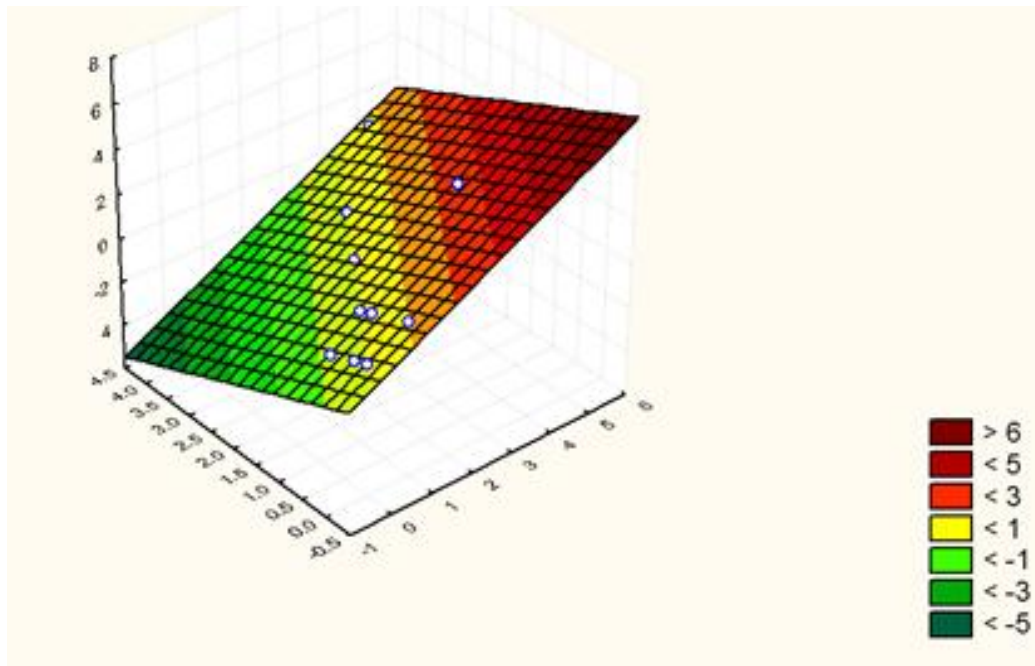


Figure 4 Classification error analysis

Recommender system is modeled in such a way that on the basis of selected text document, output result lists semantically related teaching materials. Meaning that, when student retrieves one lecture material, related teaching materials will be listed as suggestions for those who want to know more about subject of the lecture.

In future research, it is planned to include more text documents as input and to create interface that would allow students to access hyperlinks of suggested teaching materials. This is especially useful for students of multidisciplinary areas and those that have a wish to expand their knowledge.

5. CONCLUSION

In the past few years we have witnessed the fast development and increasing availability of the Internet and computer equipment to customers. The consequence of such rapid development is the increasing availability of information and data. Many companies are specialized in the field of software tools, applications and algorithms for retrieving, storing and processing text files that allow users to easily work with it.

Paper described application of text mining techniques for extraction of useful knowledge from 54 text documents form a field of Traffic and Transport Technology. This required text document pre-processing in order to define key words and form document-term matrix. Based on pre-processing, textual document have been prepared for v-fold cross-validation method in order to define optimal size of document neighborhood needed to classify it. For classification kNN algorithm was used.

The completed model has proven that using KNN algorithms can achieve the given objective of facilitating the use of files in e-learning system in the form of recommendations system to obtain teaching materials based on the teaching material that is currently selected.

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Sveučilište u Zagrebu
Fakultet prometnih znanosti

INSTITUTIONAL PROFILE

Faculty of Transport and Traffic Sciences, established in 1984, is the faculty of the University of Zagreb, and the leading high education as well as scientific and research institution in the field of transport and traffic engineering in Croatia. Faculty staff participates in national, regional and international scientific, research and development projects funded by the national Ministry of Science, Education and Sports, European Commission and international institutions. Faculty as well participates in public and commercial projects solving transport and traffic problems of transportation sectors in Croatia. International cooperation through exchange of academic staff and students presents an important part of academic and research activities.

PROGRAMME EMPHASIS

Faculty of Transport and Traffic Sciences offers programmes in Traffic and Transport, Intelligent Transport Systems and Logistics and Aeronautics. Programme of Traffic and Transport involves courses in Road, Railway, Urban, Air, Waterway, Postal, and Information and Communication Transport and Traffic. All the programmes are taught at the three-year undergraduate (180 ECTS) and two-year graduate levels (120 ECTS).

Postgraduate studies provide three-year Doctoral Studies in the field of Transport and Traffic Engineering, as well as one-year Specialist Studies in Urban Transport and Traffic, Intermodal Transport and Traffic, and Transport Logistics and Management.

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Transport and traffic engineers generally work in transport services and other related enterprises and public institutions dealing with various transport modes and/or traffic technology, logistics, and management. The job of transport and traffic engineer covers wide range of professional activities, e.g. planning, design, operation, supervision, and maintenance of transport and traffic facilities and processes.

RESEARCH ORIENTATION

The research carried out is of a high international standard with the goal of providing modern transport and traffic technology, infrastructure, logistics and intelligent transport systems solutions in road, waterway, postal, information and communication, urban, air and railway transport.

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