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9th International scientific conference

LUKE I PLOVNI PUTOVI

PORTS AND WATERWAYS

POWA 2014

ZBORNIK RADOVA

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Sisak, 25. rujna 2014.

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PREFACE

Faculty of Transport and Traffic Sciences of University of Zagreb in co-organisation with Croatian Chamber of Economy - Sisak County Chamber and Port Authority Sisak under the auspices of International Sava River Basin Commission organised the ninth International scientific conference on Ports and Waterways (POWA 2014) which took place on 25th September 2014 at Croatian Chamber of Economy, Sisak County Chamber, Kranjčevićeva 16, Sisak, Croatia.

Aim of this year conference was to present and analyse research activities and to examine technical and technological innovations primary within the field of water transport. The papers, posters and presentations, were focused on analysis and development of awareness of education and training harmonisation, transport standardisation, transport strategies, transport market liberalisation, ICT application in transport, environmental issues of transportation, transport safety and security, legal issues, transport infrastructures and design of transportation networks 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.

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 2014 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

Sisak, September 2014

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WORLD AUTOMATED CONTAINER TERMINALS

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ABSTRACT
Automation of handling systems in the world container terminals has become one of the most significant changes that have happened in the maritime container transport since the 1990s.The basic goals of this automation are especially the increase of the throughput of the container terminals, the decrease of the downtimes of containers vessels in the sea ports, the reduction of the number of port workers including the accident rates. The first automated container terminal was built in Europe in the port of Rotterdam. Nowadays, new automated container terminals are being constructed in other parts of the world, mainly in the USA and Asia. In the container terminals automated guided vehicles and various automated stacking cranes have replaced straddle carriers, rubber-tired gantry cranes at the water side transfer area and the container yard.

KEYWORDS
automation, automated container terminals, automated guided vehicles, rail-mounted gantry cranes, rubber-tired gantry cranes, straddle carriers

SVETOVÉ AUTOMATIZOVANÉ KONTAJNEROVÉ TERMINÁLY

ABSTRAKT
Automatizácia manipulačných procesov vo svetových kontajnerových termináloch sa stala jedna z najvýznamnejších zmien, ktoré sa odohrali v preprave kontajnerov námornou dopravou od deväťdesiatych rokov dvadsiateho storočia. Základnými cieľmi automatizácie je najmä zvýšenie výkonnosti kontajnerových terminálov, zníženie pobytu kontajnerových lodí v námorných prístavoch, počtu prístavných pracovníkov vrátane úrazovosti. Prvý automatizovaný kontajnerový terminál bol postavený v európskom prístave Rotterdam. V súčasnosti sa nové automatizované kontajnerové terminály budujú v ostatných častiach sveta, najmä v USA a Ázii. Automaticky riadené vozidlá, rozličné automatizované portálové žeriavy nahrádzajú obkročné transportéry, portálové žeriavy na pneumatikách v nábrežnej manipulačnej ploche a kontajnerovej skládke terminálu.

KĽÚČOVÉ SLOVÁ
automatizácia, automatizované kontajnerové terminály, automaticky riadené vozidlá, portálové žeriavy na koľajniciach, portálové žeriavy na pneumatikách, obkročné transportéry

1. AUTOMATED CONTAINER TERMINALS

Automated container terminals are terminals where some container handling equipment operates without direct human interaction. Drivers of the cranes have been physically removed, or they have remained in their cabins but they are not needed for the entire duty cycle [2].

These terminals use some automated handling equipment (automated guided vehicles, various automated stacking cranes or automated straddle carriers) that:

- transports the containers at the water side transfer area from the wharf and to the container yard (automated guided vehicles, automated straddle carriers),
- moves the containers between the water side transfer area and the container yard, the container yard and the land side transfer area and in the blocks of the container yard (various automated stacking cranes, automated straddle carriers),
- transfers the containers at the railway station located at the land side transfer area between semi-trailers and wagons (rail-mounted gantry cranes).

Automated container terminals differ one from another the level of automation, the type of handling equipment and system. Some of them use only automated handling equipment at the container yard. Automated stacking cranes (automated rail-mounted gantry cranes or rubber-tired gantry cranes) move and stack the containers into the blocks of the container yard. They also transfer the containers between handling equipment that is located at the water or land side transfer area and the container yard.

More modern automated container terminals also use automated handling equipment at the water and land side transfer area. Automated guided vehicles or straddle carriers that are located at the water side transfer area transport the containers between the wharf and the blocks of the container yard. Automated / semi-automated stacking cranes that are located at the railway station at the land side transfer area transfer the containers between the means of transport of road and railway transport.

1.1. Automated guided vehicles

Automated guided vehicles (Figure 1) are the vehicles that transport the containers from the wharf to the blocks of the container yard. Their movements are controlled by the terminal computer system. They follow the reference points (transmitters) located into the floor of the water side transfer area (greed navigation system). They also use the laser navigation system that prevents their mutual accidents.

Automated guided vehicles belong to the group of the passive handling equipment because they do not load, unload the containers like another handling equipment. They only transport the containers. They can have diesel or electric engine. They are used into the container terminals due to the reduction of the accident rates, the number of port workers and the staff costs.

Figure 1 Automated guided vehicle in the Terminal ECT Delta in the port of Rotterdam
Source: Andrej Dávid

1.2. Automated stacking cranes

In the container yard of automated container terminals two types of automated stacking cranes are used: rail-mounted gantry cranes and rubber-tired gantry cranes.

Figure 2 Rail-mounted gantry cranes at the container yard of the Terminal ECT Delta in the port of Rotterdam
Source: Andrej Dávid

Rail-mounted gantry cranes run on steel wheels over fixed rails. They are used in the combination with tractor-trailer sets for wharf transfer operation. In the automated container terminals two types of cranes are used. The first type of cranes is used for stacking and movement of the containers in the blocks of the container yard that are perpendicular to the wharf (Figure 2). The second type of cranes (Figure 3) is used on receipt and delivery operations at the rail station. They usually have large spans and may stack the containers up to 6 tiers.

Figure 3 Rail-mounted gantry cranes at the railway station of the Container Terminal Altenwerder in the port of Hamburg
Source: Andrej Dávid

Rubber-tired gantry cranes run on heavy duty pneumatic-tired wheels. They are similar to rubber-tired gantry cranes in the function. They are container-yard stacking device and are used in the combination with other container handling equipment (tractor-trailer set) for the wharf transfer operation. They handle containers within the block that is parallel to the wharf. They can also move from one block to another. In the automated container terminals they are less used than rail-mounted gantry cranes.

1.3. Straddle carriers

Straddle carriers are the most popular type of container handling equipment in the container terminals. They have a wheeled frame that lifts and transports containers within its framework. They can stack containers up to 3 tiers.

In the automated container terminals it is not widespread handling equipment. In the world only one automated terminal has used them so far.

2. AUTOMATED CONTAINER TERMINALS IN THE WORLD

2.1. European Automated Container Terminals

In Europe there are a few automated container terminals that are located in the port of Rotterdam, Hamburg and Algeciras.

In the port of Rotterdam there are some automated container terminals located in the part called Maasvlakte 1 and 2. In the 1980s the container terminal operator European Container Terminals (ECT) built the ECT Delta Terminal. It was the first European automated container terminal that started using the system of automated guided vehicles in 1992. It also uses automated stacking cranes in the container yard. The handling system (Figure 4) consists of gantry container cranes, automated guided vehicles (Figure 1), automated rail-mounted gantry cranes, straddle carriers and semi-trailers. Gantry container cranes transfer the containers between the container ships and automated guided vehicles. These vehicles transport containers from the wharf and to the container yard. This yard is divided into the blocks according to type of the containers, their final destinations, cargo that is loaded into containers. Each block is equipped with one automated rail-mounted gantry crane that transfers the containers between automated guided vehicles and this block. It also manipulates containers within the block. Straddle carriers handle the containers between the blocks of the container yard and semi-trailers. In the terminal there is also a railway station where the containers are loaded on the wagons by rail-mounted gantry cranes and are transported to the hinterland.

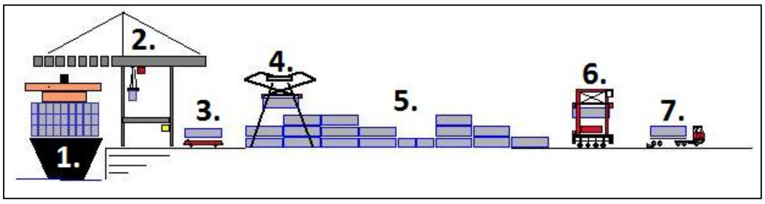

Figure 4 Handling system in the ECT Delta Terminal
Source: http://www.ect.nl

The Euromax Terminal Rotterdam is another automated terminal in Maasvlakte 1. The handling system (Figure 5) of this terminal is similar to ECT Delta Terminal. Gantry container cranes can also serve the latest generation of container ships with 22 or 23 rows of containers on deck. The basic difference is that each block is equipped with two automated rail-mounted gantry cranes. The first crane transfers containers between automated guided vehicle and the block of the container yard, the second crane transships the containers between the block of the container yard and semitrailer. In the land side of the terminal there is also a railway station where containers are loaded on the wagons [10].

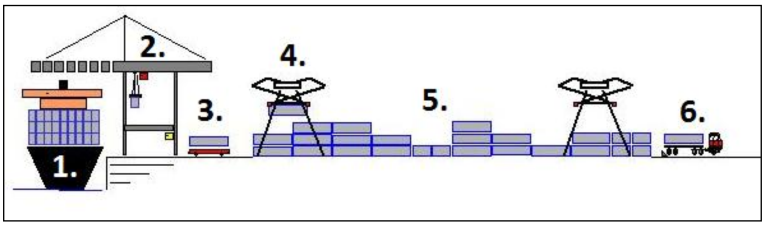

Figure 5 Handling system in the Euromax Terminal Rotterdam
Source: http://www.ect.nl

In the port of Hamburg there are two automated container terminals. The first one is the Container Terminal Altenwerder (Figure 3) that belongs to the most modern terminals in the world. It has been in the operation since 2002. The handling system of this terminal is the same as in the Euromax Terminal Rotterdam. Automated handling equipment (automated guided vehicles and rail-mounted gantry cranes) is located at the water side transfer area and the container yard. Each block of the container yard is equipped by two rail-mounted gantry cranes that have a different gauge.

The second one is the Container Terminal Burchardkai (Figure 6) that is being reconstructed now uses automated handling equipment at the container yard. Each block is equipped by three automated rail-mounted gantry cranes (two of them have smaller gauge, one of them has bigger gauge). The first one moves the containers between straddle carriers located at the water side transfer area and the blocks of the container yard. The second one moves the containers within the block of the container yard. The third one moves the containers between the blocks of the container yard and semi-trailers. At the land side transfer area there is also a railway station where rail-mounted gantry cranes transfer containers between semi-trailers and wagons.

Figure 6 Handling system in the Euromax Terminal Rotterdam
Source: Andrej Dávid

Last automated container terminal in Europe is located in the port of Algeciras. The Total Terminal International (TTI) uses automated handling equipment in the container yard. Automated rail-mounted gantry cranes move the containers within the blocks of the container yard.

2.2. Asian automated container terminals

In Asia there are some automated container terminals such as the Terminal International in the port of Hong Kong, the Terminal Newport in the port of Busan, the Terminal Evergreen in the port Kaohsiung, the Terminal Tobishima in the port of Nagoya and the Terminal Pasir Panjang in the port of Singapore. These terminals use some automated handling equipment (automated rail-mounted gantry cranes) in the container yard.

The Terminal Tobishima uses some automated handling equipment (automated rubber tired gantry cranes and automated guided vehicles.) in other parts of the terminal.

The Terminal International 6, 7 is located in the port of Hong Kong. It belongs to the busiest container ports in the world. It has got nine container terminals. In the Terminal International automated rail-mounted gantry cranes handle the container in the container yard.

The Terminal Newport is located in the port of Busan that is the most important port in South Korea. The Terminal Newport was the first Asian terminal that started using automated handling equipment. It has got four berths with the depth of 16 to 17 m; it can serve the latest container ships. It also uses automated stacking cranes for handling of the containers in the container yard.

The Terminal Tobishima is located in the port of Nagoya. This port has got 5 container terminals; the Terminal Tobishima has got two berths with the depth of 16 m. Container gantry cranes can serve container vessels that have got 22 rows of the containers on the deck. This terminal uses the following automated handling equipment such as automated rubber-tired gantry cranes and automated guided vehicles. At the water side transfer area automated guided vehicles transport containers between the wharf and the container yard. Automated rubber tired gantry cranes move the containers in the container yard. Automated guided vehicles also transport the containers at the land side transfer area.

2.3. American automated container terminals

In North America there is the only one automated container terminal APM located in the port of Norfolk. Two automated container terminals (Terminal TraPac and Terminal APL Pier 300) are being constructed in the port of Los Angeles.

The terminal APM is located in the port of Norfolk. The port of Norfolk is situated on the south bank of the Elizabeth River in Virginia. It is the largest army port in the world. The handling system of this automated container terminal consists of Post Panamax gantry cranes that transfer the containers between container vessels and the terminal. Straddle carriers move containers between the water side transfer area and the container yard. Automated handling equipment is only used in the container yard. Automated rail-mounted gantry cranes handle containers in the container yard. They can stack containers up to 4 and 5 levels. A modern monitoring system allows the monitoring every movement of the container in the terminal.

The port of Los Angeles that is situated on the coast of the North Pacific is the largest port in the USA. It has got nine container terminals. In a near future the port will have two automated container terminals: the Terminal TraPac and the Terminal APL PIER 300.

The Terminal TraPac that is being extended and reconstructed now will be the first automated container terminal on the West Coast of the USA. This terminal will use the following automated handling equipment such as automated straddle carriers and automated rail-mounted gantry cranes. The handling system will consist of some container gantry cranes, automated straddle carriers, automated rail-mounted gantry cranes, semi-trailers or wagons. Container gantry cranes will transfer containers between a vessel and the terminal. Then, fully automated straddle carriers will transport the containers from the wharf to the water side transfer area or the container yard. Straddle carriers will be guided by terminal logistics system. It will use thousands of magnets, laser sensors and GPS for monitoring of the movement of the containers. In the container yard electrically powered rail-mounted automated stacking cranes will move the containers in the blocks. At the land side transfer area these cranes will load the containers on semi-trailers that will transport them to the hinterland. In the terminal 35 per cent of containers will be transported by rail transport.

The Terminal APL PIER 300 will accommodate the latest generation of container vessels. It will use automated guided vehicles and automated rail-mounted gantry cranes for moving the containers in the terminal. The handling system of this terminal will be the same as in the Container Terminal Altenwerder in the port of Hamburg or the ECT Euromax in the port of Rotterdam.

2.4. Australian automated container terminal

In Australia there is the only one automated container terminal Patric that is located in the port of Brisbane. The port of Brisbane is the fastest grooving container port in Australia. It is situated in the estuary of the Brisbane River. The terminal Patric has got two berths; four Post Panamax gantry cranes transfer the containers between a container vessel and the terminal. This terminal uses automated straddle carriers that move containers between the water side transfer area and the container yard of the terminal. They also stack the containers in the container yard 24 hours per day. In the world the system of automated straddle carriers is only used in this terminal. Their advantages are their long life cycle and energy saving.

3. CONCLUSION

World automated container terminals differ one from another the level of automation and the type of automated handling equipment (Table 1) and handling system. The most modern container terminals are located in Europe. They use automated handling equipment at the water side transfer area and the container yard.

In other parts of the world automated handling equipment is mainly used at the container yard where move and stack the containers between the blocks of the container yard and other means of transport, Some new automated terminals are being constructed, mainly in the USA and Asia.

Table 1 The list of automated handling equipment in the world automated container terminals

continent	port	terminal	water side transfer area	container yard	land side transfer area
Europe	Rotterdam	ECT Delta	automated guided vehicles (AGVs)	one automated rail-mounted gantry (RMG) crane	-
		ECT Euromax	AGVs	two automated RMG cranes	-
	Hamburg	CTA	AGVs	two automated RMG cranes	-
		CTB	-	two automated RMG cranes	-
	Algeciras	TTI	-	two automated RMG cranes	-
Asia	Hong Kong	International	-	automated RMG cranes	-
	Busan	Newport	-		-
	Kaohsiung	Evergreen	-		-
	Nagoya	Tobishima	AGVs	automated rubber-tired gantry cranes	-
	Singapore	Pasir Panjang	-	automated bridge cranes	-
America	Norfolk	APM	-	two automated RMG cranes	-
	Los Angeles	TraPac	automated straddle carriers		-
		APL PIER 300	AGVs		-
Australia	Brisbane	Patrick	automated straddle carriers		

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INTEGRATED ICT IN MARITIME TRAFFIC SYSTEM

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ABSTRACT
The paper analyses the existing solutions in navigation management system in the Republic of Croatia and worldwide, and their possible enhancement. Within the given context, the paper discusses the current and improved future integrated information-communication technologies that considerably enhance the navigation management system. Given the intensified maritime traffic, the growing number of the participants and the fast development of new technologies over the past ten years, it is expected that the further development and higher level of integrity will have a beneficial impact on the traffic system, economy and higher quality of seaborne transportation services. The existing information-communication technologies implemented into the navigation management system include applications for controlling inshore navigation, introduction of virtual object in navigation, and use of AIS systems aimed at avoiding collisions at sea. The essential purpose of the application of new technologies is to increase the level of safety in controlling the vessels and navigation.

KEYWORDS
Information-communication technology, integrity, VTS, safety, vessel control, navigation

INTEGRIRANE INFORMACIJSKE TEHNOLOGIJE U POMORSKOM PROMETNOM SUSTAVU

SAŽETAK
U radu se analiziraju postojeća rješenja u sustavu upravljanja plovidbom u svijetu i Republici Hrvatskoj i mogućnost njihova poboljšanja. Obrađuju se postojeće i poboljšane buduće integrirane informacijsko-komunikacijske tehnologije koje značajno poboljšavaju sustav upravljanja plovidbom. S obzirom na porast intenziteta pomorskog prometa i broja sudionika te ubrzani razvoj novih tehnologija zadnjih deset godina očekuje se da će daljnji razvoj i podizanje razine integriranosti imati pozitivan utjecaj na prometni sustav, gospodarstvo i na razinu kvalitete usluge pomorskog prijevoza. Postojeće informacijsko komunikacijske tehnologije primijenjene u sustavu upravljanja plovidbom uključuju aplikacije za upravljanje plovidbom u obalnom području, primjenu virtualnih objekata u navigaciji, korištenje AIS sustava s ciljem izbjegavanja sudara na moru. Glavni cilj primjene novih tehnologija je povećanje razine sigurnosti upravljanja plovidbom i plovilima.

KLJUČNE RIJEČI
informacijsko-komunikacijska tehnologija, integriranost, VTS, sigurnost, upravljanje plovilima, plovidba

1. CURRENT APPLICATION OF ICT IN NAVIGATION MANAGEMENT

The essential purpose of the implementation of the ICT in navigation management has been to maintain efficient, safe and economical navigation from berth to berth, i.e. from the point of departure to the point of arrival. In maritime shipping, the points of departure and arrival are the places where the safety of navigation control is threatened by a number of factors.

These factors refer to the increased density of sea traffic, confined areas where vessels are expected to perform adequate maneuvering, changeable water levels that affect the ability of the ship to enter or leave port only at certain time intervals due to her draught, various weather conditions within port waters, density of traffic flow entering or leaving the fairway, etc.

These factors affect the safety of navigation and therefore require a continuous upgradation of electronic systems applicable to the systems of navigation management. One of the most important reasons for developing and upgrading the existing vessel control electronic systems arises from the need for a more reliable and faster flow of information between:

- Shore and ship,
- Ship and ship, and
- Ship and shore.

The ICT integrity is considered necessary in order to increase the safety of navigation and safety of ports, save time and length of passage, reduce costs related to marine services (e.g. reduced need for the use of pilotage[1], towboats, VTS[2] service, port agents and so on) and in order to improve the automated update of important navigation information. One of the goals of ICT integration is connecting the essential components within the navigation management system:

- ships,
- shorelines, and
- seaways.

The integrated ICT is partly introduced in vessel control through the Integrated Bridge System (IBS), Integrated Navigation System (INS), Integrated Engine Room System, Vessel Monitoring System, Cargo Control and Monitoring System and other systems. IBS is described as a system consisted of interconnected sub-systems that allow central approach, as well as monitoring and commands through the central computer. INS features sub-systems for navigation, e.g. radar, communication system, and Electronic Charts Display Information System (ECDIS). The requirements of the International Convention for the Safety of Life At Sea (SOLAS) stipulate that the failure of one INS sub-system must not disable the operation of other sub-systems.

The system of navigation management is controlled by VTS service consisting of the headquarters and sub-centers. VTS is defined as the shore-side system whose services range from providing simple information to vessels (position, hazards, etc.) to overall supervision of traffic within ports or fairways. VTS service is available in the areas covered by monitoring services and where VTS surveillance implementation is deemed compulsory.

Vessels entering a VTS area have to report to the control center within the VTS zone. Vessels are obliged to maintain permanent communication with VTS operators during their passage through the VTS zone and report to the VTS centers at specified locations. VTS is obliged to warn the vessel in case of any hazards within a VTS surveillance area.

The shore-based management system comprises coastal infrastructure and technical support established along the shore. The technical support typically includes VTS, Search and Rescue (SAR) and Long Range Identification Tracking (LRIT) services. The vessel traffic

[1] Process of approaching or leaving berth with the assistance of authorized persons, i.e. pilots
[2] VTS (Vessel Traffic Service) is the vessel traffic control system in traffic separation zones

service (VTS) is in charge of monitoring the movement of vessels and providing information with the purpose of increasing the safety of traffic.

Global Maritime Distress Safety System (GMDSS) is a communication system that makes part of the integrated system of vessel traffic management.

The system of waterway control includes the equipment for meteorological and hydrological monitoring and supplementary Aids to Navigation (AtoN). AtoN aids are auxiliary applications used by AIS devices. These aids are defined as an external system that includes various equipment such as buoys, shore stations and other features designed and used for enhanced, safe and efficient flow of maritime traffic.

Figure 1 shows a simplified diagram of integrated technologies engaged in the navigation management system.

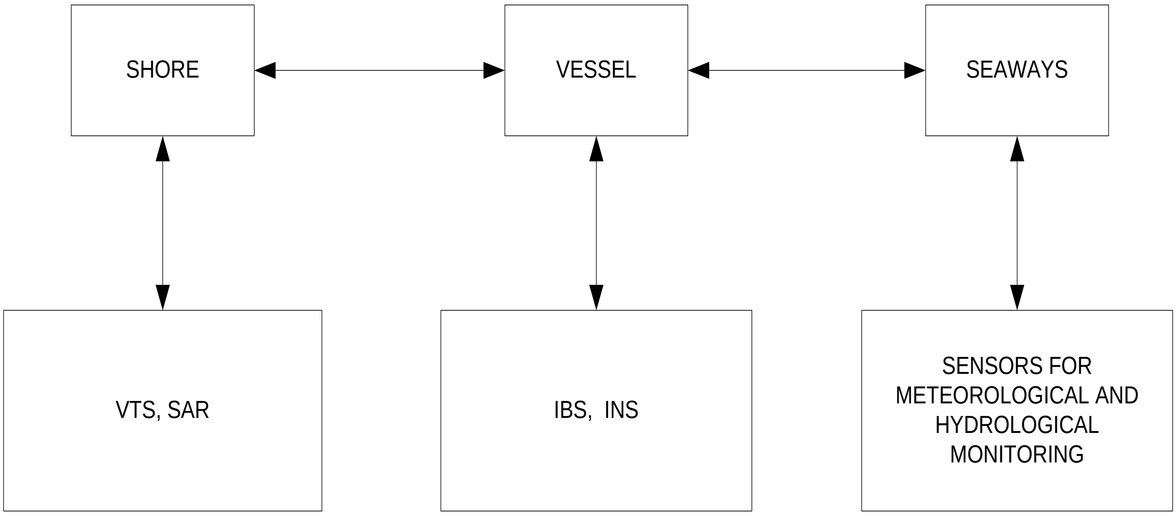

Figure 1. Integrated technologies in navigation management
Source: Author

2. PROPOSAL FOR ENHANCING ICT INTEGRATION THROUGH E-NAVIGATION

Implementation of an improved ICT integration through e-Navigation by upgrading the existing electronic systems is suggested. Electronic Chart Display and Information System (ECDIS) is used as a modern electronic aid whose essential aim is to facilitate course plotting and voyage planning. The system can be upgraded in order to enable the calculation of optimum courses and routes with regard to meteorological factors [8]. The following actions are suggested for obtaining an efficient integration of ICT systems through ECDIS:

- Integration of vessels' sensors,
- Transfer of information on ECDIS interface (vessel-shore, shore-vessel, vessel-vessel),
- Simplification of the systems for detecting the objects obtained through the radar on the ECDIS interface,
- Simplification of the systems for detecting the objects obtained through AIS system on the ECDIS interface,
- Increasing the accuracy of electronic positioning – Global Positioning System (GPS) [2],
- Embedding additional sensors for vessel positioning,
- Analysis of various simulations in diverse navigating conditions using ECDIS in order to reduce human errors,

- Greater availability of information for the areas considered as dangerous for navigation [3], [8].

Due to a relatively large amount of data generated by the bridge electronic devices, there is a need of filtering them before processing to avoid the system's information glut. The data that are important for navigation could be efficiently filtered and processed by applying the e-Navigation. The operation of VTS systems should be enhanced through better coordination and sharing of information. Information sharing can be improved through the integration of ICT and introduction of new applications (Figure 2) [8]. The new applications refer to:

- Virtual aid to navigation and auxiliary navigational assistance services [12],
- Assistance in avoiding collisions at sea with the aid of AIS system,
- Navigational services.

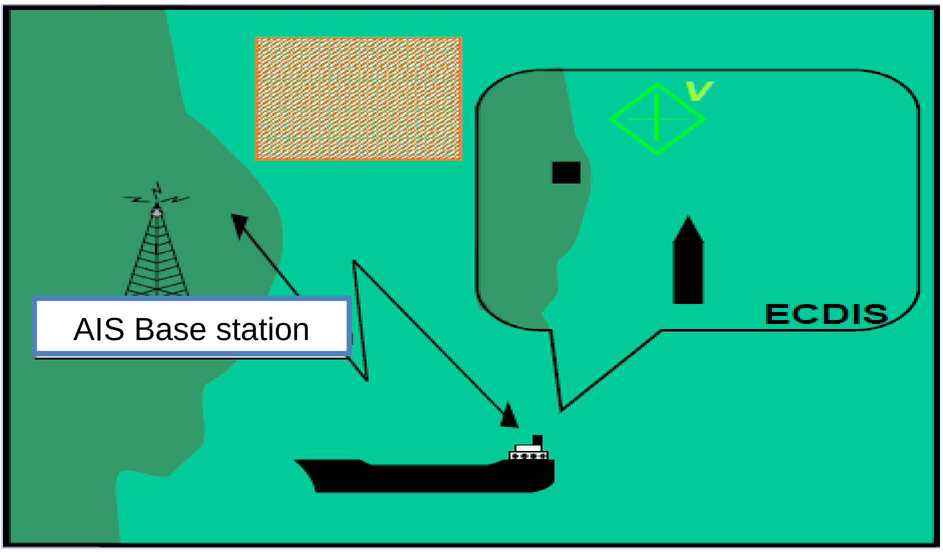

Figure 2. Virtual aid in navigation through VTS zones

Source: http://www.skematransport.eu/uploadfiles/SRW2.2%20e-Navigation%20NickWard.pdf

Virtual aid in navigation (Figure 2) can be defined as a supplementary service in navigation. The service is still at the experimental stage: virtual buoys (that do not really exist at sea) are planted and are visible at the radar screen or the electronic chart display screen. The main objective of introducing these buoys is to reduce costs related to the port extension by planting virtual buoys assisting the vessels in approaching the port area where the maneuvering space is limited. Introduction of virtual buoys would allow larger ships to enter the ports without having to extend the port infrastructure for their accommodation.

The suggested enhancement of the VTS system through ICT integration could be achieved by the complementary use of the Automatic Identification System (AIS[3]) which would provide efficient information for the safe navigation of vessels, including the state of the sea, traffic details, information in case of emergency, etc. Upon passing the given reference line, a vessel would be given the information according to the navigational priorities defined by shore-based stations (Figure 3). The defined reference lines would be set towards base stations at the shore with additional reference transponders reporting to the base stations. In Figure 3 the ship "B" would receive information between the transponders (observation points) B and C. Information from the base station A and transponder (observation point) A would not be sent to the ship "B" as she is leaving the area A so that the information referring to this area is no longer important to the ship "B".

[3] AIS is an automatic tracking system used for identifying and locating vessels by electronically exchanging data with other nearby vessels, AIS base stations and satellites. Typical data include the vessel's name, call sign, destination, estimated time of arrival, type of vessel and her draught.

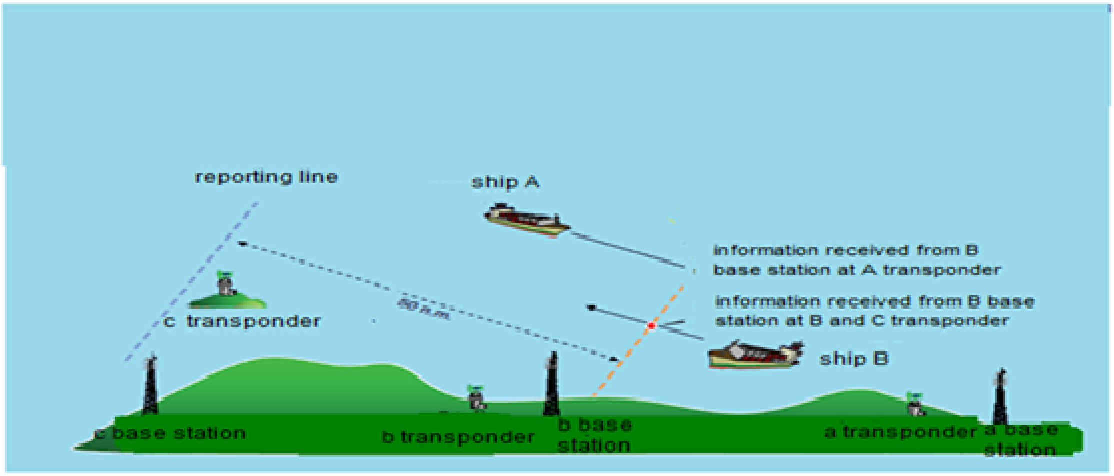

Figure 3. Proposal for enhanced ICT integration within a VTS zone
Source: Author

Communication systems have to meet the requirements of the end users [4]. The existing communication systems consist of: sensors, antennas, transponders and devices whose task is to receive and transmit information to end users. The suggested enhancement of the integrated ICT and its application through e-Navigation involves the introduction of robotics, machine sensitivity, ergonomics and intelligent computing.

Increased efficiency of AIS facilities is suggested; these devices are expected to send safety messages towards vessels and VTS operators in order to enhance the safety of navigation in the dense traffic areas where AIS services are much more needed than in the areas where the traffic is scarce (Figure 4). In this particular case, it is suggested that an “intelligent notification model” is established. On the basis of diagrams that follow the movement of vessels, the model would report necessary information in the event of crossing the passage restriction line (red line). The red line represents the area of the dangerous proximity of the shoreline to the shallow waters. These messages would be sent by the VTS operator and would include:

- Monitoring of the vessel under way (in the event of grounding or any other unforeseen situation),
- Monitoring of the vessel at anchorage (in the event of anchor dragging or shifting).

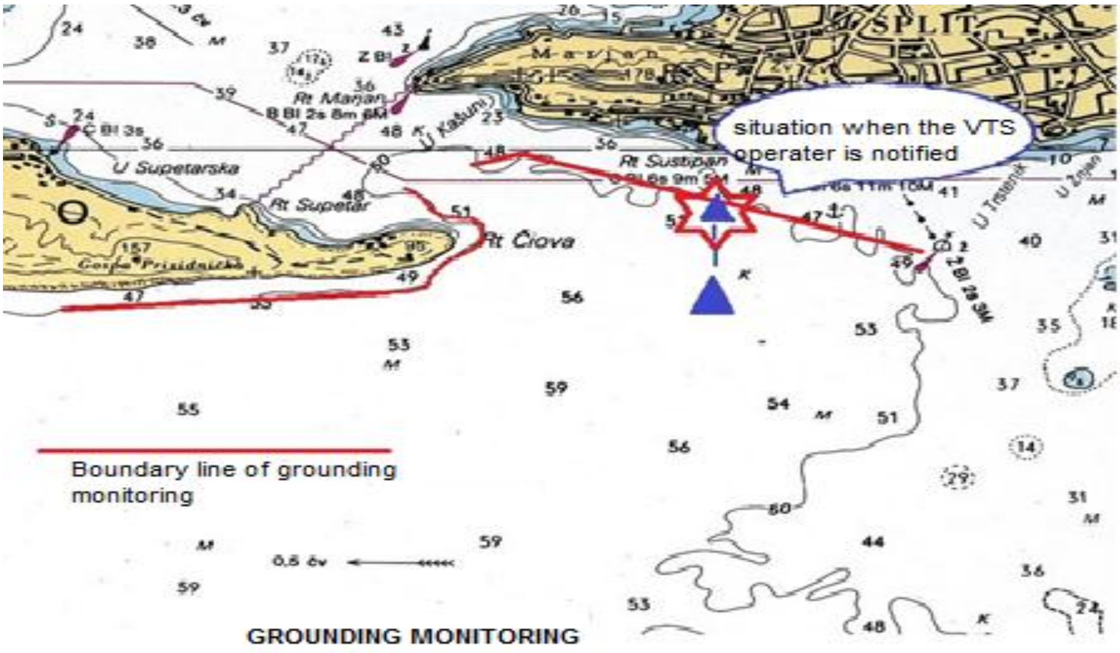

Figure 4. Monitoring of the vessel's position through enhanced ICT integration
Source: Author

In the event of crossing the red line, the proposed intelligent notification model would produce dynamic information on (n) vessels along the given (m) length of the track for various vessels that are entered into the diagram according to certain parameters:

- Vessel's draught (D),
- Vessel's course (K),
- Vessel's turning radius (T),
- Vessel's speed (S).

In addition to the vessels' parameters, the model would make use of the environment's parameters such as:

- Stream / current in the vessel's area (C),
- Wind in the vessel's area (W),
- Water depth beneath the vessel (UKC).

Apart from the parameters related to the vessel's features and her natural environment, the model would also use the parameters of forces acting interactively between vessels and between a vessel and the mainland, i.e. the port. Deviations displayed on the diagram which are obtained through simulations of movement for various vessel sizes and speeds in various weather conditions would be closely monitored. These oscillations would provide a groundwork for dividing the area in zones (intended for small, medium and large vessels). The alert would be sent automatically to the VTS operator whenever a vessel would pass the allocated zone, i.e. the areas where her passage is allowed (red line - Figure 4). These features and enhancements would increase the operational safety of the very vessel and other nearby vessels. Finally, in this way the observed area would be better protected against undesirable threats to the marine environment.

3. EXPECTED RESULTS OF IMPLEMENTING THE ICT INTEGRATED SYSTEMS

A certain period of observation time is required to achieve efficient results and to obtain a quality analysis of these data. The implementation of ICT and the application of e-Navigation in maritime shipping would affect four segments of the sea traffic [7] :

- Integrated systems of the onboard management,
- Organization of the maritime traffic,
- Communication systems,
- Passage planning processes.

Results of the implementation of integrated systems of the onboard management are expected to be gradually applied in Resilient Position Timing (RPNT[4]). Results of the implementation of integrated systems within the organization of the maritime traffic are expected in the area of additional reduction of CO_2 emission, higher efficiency and increased level of safety of the maritime traffic by means of the suggested actions in the monitoring of vessels (Figure 4). Results of the implementation of integrated systems in communication are expected within the integration of electronic equipment that is necessary for an efficient and enhanced vessel-vessel and vessel-shore-vessel communication, and in better utilization of the AIS systems in communication. As for communication systems in the domain of e-Navigation, we propose the introduction of automated and standardized functions for optimal navigational communication and for obtaining accurate information for a particular voyage. These functions should include safety and security information sent from the shore to the end onboard users. The implementation and application of e-Navigation would result in improved passage planning due to the faster availability of data, and the faster corrections of e-charts because of the introduction of onboard on-line systems. The immediate result of the implementation of on-line systems onboard merchant vessels will be the faster optimization of the sailing routes with regard to weather parameters.

It is expected that the ICT integration will reduce errors as the integration will provide important safety and navigational information (tidal streams, high/low tides in a given port and other data available at ECDIS interface), which is essential when maneuvering in confined port waters. The successful integration could be a great support to navigation control systems in collision avoidance and assessment of risks and hazards in a variety of scenarios (canals, port entrances, shallow inshore waterways, high density traffic areas…). The integration of communication systems should involve an authorized transfer of data towards a vessel, between vessels and the shore, and across shore and port authorities.

4. CONCLUSION

The enhancement of the existing electronic systems and services, which is facilitated through ICT integration, enables a simpler and safer maritime traffic management. The safety of sea traffic would particularly improve sailing through the areas that are considered as dangerous for navigation (polar routes, the North-West Passage, etc.) or in confined areas (straits, canals, ports, etc.). The enhancement of the electronic systems is enabled by using a model that calculates the anticipated vessel's movement beforehand.

It is expected that the implementation of the enhanced systems and services would also reduce operational costs, especially the costs associated with towage, fuel consumption, delays, adverse weather conditions and the like. The services provided by the integrated ICT system do not require major modifications of the existing infrastructure and devices. Previous and present researches focused on e-Navigation application, particularly the ones conducted in Germany and Denmark, have not resulted in a wider implementation of the e-Navigation. The latter has not yet been recognized as a potential solution to the enhanced traffic management due to unsatisfactory efforts in establishing efficient links among vessels, shore and seaways. Further ICT integration research producing comparative analyses of the

[4] RPNT is a suggested system using backup positioning in the event of failure or loss of GPS signals

current systems and services and the suggestions for possible improvements can significantly enhance the safety of navigation in dangerous areas.

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CONTRIBUTION TO ECDIS RELIABILITY

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ABSTRACT
Integrated Bridge and Navigation Systems (IBS/INS) are designed to meet all IMO International Maritime Organization and classification societies' requirements all the way up to one-man bridge operation on modern merchant ocean going ships. Although main subsystem's Electronic Chart Display and Information System (ECDIS) redundancy is mandatory onboard ocean going merchant ships, that is far from being truly redundant. Duplication of exact same equipment does not double reliability and availability of system. Statutory rules request to maintain ECDIS as part of safety plan. This procedure of updating, as part of obligatory maintenance, in praxis, leads to errors emphasized even by manufactures: either from provided equipment producer, or by nautical charts producer. If those systems errors occur, ship safety is in danger, because ECDIS producers suggest mariners to use paper charts backup in such situations. New approach in design concept of technical solution is presented and proposed.

KEYWORDS
e-navigation, ECDIS, redundancy, availability, reliability, backup

DOPRINOS POUZDANOSTI ECDIS-A

SAŽETAK
Integrirani navigacijski sustavi zapovjednog mosta engl. Integrated Bridge and Navigation Systems (IBS/INS) su izrađeni prema svim zahtjevima IMO engl. International Maritime Organization i klasifikacijskih društava kako bi omogućili upravljanje modernim prekooceanskim trgovačkim brodom na razini jednog čovjeka. Iako je redundancija glavnog podsustava ECDIS engl. Electronic Chart Display and Information System (ECDIS) obvezna na prekooceanskom trgovačkom brodu, sustav je daleko od toga da bude doista redundantni. Dupliranje identične opreme ne udvostručuje pouzdanost i dostupnost sustava. Zakonom propisana pravila zahtijevaju održavanje ECDIS kao dio plana sigurnosti. Ovaj postupak ažuriranja, kao dio obveznog održavanja, u praksi, dovodi do pogreški koju čak i proizvođači ističu: ili proizvođač same opreme, ili proizvođač nautičkih karata. Ako se pojave takve greške sustava, sigurnost brodova je kompromitirana, jer ECDIS proizvođači sugeriraju pomorcima koristiti tada papirnate pomorske karte kao backup u ovoj situaciji. Novi pristup u dizajnu tehničkog rješenja predstavljen je i predložen.

KLJUČNE RIJEČI
e-navigacija, ECDIS, redundancija, raspoloživost, pouzdanost, backup

1. INTRODUCTION

Implementation of computer based technology onboard delivers new risk factors to maritime safety. IMO [3] due to new trends in e-navigation and it close relationship to communications has consolidated former sub-commissions for navigation (NAV) and communications/Search and Rescue (COMSAR) in new sub-comitee Navigation, Communications and Search and Rescue (NCSR). First session was held 30 June to 4 July 2014 [1]. E-navigation, mainly its electronic navigation systems, is part of IBS/INS design. Subsystem that operates the ship, not only that replaces paper charts, but offers advantages concerned to implementation of Information System with extra features is called Electronic Chart Display and Information System (ECDIS). When one device is used to replace functions of few devices, key problem is malfunction of such device. Mandatory redundancy of such system becomes obligatory, but even that does not provide satisfactorily level of reliability and safety is not. Second part contains ECDIS description. It gives an overview of device design, application, nautical charts, back-up, crew training requirements for ECDIS and updating of ECDIS in details. An error could occur due to maintaining and updating of such complex system as ECDIS and that error can lead to system's malfunction. Third part contains redundant model of present state and proposed technical solution for improvement of present state. In final part conclusions and literature overview is given.

2. ECDIS

An ECDIS is a computer-based navigation system that complies with IMO and its International Convention of the Safety of Life at Sea (SOLAS) [2] regulations. ECDIS replaces classic navigation chart room with traditional lithographic (paper) nautical charts and makes work with paper charts easier – that results with production of faster and more accurate results. It is used to display and work with Electronic Navigational Chart (ENC). This includes passage planning, observation inputs, position fixing and electronic nautical charts corrections updating with data given by Notice to Mariners. ECDIS itself represents equipment consisted of computer, application software and database.

2.1. ECDIS device integration with other electronic systems

Device design can be produced as standalone device. It can also be produced as dual configuration, or it can be fully integrated in IBS/INS as part of multifunctional console (MFC).

ECDIS is the most complex and most expensive device onboard navigation system. ECDIS is an automated decision aid capable of continuously determining a vessel's position in relation to land, charted objects, navigation aids and unseen hazards while integrating a variety of real-time information. System is capable of displaying selected information from a system electronic navigational chart (SENC) with positional information from navigation sensors to assist the nautical officer in watch in route planning and route monitoring, and by displaying additional navigation related information if required. Own position system on ECDIS display is derived from GPS. Surrounding ships positions to the system are provided by means of radar. System displays own ship movement as well as other ships movement to similar way as radar display.

Due to fact that an ECDIS includes information system, it is possible that ECDIS provides information mariner request about displayed item. For instance, for lighthouse marked on chart by means of tower symbol, system can provide additional information about object. For example, tower is build from stone, 22m high from sea level, situated on Palagruža island, and has crew. Furthermore it can show object photo, and various other data that database contains. ECDIS stores various data in geographic object oriented database. System belongs to Geographic Information Systems (GIS).

ECDIS is usually high performance PC or graphic workstation computer installed into console, connected to other devices of ship's equipment as shown in Figure 1.

To assure correct display data interpretation on ECDIS screen it is needed to link system according to IMO mandatory and additional sensors. True heading is provided by gyro compass and speed of ship is provided by speed log. One of main advantages of using ECDIS is link to onboard position systems (eLoran, GPS, GLONASS and others) which bring constant precise flow of accurate position data. It is possible to link ECDIS to an Automatic Radar Plotting Aid (ARPA) – Radio Detection And Ranging (RADAR) and get data of surrounding ships movements from.

Overall system used for navigation onboard IMO SOLAS [2] ships must include that:

- ECDIS device needed to be manufactured under all required regulations and have all necessary certifications,
- ECDIS maintenance must comply regulations and
- Crew handling and using ECDIS must be certified.

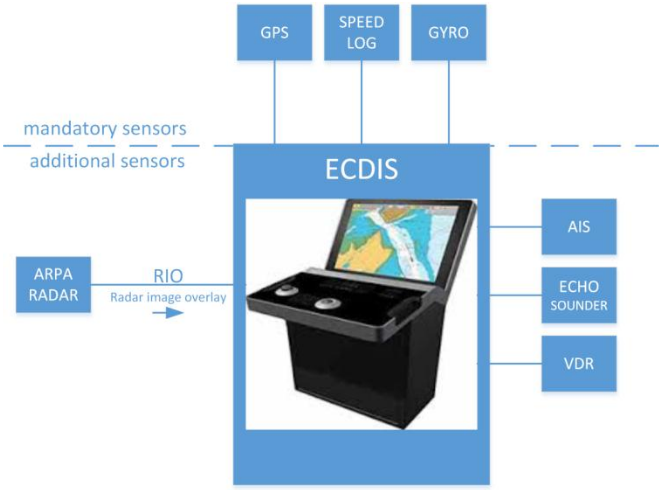

Figure 1. ECDIS with sensors
Source: authors

Application that a computer makes ECDIS compliant is made from user interface (UI) and so called ECDIS kernel, part of application program that provides data management and data displaying. This part of program is called function library. As appendix to chart displayed, user interface displays command buttons and other radio buttons used to work with nautical charts.

2.2. Implementation of ECDIS onboard ships

IMO established standard which regulates the use of ECDIS for navigation purpose as part of IBS/INS in 1995th year with Resolution A.817of Assembly during 19th session. IMO approved amendments to the international convention for SOLAS at the 86th session of the Maritime Safety Committee (MSC) in June 2009 which made it compulsory to fit an ECDIS. The amendment to SOLAS means that all large passenger liners, tankers and cargo ships will be obliged to fit ECDIS on a rolling timetable which begins in July 2012. Various ship types have different timetable for ECDIS implementation as presented in Figure 2.

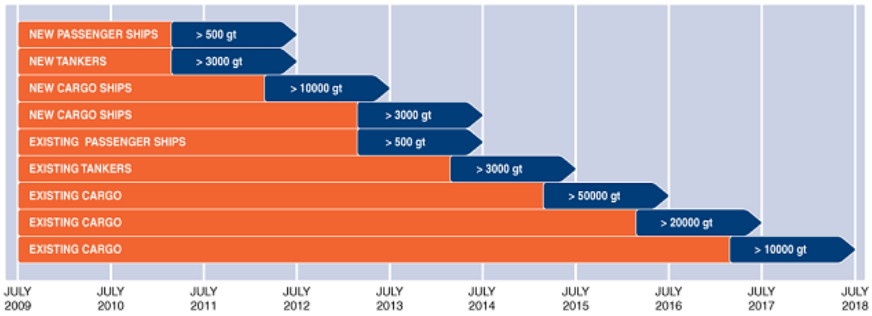

Figure 2. ECDIS rolling timetable
Source: PRIMAR

2.3. Electronic nautical charts

Electronic nautical charts (ENC) are usually delivered onboard ships by means of CD-s, DVD-s or over the Internet.

The requirements for carriage of nautical charts are outlined in SOLAS Chapter V. The relevant regulations are:

- Regulation 2, defines the nautical chart or publication (commonly called "official charts and publications")
- Regulation 19, specifies the equipment to be carried on different types of ships
- Regulation 27, specifies the requirement to keep charts and publications up to date.

Original data is also known as ENC. Chart database is organized by means of cells, so it spreads entire Earth surface without overlaps. All nautical chart objects are stored in cells, as well as objects produced by system operation such as: waypoints, notes, own ship positions, target ships positions. Officially authorities for producing of electronic nautical charts are national hydrographic offices only, as well as it is in paper charts production cases. Hydrographic bureaus can produce data by themselves, or they can consign it to private companies, take the commission, and at the end certify the results. Data produced by private companies without official certification cannot be used for navigational purposes, but only as add in data to official charts (paper or ENC's).

ECDIS can display either raster or vector electronic charts. Mariner main difference when using raster (scanned) or true vector chart is in active alarms when using electronic charts.

2.3.1. Scanned – raster nautical charts

United Kingdom Hydrographic Office (UKHO) over two hundred years produces various marine publications, primary nautical charts under Admiralty brand. Since 1996 UKHO has started digitalization by means of scanning own paper charts. This format is known under name Admiralty Raster Chart Service (ARCS). Beside this format US office - National Oceanographic and Atmospheric Administration (NOAA) has developed Raster Navigational Charts in BSB format from which it was developed hybrid, combined so called Dual Fuel ECDIS. It was capable of displaying raster charts overlaying with vector chart data overlay. This data where not input manually, but data origin directly from vector chart. Main advantage of this format was that whole paper charts did not have to be produced as vector data, but only the important parts of paper chart.

Simple raster chart is not part of information system; it is only scanned data, without added functionalities. Almost all paper charts are produced with North-up direction. If such chart is rotated in direction other than north, which cannot be divided by 90 degrees, lines become jaggy. All marks on chart are produced for North-up direction. When sailing, if officer in watch often orient chart in Course-up direction, raster chart will become blur. When zooming data in all marks proportionally become bigger, and when zooming out all marks are (unnecessarily) are shown

2.3.2. Vector nautical charts

Vector nautical charts are part of information system from very beginning of production. An ENC is a database; standardized to content, structure and format, issued for use with an ECDIS on the authority of a Government authorized hydrographic office. The ENC contains all the chart information necessary for safe navigation, and may contain supplementary information in addition to that contained in the paper nautical chart (e.g. sailing directions) which may be considered necessary for safe navigation.

IMO's definition for the Electronic Navigational Chart – ENC:

ENC means the database, standardized as to content, structure and format, issued for use with ECDIS on the authority of government - authorized Hydrographic Offices. The ENC contains all the chart information useful for safe navigation, and may contain supplementary information in addition to that contained in the paper, which may be considered necessary for safe navigation.

The publication "S-57—IHO Transfer Standard for Digital Hydrographic Data" describes the standard to be used for the exchange of digital hydrographic data between national hydrographic offices and for its distribution to manufacturers, mariners and other data users. This transfer and distribution has to take place in such a way that none of the meaning of the data is lost. This standard is not encrypted. Therefore IHO developed new S-63 standard to implement encrypting to standard S-57. Scheme S-63 provides specifications that allow participants to build S-63 compliant systems and distribute data in a secure and commercially viable manner. It is protected from piracy by prevention of unauthorized use of data by encrypting the ENC information. Determined by scheme, encrypted data decreases potential piracy risk and distribution of unofficial possible dangerous ENC's to mariners.

In Republic of Croatia only official nautical charts producer is Hydrographic Institute of Croatia. Contribution of world seas charting is done by producing ENC of east Adriatic sea.

All type approved ECDIS are manufactured to use official ENC S-63 formats with updates, respectively [3].

United Kingdom Hydrographic Office produces vector charts Admiralty Vector Chart Service (AVCS). Marks can have different attributes of importance. There is no need to display all information in any scales. There also must be scale minimum (SCAMIN) data.

Display base, permanently retained on the ECDIS display, consisting of:

- coastline (high water);
- own ship's safety contour, to be selected by the mariner;
- indication of isolated underwater dangers of depths less than the safety contour which lie within the safe waters defined by the safety contour;
- indication of isolated dangers which lie within the safe water defined by the safety contour such as bridges, overhead wires, etc., and including buoys and beacons whether or not these are being used as aids to navigation;
- traffic routing systems;
- scale, range, orientation and display-mode;
- units of depth and height;
- display type.

2.4. Back up ECDIS-a

Electronic navigation systems cannot be failsafe. There must be some form of back-up or redundancy to cover ECDIS failure.

IMO standards specify overall system which include primary ECDIS and appropriate back-up solution that must ensure safe takeover of ECDIS functions without resulting in a critical situation.

Back-up options are generally accepted as meeting SOLAS carriage requirements as following:

- For ships using ECDIS as their primary means of navigation (no paper charts), an additional and independent ECDIS shall be provided as a back-up. The back-up ECDIS should be connected to an independent power supply and connected to systems providing continuous position-fixing capability.
-
- When the ECDIS is being operated in Raster Chart Display System (RCDS) mode using RNC data due to lack of suitable coverage of electronic navigational charts (ENC), then an appropriate folio of up-to-date paper charts must be maintained for areas where only raster chart coverage is available.
- For ships using ECDIS as an aid to navigation, the ship must carry and maintain an appropriate folio of up-to-date paper charts.
- The ECDIS should be able to operate in a normal capacity even when it is connected and supplied by an emergency source of electrical power. As an ECDIS is a computer based system it must be protected by a UPS (uninterruptible power supply) capable of handling a 45 second blackout during a switch from the vessel's main to back-up power source without rebooting.

In this paper only ships using ECDIS as their primary means of navigation (no paper charts), and have mandatory redundant ECDIS accordance with figure 2. will be analyzed. Backup of ECDIS is mandatory in accordance with IMO SOLAS regulation V/19.2.1.4. where is clearly stated that ECDIS that is not updated on regular basis does not meet requirements for systems used for navigation. Air condition of ECDIS workplace must also have redundancy and possibility to power from emergency power source.

Flag state must approve suggested backup solution and must comply to IMO regulations.

2.5. Crew requirements to work with ECDIS

In accordance to Manila amendments to International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) from year 2010 certain flag states have issued requirements that if a ship is using ECDIS as a primary means of navigation, then officers must have generic and type specific training/certification [4].

- Generic ECDIS training should follow the provisions of the IMO-approved standardized Model Course 1.27, which lays down the minimum training and knowledge requirements for a navigation officer to operate ECDIS equipment.
- Type/model specific ECDIS training is a requirement of the International Safety Management (ISM) Code under section 6: "The Company should establish procedures to ensure that new personnel and personnel transferred to new assignments related to safety and protection of the environment are given proper familiarization with their duties. Instructions which are essential to be provided prior to sailing should be identified, documented and given." Under the terms of the ISM Code, all officers must be familiar with the equipment they are expected to use; this includes ECDIS equipment.

2.6. Updating and maintaining EDCIS described

According to IMO regulations, ECDIS need to be updated and maintained. Example of maintaining of ECDIS with UKHO Admiralty charts (Admiralty database) is considered [5].

AVCS ENCs are distributed on physical optical (CD or DVD) or USB media and are encrypted according to the International Hydrographic Organization (IHO) S-63 Data Protection Scheme. Initially the AVCS user is provided with all of the latest base and update discs which contain all the ENCs in the Admiralty Vector Chart Service. However these cannot be accessed by the ECDIS unless a valid set of S-63 ENC Permits is installed. Each ENC Permit is unique and is the method which gives the user selective access to particular ENCs required for an intended voyage(s). On an exceptional basis, in certain circumstances it may be necessary for a vessel to get access to an AVCS chart at very short notice, for instance if she has to divert her route due to a medical or safety emergency. Then (by means of communication link) free temporary license key can be obtained which unlocks the maps that are not covered with paid license key. The AVCS Base CDs are periodically re-issued to free up space on the AVCS Update CD , this is about every 6 to 8 weeks. The AVCS Base CDs must be loaded first before any AVCS Update CD can be loaded. The AVCS Base CD label contains the date and week of issue. Users should be careful to only load an AVCS Update CD that is newer than the installed bases. Users with internet link can check the status of the latest AVCS Base CDs using: http://www.ukho.gov.uk/AVCS. Although ECDIS equipment and ENCs are designed to be very reliable, there is a slightly increased risk of problems occurring when ENCs are being added, removed or updated. For this reason, attempting of updates when the equipment is being used for primary navigation or if the vessel is committed to an imminent departure is strictly forbidden [5].

In [5] it is emphasized that any updating is great potential danger to ship's safety and can lead to malfunction. Other manufacturers of charts and equipment claim same. Importance of updating is mentioned in all publications concerned, and also in training facilities. All masters and navigation officers should be fully aware of how to update and maintain the specific onboard ECDIS. It should not be left for the designated navigation officer to have sole knowledge on the updating procedure and process [6]. Maintaining und updating of ECDIS not always have happy ending, and additional precautionary measures must be considered [7].

ECDIS and built in ENC's (databases) must be updated [6]. It can be occasionally and continuous. Occasionally update needed by application that runs ECDIS and new ENC versions [5]. Continuous updating concerns input of sailing data in information system, e.g. chart corrections. Updating can be efficient over data link, if provided.

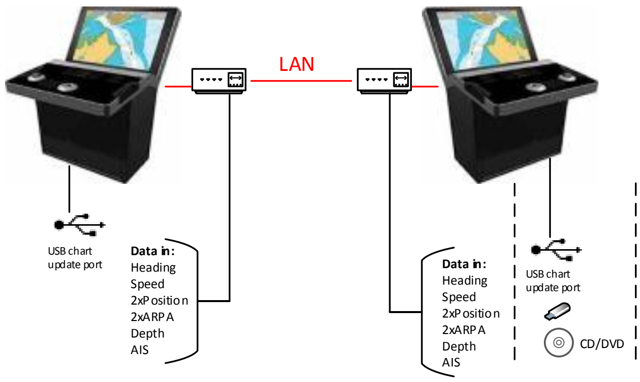

Figure 3. Dual ECDIS configuration
Source: authors

Example of ECDIS update redundant system is shown in Figure 3. Implementation of IBS/INS onboard ECDIS demonstrated that user interface is often main barrier to crew's good understanding of specific tasks and device familiarization.

3. ECDIS MODELLING

Subsystem of IBS/INS presented in figure 3. ECDIS could be represented with model shown in figure 4. ECDIS marked with 1 and 2 with related coefficients is shown [9].

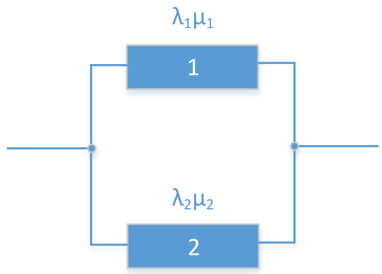

Figure 4. Redundant ECDIS configuration
Source: authors

Since system must be updated to comply stated IMO regulations, in parallel system serial update element is added marked with 3 in figure 5. This model corresponds to real ship ECDIS installation in accordance with SOLAS chapter V requirements. Due to serial update link nature, any imperfect update would lead to an in error both ECDIS devices, or system malfunction in spite of IMO intentions of increasing reliability of system with implementation of redundant devices.

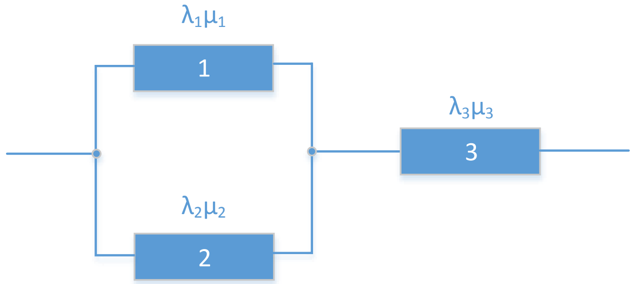

Figure 5. Redundant ECDIS configuration w/update
Source: authors

Inactive, cold standby system is proposed as technical solution of problem. Added green elements marked with 4 and 5 in Figure 6 introduce true parallel redundant system into system design. This can be accomplished by means of installing of totally different producer from either hardware with ECDIS application itself and different producer of ENC's. This solution implemented onboard as new backup option could completely avoid paper charts.

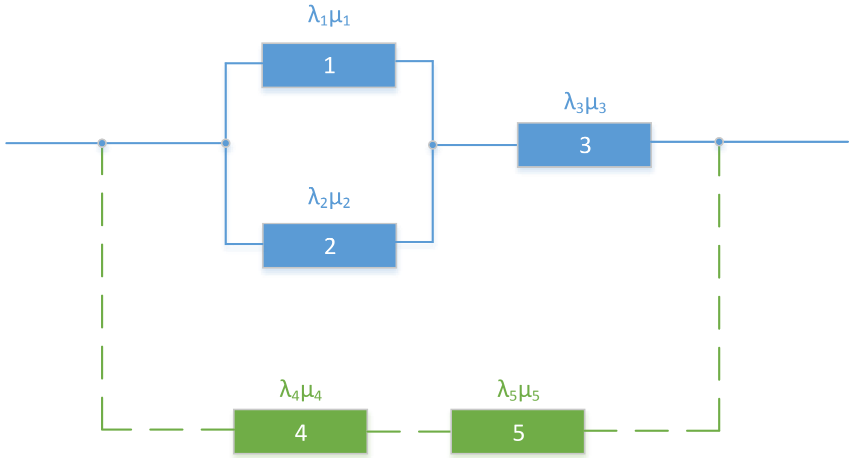

Figure 6. Model of redundant ECDIS with cold standby
Source: authors

Increased number of elements in parallel structure by adding another device as shown in Figure 7, increases the price of overall system. Despite that fact maritime safety would be less jeopardized than in obligatory present system.

Paper chart of sailing area for backup is, even if it is present onboard ship, not maintained - updated to newest chart corrections. Complications are even more because on one voyage it is not only one chart concerned, but few charts for single voyage. Paper chart usage is step backward compared to ECDIS driven IBS/INS functionality.

Cost of ownership of additional ECDIS installation and additional type/model specific crew training is not contribution to this solution, but it is definitely significant increase of reliability that results in significant increase of ship safety issue, for, relatively, small price.

If that additional, cold standby device installation one day IMO proclaims as mandatory safety device when main redundant system malfunction, updating of cold standby device would not treated as commercial price license because it could be proclaimed as maritime emergency and updating of such need can be free of charge with temporary license key permit provided by data link.

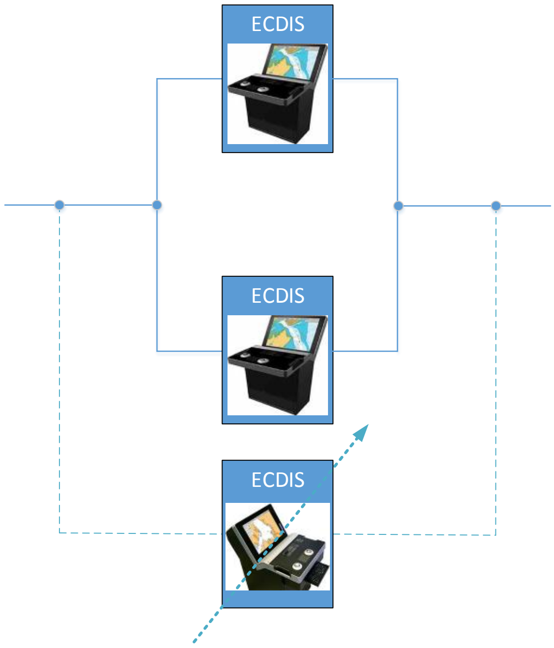

Figure 7. Proposed technical ECDIS solution
Source: authors

4. CONCLUSIONS

Modern e-navigation is a set of integrated technologies in IBS/INS. Navigator mission is to pilot ship on desired route in safe manner. ECDIS devices developed historical development from device which was aid to navigation to mandatory device used for navigation as primary, vital means.

Two redundant ECDIS are IMO mandatory devices in IBS/INS design. IMO's intention was with device duplication, UPS duplication and physical distance between devices contribute to higher overall system reliability. Reliability and availability of obligatory equipment in not doubled by means of duplicating equipment.

ECDIS is the most complex and most expensive device onboard navigation system. ECDIS is an automated decision aid capable of continuously determining a vessel's position Assigned role in IBS/INS does not authorize that vital subsystem to malfunction, because usage of non updated paper charts significantly decreases high level of accomplished maritime safety.

Proposed model of cold standby device system will return high level of accomplished maritime safety in case of active redundant system malfunction much better then paper chart. The use of third ECDIS device of different producer either device or chart system will be significant improvement to maritime safety.

Only important limit to proposed technical solution is cost of ownership of additional ECDIS installation and additional type/model specific crew training. When updating suggested cold standby device, when main redundant system malfunctions, updating is not commercial, but maritime safety issue in emergencies. Proper implementation in IMO procedures should negotiate to manufactures build additional system at competitive price of both; ENC and ECDIS device itself.

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PLOTTING OF MANUALLY OBTAINED FIXES ON ECDIS

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ABSTRACT
In this paper the problem of sailing solely by using ECDIS without signal from GPS is emphasized. There is a very present danger of GPS signal being jammed or lost and chance of malfunction of GPS receiver onboard a ship. ECDIS shows ground stabilised motion of the vessel. In the case of GPS signal being lost, ground stabilised picture can not be presented. If the position data becomes invalid some systems switch automatically to water stabilized mode. Authors put emphasis on the need of proper understanding of used input data in a system. Analyizing K-Bridge ECDIS using various input parameters when GPS signal is lost authors recommend plotting fixes manually without vectors presented either ground stabilized or sea stabilized.

KEY WORDS
ECDIS, lost of GPS signal, manual fixing

UCRTAVANJE OPAŽENE POZICIJE U ECDIS

SAŽETAK
U ovom radu je naglašen problem plovljenja bez GPS signala koristeći isključivo ECDIS. Postoji stalno prisutna opasnost gubitka ili ometanja GPS signala kao i vjerojatnost kvara GPS uređaja na brodu. ECDIS prikazuje kretanje broda u odnosu na dno. U slučaju gubitka GPS pozicije ECDIS ne može prikazati stabilizaciju preko dna. Kada se izgubi podatak o poziciji broda neki od sustava automatski prebacivaju na prikaz kretanja broda u odnosu na površinu mora. Autori ističu potrebu shvaćanja korištenih ulaznih podataka. Analizirajući K-Bridge ECDIS, koristeći različite ulazne parametre, kada se izgubi GPS signal, autori preporučuju ucrtavanje pozicije bez prikazivanja vektora kretanja broda bilo preko dna bilo preko površine mora.

KLJUČNE RIJEČI
ECDIS, gubitak GPS signala, ucrtavanje pozicije

1. MANDATORY REQUIREMENTS

Electronic Chart Display and Information System (ECDIS) means a navigation information system which with adequate back-up arrangements can be accepted as complying with the up-to-date chart required by regulation V/20 of the 1974 SOLAS Convention, by displaying selected information from a system electronic navigational chart (SENC) with positional information from navigation sensors to assist the mariner in route planning and route monitoring, and if required display additional navigation-related information[1].

IMO SOLAS regulations V/2, V/19 and V/27 show that the carriage requirement for charts and publications can be fulfilled by:

- - Carriage of official and up to date paper charts, or
- - Carriage of a type-approved ECDIS .

Only a type approved ECDIS operating with up to date ENCs (Electronic Navigational Chart) and with appropriate back up may be used to replace all paper charts on a vessel.

In order to replace paper charts, ECDIS must fulfill considerable technical requirements laid down in ECDIS Performance Standards:

- The chart data in use must be official - ENCs where these are available (By IMO definition ENCs can only be produced by or on the authority of a government, authorised Hydrographic Office or other relevant government institution. Any other vector data is unofficial and does not meet carriage requirements);
- The graphic display on the screen must meet the equipment-independent specification; and
- The equipment must support the full range of navigational functions that can be performed on the traditional paper charts.

No electronic system is completely failsafe. IMO Performance Standards therefore require that the “overall system” include both a primary ECDIS and an adequate independent back up arrangement that provides:

- Independent facilities enabling a safe take over of the ECDIS functions in order to ensure that a system failure does not result in a critical situation; and
- A means to provide for safe navigation for the remaining part of the voyage in case of ECDIS failure.

These statements allow various interpretations as to what are the minimum functional requirements or back up arrangements. There are two commonly accepted options:

- A second ECDIS, connected to an independent power supply and a separate GPS position input;
- An appropriate up to date folio of official paper charts for the intended voyage

Some Flag States may permit other options (e.g. radar-based systems such as ”Chart-Radar”).

According to IMO Resolution A.817 (19) radar information or other navigational information *may be* added to the ECDIS display. It should not degrade the SENC information, and should be clearly distinguishable from the SENC information. It is stated that ECDIS and added navigational information should use a common reference system. If this is not the case, an indication should be provided. Transferred radar information may contain both the radar image and ARPA information. If the radar image is added to the ECDIS display, the chart and the radar image should match in scale and in orientation. The radar

[1] Imo Resolution A.817 (19) Performance Standards For Electronic Chart Display And Information Systems (ECDIS)

image and the position from the position sensor should both be adjusted automatically for antenna offset from the conning position. It should be possible to adjust the displayed position of the ship manually so that the radar image matches the SENC display. It should be possible to remove the radar information by single operator action.

Performance standard 10.5 *Route monitoring* states that the ship's position should be derived from a continuous positioning system of an accuracy consistent with the requirements of safe navigation. Whenever possible, a second independent positioning method of a different type should be provided; ECDIS should be capable of identifying discrepancies between the two systems. ECDIS should provide an indication when the input from the position-fixing system is lost. ECDIS should also repeat, but only as an indication, any alarm or indication passed to it from a position-fixing system. Also, it is highlighted that the positioning system and the SENC should be on the same geodetic datum. ECDIS should give an alarm if this is not the case.

Performance standard 12. *Connections with other equipment* quates that ECDIS should not degrade the performance of any equipment providing sensor inputs. Nor should the connection of optional equipment degrade the performance of ECDIS below this standard. ECDIS should be connected to systems providing continuous position-fixing, heading and speed information.

2. MANUALLY PLOTTING POSITION ON ECDIS

There is a very present danger of GPS signal being jammed or lost. Also, there is a chance of malfunction of GPS receiver onboard a ship. There should be a method of recording when and how satellite derived position has been checked.

ECDIS equipment has a facility for plotting manually-obtained lines of position (LOPs) to determine own ship's position on the display. ECDIS manufacturers need to install these features to improve safety of navigation. LOPs can be obtained from RADAR or by visual observations.

The radar transmits a short radio pulse with very high pulse power. This pulse is focused in one direction only by the directivity of the antenna, and propagates in this given direction with the speed of light.

If in this direction is an obstacle a very small portion is also reflected back to the radar. Since the propagation of radio waves happens at constant speed (the speed of light **c_0**) this distance is determined from the runtime of the high-frequency transmitted signal. Since the waves travel to a target and back, the round trip time is dividing by two in order to obtain the time the wave took to reach the target. Therefore the following formula arises:

$$R = \frac{c_0 \cdot t}{2} \quad (1)$$

where: C_0 = speed of light = $3 \cdot 10^8 \, {}^{m}/_{s}$
t = measured running time [s]
R = slant range antenna - aim [m]

The distances are expressed in kilometers or nautical miles (1 NM = 1.852 km)[2].

According to performance standards for minimum range with own ship at zero speed, an antenna height of 15 m above the sea level and in calm conditions, the navigational buoy [The typical navigation buoy is taken as 5.0 m^2 for X-Band and 0.5 m^2 for S-Band; for typical channel markers, with an RCS of 1.0 m2 (X-band) and 0.1 m2 (S-band) and height of 1

[2] www.radartutorial.eu

metre, a detection range of 2.0 and 1.0 NM respectively] should be detected at a minimum horizontal range of 40 m from the antenna position and up to a range of 1 NM, without changing the setting of control functions other than the range scale selector. The radar system should be capable of displaying two point targets on the same bearing, separated by 40 m in range, as two distinct objects. The radar system should be capable of displaying two point targets at the same range, separated by 2.5° in bearing, as two distinct objects. The target detection performance of the equipment should not be substantially impaired when own ship is rolling or pitching up to +/-10°.

The system accuracy of fixed range rings should be within 1% of the maximum range of the range scale in use or 30 m, whichever is the greater distance. The VRMs (Variable Range Markers) should enable the user to measure the range of an object within the operational display area with a maximum system error of 1% of the range scale in use or 30 m, whichever is the greater distance. At least two electronic bearing lines (EBLs) should be provided to measure the bearing of any point object within the operational display area, with a maximum system error of 1° at the periphery of the display.

Measurements from own ship (e.g. range rings, target range and bearing, cursor, tracking data) should be made with respect to the consistent common reference point (e.g. conning position). Facilities should be provided to compensate for the offset between antenna position and the consistent common reference point on installation. Where multiple antennas are installed, there should be provision for applying different position offsets for each antenna in the radar system. The offsets should be applied automatically when any radar sensor is selected.

Accuracy of lines of position obtained by a radar should be within 30 m using a fixed range rings or VRMs while LOP using an electronic bearing line (EBL) should be provided to measure the bearing of any point object with a maximum system error of 1°.

This makes RADAR reliable means for providing accurate position on ECDIS. Beside that a mariner can use any available means, independent of GPS, to provide lines of position to be used for plotting position on ECDIS.

Assuming that there is only ENC for position to be plotted without GPS position (latitude, longitude), LOPs should be used accordingly. LOP is a line connecting all the possible positions of a ship as determined by a single observation. When two LOPs intersect we can construct a position fix.

Without GPS signal a mariner should proceed with monitoring of planned route. A mariner must be aware that movement of ship's symbol on chart depends on input data.

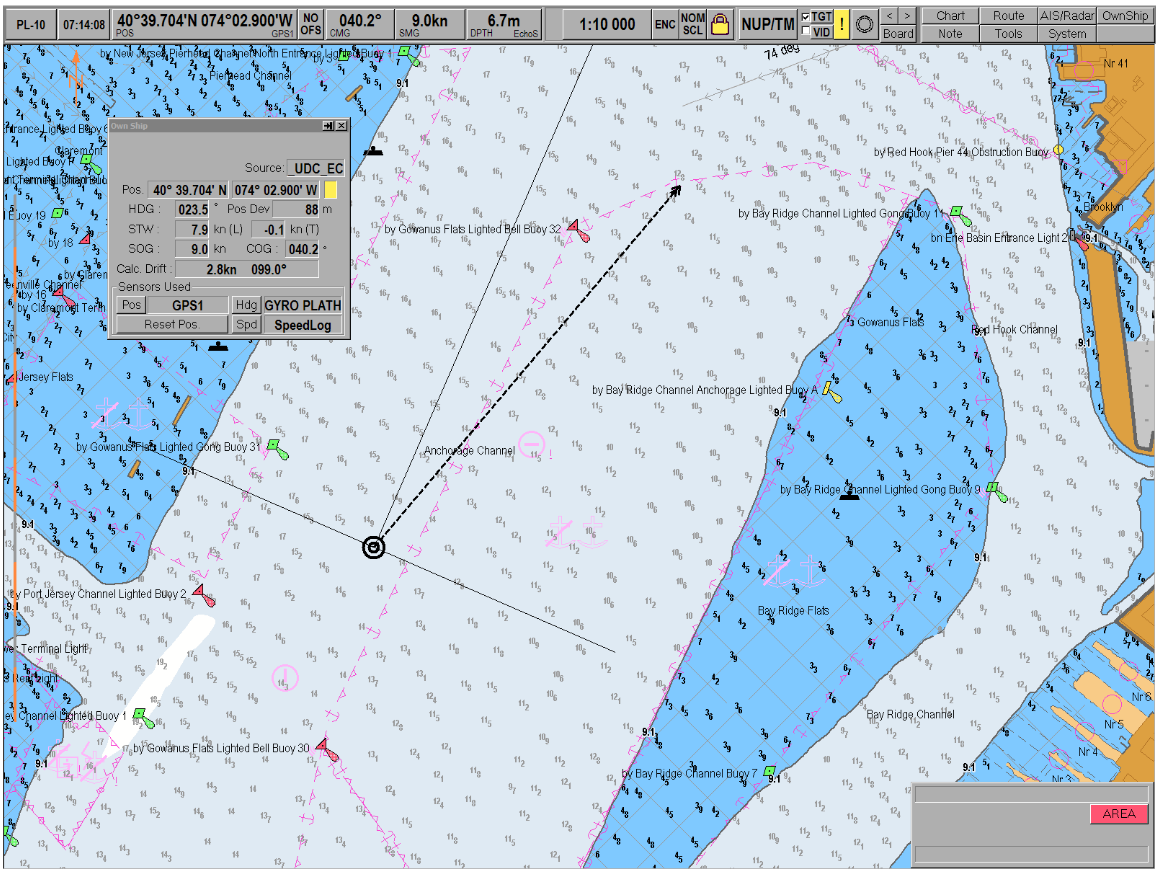

Figure 1. ECDIS showing ship's heading and ground stabilised vector
Source: K-BRIDGE ECDIS, Kongsberg

By displaying electronic navigational chart (ENC) with positional information from navigation sensors, ECDIS assists a mariner in route monitoring. ECDIS shows ground stabilised motion of the vessel as it is presented in figure 1. The own ship vector symbol is a line indicating ship's direction and speed. The end of the line is presented with a double arrowhead when in ground stabilization mode and a single arrowhead when in water stabilization mode.

In figure 1. our vessel, besides her motion through water, runs into danger (outside the buoyed channel) if she proceeds with present course over ground and speed over ground. Heading of the ship is 023.5°; STW (Speed Through Water) is 7.9 Kn, COG (Course Over Ground) is 040.2° and SOG (Speed Over Ground) is 9.0 Kn which makes calculated drift of 2.8 Kn in 099.0°.

Taking a quick look at ECDIS screen makes an observer aware of ship's position, direction and speed (course/speed over ground).

In the case of GPS malfunction, ground stabilised picture can't be presented. If the position data becomes invalid some system switch automatically to water stabilized mode (speed through water and heading) for dead reckoning. It follows saying „RUBBISH IN RUBBISH OUT". For an unexperienced observer it can be extremly hazardous. Without GPS signal drift calculation is not an easy job for a mariner. Relying solely on ECDIS one can think that this should be correct movement of the ship as it can be seen in figure 2.

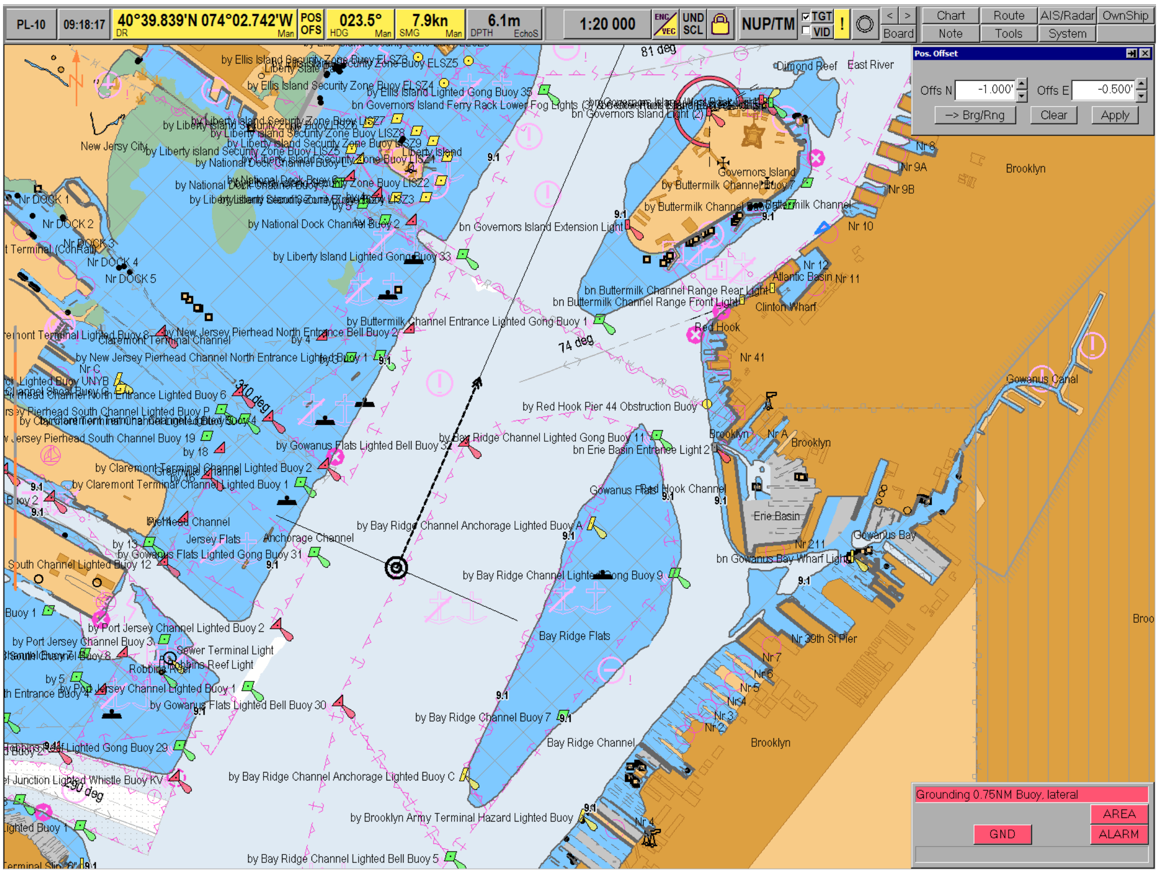

Figure 2. ECDIS showing ship's heading and sea stabilised vector
Source: K-BRIDGE ECDIS, KONGSBERG

To avoid misunderstanding of available input parameters, the best way is to have ship's symbol freezed in a position without speed data (see figure 3.). To monitor ship's movement, manually position fixing using LOPs obtained by RADAR or any other available means must be utilized. ECDIS systems use two additional options in tool menu: line of position and position fix. After plotting position, system allows a mariner to offset ship symbol in a new position. The procedure of getting position fix is different in various types of ECDIS.

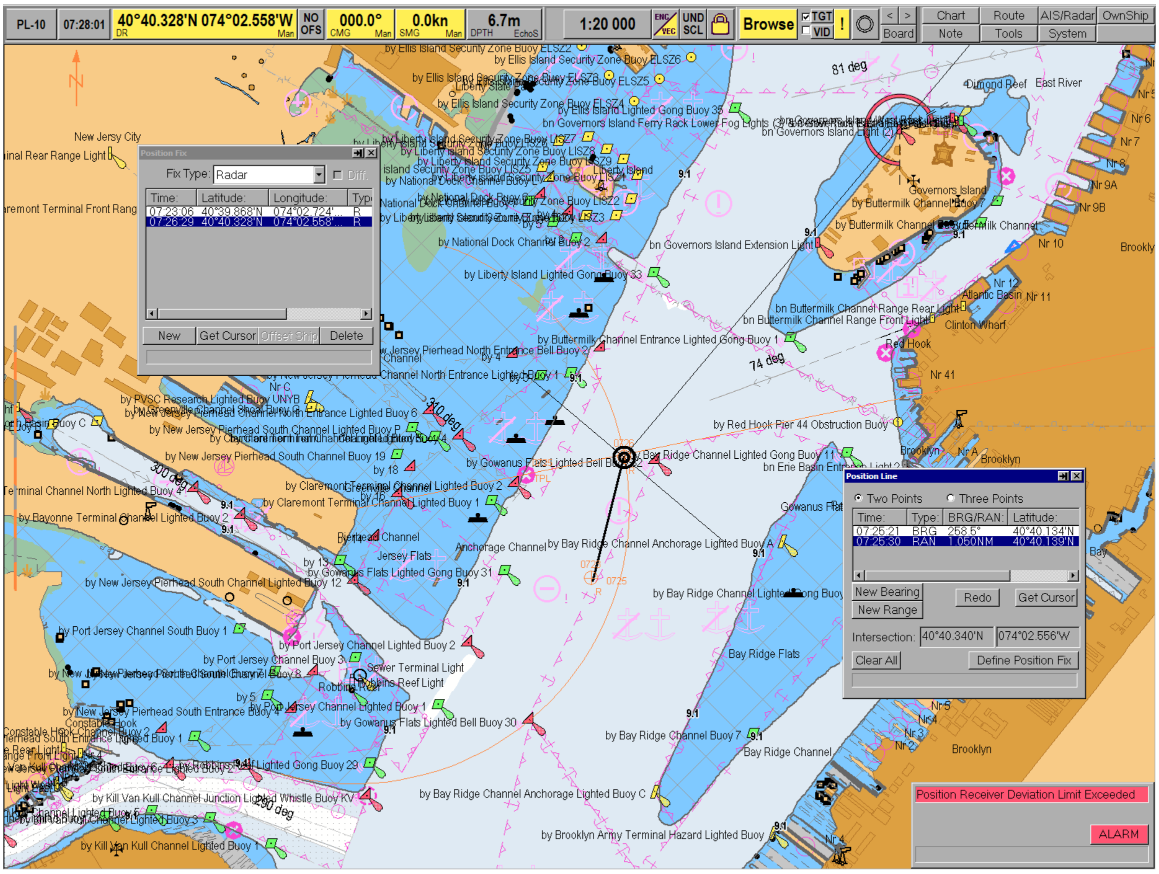

Figure 3. ECDIS showing ship's position by manual fixing using bearing and range from an object

Source: K-BRIDGE ECDIS, Kongsberg

Regarding K-Bridge, position fix can be obtained by using two or three LOPs (see figure 3.). Position fix can be found in intersection of bearing(s) and/or range(s) from an object(s). Then, point of intersection is marked by cursor from another panel named “Position Fix”. After that, using function “Offset Ship” system moves a ship’s symbol to a new position on electronic chart. To check if this position is correct radar overlay can be used. If radar overlay and chart matches one can consider that position obtained by this way is correct as it can be seen in figure 4.

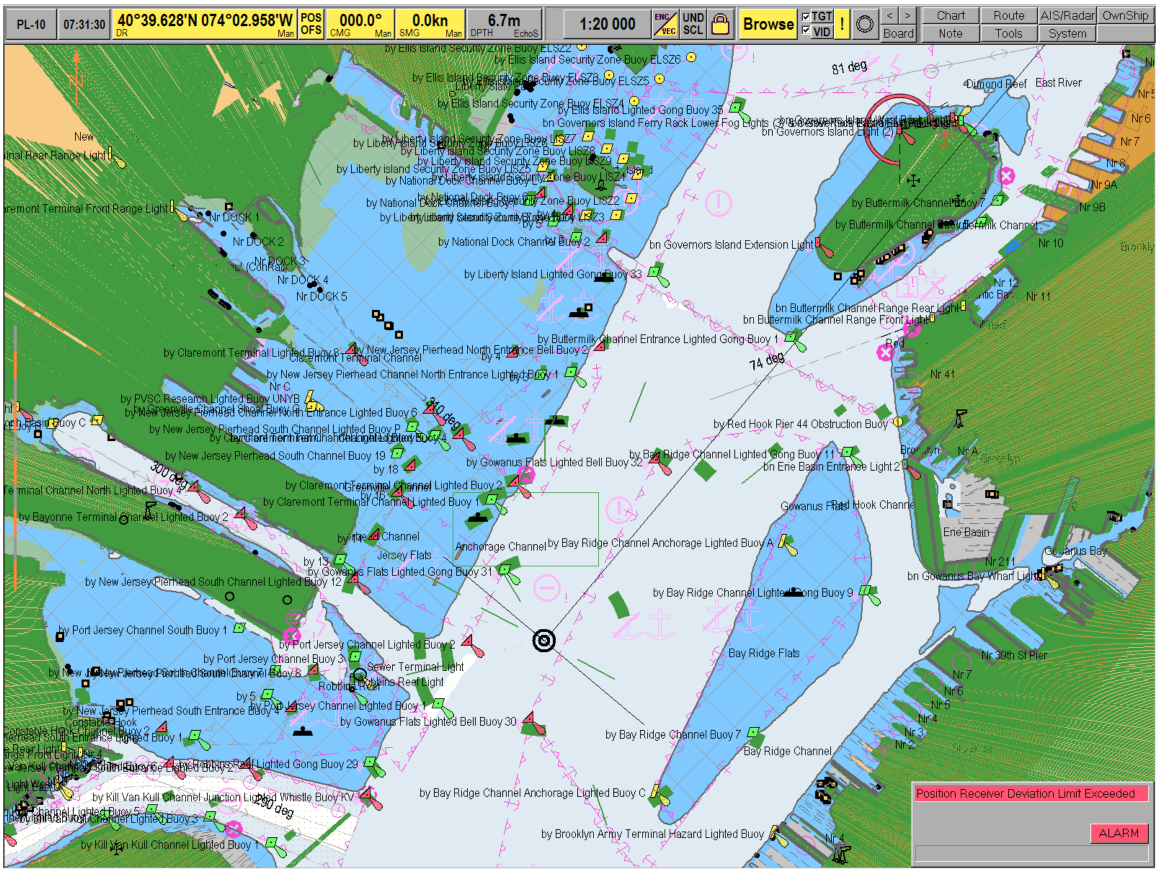

Figure 4. ECDIS showing RADAR video
Source: K-BRIDGE ECDIS, Kongsberg

3. CONCLUSION

By displaying electronic navigational chart (ENC) with positional information from navigation sensors, ECDIS assists a mariner in route planning and monitoring. In this paper, authors study the situation of loosing GPS signal. In the case of GPS malfunction, ground stabilised picture can't be presented. If the position data becomes invalid some system switch automatically to water stabilized mode (speed through water and heading) for dead reckoning. For an unexperienced observer it can be extremly hazardous. To monitor ship's movement on an ECDIS without GPS signal authors suggest manually fixing position using LOPs obtained by RADAR or any other available means. After plotting position on an ECDIS, system allows a mariner to offset ship in a new position. To check if this position is correct radar overlay can be used. If radar overlay and chart matches one can consider that position obtained by this way is correct. Sea stabilized vectors, without taking into account the current (known as *set and drift* in marine navigation) shouldn't be used.

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THE RFID CHIPS IN IMPROVING LOGISTICS PROCESSES AND REDUCING RISKS AT THE CONTAINER TERMINAL

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ABSTRACT
In recent years RFID technology has recorded a huge progress in almost all areas of the business where monitoring and control in real time are necessary. The opportunities that RFID offers are still limited, but only in terms of range. On the other hand, this system ensures great reduction of the time needed to carry out port operations and increase the safety of both cargo and workers at the port. A particularly interesting part of our work/paper that we would like to review is in the field of security and surveillance of port terminals. Today, we see an increasing number of port operations carry risks: pollution, injuries and the impact on the health of workers and similar. Given that the range of RFID (tags) increased and their price has decreased significantly as passive, semi active and active, their use has become more certain. Since it is possible to put tags on protective equipment of workers (shoes, belt, hat), supervision and safety is greatly improved and upgraded. The RFID tags are designed so that they itself can have a large number of sensors for humidity, distance, light, temperature, position, speed, biometrics and others. All data read from the sensor and transmitted by tag are available for an operator at the port in real time, who can warn workers through radio links if necessary.

KEYWORDS
RFID, monitoring, logistical integration, reducing risks

RFID ČIPOVI U POBOLJŠANJU LOGISTIČKIH PROCESA I SMANJENJU RIZIKA NA KONTEJNERSKOM TERMINALU

APSTRAKT
RFID tehnologija je proteklih godina zabilježila ogroman napredak u gotovo svim sferama poslovanja gdje je neophodan nadzor i upravljanje u realnom vremenu. Mogucnosti koje RFID pruža su i dalje ograničene, ali samo u smislu dometa. S druge strane, ovaj sistem obezbjedjuje da se u velikoj mjeri smanji vrijeme koje je do sada bilo potrebno za obavljanje luckih operacija i poveća bezbjednost, kako tereta tako i radnika u luci. Posebno interesantan dio na koji bi se osvrnuli u našem radu je iz sfere bezbjednosti i nadzora lučkih terminala. Danas se susrećemo sa sve većim brojem lučkih operacija koje sa sobom nose rizike od: zagađenja, povreda i uticaja na zdravlje radnika i sl. Sobzirom da je domet RFID (tagova) povećan i da se njihova cijena znatno smanjila kako pasivnih, poluaktivnih i aktivnih, njihova primjena je postala sve izvjesnija. Sa mogućnošću da se tagovi postave na zaštitnu opremu radnika (cipele, pojas, šlem), nadzor i sigurnost radnika je u mnogome poboljšan i unaprijeđen. RFID tagovi su dizajnirani tako da na sebi mogu imati veliki broj senzora za vlažnost, udaljenost, svjetlosti, temperaturu, poziciju, brzinu, biometriku i dr. Svi podaci koji se očitavaju sa senzora koje tag prenosi su dostupni operateru u luci, u realnom vremenu, koji može putem radio veze da upozori radnika u koliko je to neophodno.

KLJUČNE RIJEČI
RFID, monitoring, logisticka integracija, smanjenje rizika

1. INTRODUCTION

The RFID is automatic radio frequency identification system that uses a different radio frequency to communicate between the transmitter and the reader. The system is therefore consisted of a reader and a tag. The reader reads the data from the tag via antenna and then through a network, which can be internal (intranet) or external (internet), transfers it to the main control center, where the operator has complete insight to the sensor readings. Tags can therefore be: passive, semi-active and active. Passive tags do not have an independent power supply and work only when the tag is near the reader that reads data from it, i.e. only when it flashed its frequency beam. Their range is small only a few tens of centimeters and they carry a very small amount of information, so that the issues in question here are not suitable. Semi-active tags are tags that have their own power supply unit but are only used for special operations that tag carries. Data transfer is done only when the tag is flashed by a beam frequency drive, as with passive tags. The range of semi active tag can be up to a few meters.

However, key tags which provide the best insight into the current situation of both cargo and workers are active tags. They can store as well as deliver/provide a large number of data gathered from the sensor. The range of active tags can be several tens of meters, regardless of visibility between the reader and the tag. Also, readers can collect data from hundreds of tags simultaneously.

In this paper, we specifically address the active tags because they are the best suited for monitoring and management of port ops. Considering their range, speed, amount of data transmitted per unit of time, they are a natural choice in the transportation industry. With the development of internet and intranet networks providing a high level of security, RFID system has received the support needed in terms of transmission of data to the server for data storage and processing and to the operator. Planning an organized network of readers that are strategically arranged on the terminal would achieve maximum performance in terms of covering the entire terminal and easy communication between them and the transmitter, regardless of physical barriers. With the help of Wi-Fi networks, rapid transfer of large amounts of data with hundreds of tags per time unit to the operator and the server would be enabled. Here we focus on wireless mesh networks due to their ability to should a router fail to function properly override to the closest router in order to enable smooth operation of the entire system until the fault is rectified.

2. RFID TAGS: PAST AND PRESENT STATES

There is a disagreement when it comes to the predecessor of RFID technology. Some scientists believe the precursor of RFID is Russian scientist Leon Termin who designed a spy tool similar to the bug which could send signals only when using radio frequency energy in 1945. However, the British in the Second World War in 1939 used a similar technology IFF (Identification Friend or Foe), which was used for identification of Allied planes, by means of special tags and radar signals. RFID technology has slowly begun to develop more in seventies, although Harry Stockman published a paper on the topic of RFID technology in 1948 called the "Communication as a reflection of power" and even then foresaw wide application of this technology in the future. However, until recently this technology has been too expensive to get into the mass production due to complex systems of metal coils, antenna and glass. It was originally used to track large and expensive items in the rail and air traffic in overseas delivery.

In order to put RFID technology into extensive use the production costs had to be reduced. The Bi-Static Motorola RFID tags were the first to make a step forward in terms of bringing closer this technology to everyday needs. They used silicon chips that were only 3 millimeters wide and could contain 96 bits of data. However, this technology had not been accepted by the dealer and went out in 2001. Innovation in RFID technologies came up with active, semi active and passive RFID tags, which consist of a microchip, antenna and batteries in active and semi active tags. Today's RFID tags can store a huge amount of data and, depending on where those are applied, can be made from different materials such as metal, glass, silicone, plastic, etc.. Also, the number of sensors connected to the RFID tag is growing and they may include sensors of heat, humidity, position, earthquakes, seals, light, speed, etc.

3. DIFFERENCES IN TRANSPONDER OPERATING FREQUENCIES

Transmitters, tags that is, communicate with a reader via radio waves and thus convey information about the cargo being monitored. Radio waves are part of the electromagnetic spectrum in which each country has legislation. In various parts of the world there are different regulations concerning electromagnetic spectrum which is allocated by purpose. That means that the malocclusion directly affects the operation of RFID systems in different parts of the world ie. tag, which works on 135 kHz in one part of the world, will not operate on the same frequency in another part of the world, because the range is intended for another application.

With the existence of the regulation of the three existing areas where Europe and Africa belong to Region 1, North America, South America and Australia to Region 2 and Asia to Region 3, the use of RFID technology at the global level currently seems unattainable. There was an initiative to get to an agreement on the harmonization of frequency bands in 2010, however currently there is very little that could be singled out as the universal.

Application of RFID tags cannot be limited to a particular frequency range because the different frequencies have different features in certain applications. Low frequency transponders are cheaper and consume less power if the tag has its own power source, and better output signal to a smaller distance in the presence of obstacles. Also, they broadcast signal better through the water. UHF transponders have bigger range, faster data transfer, but higher energy consumption and weaker transmission in the presence of obstacles.

According to the frequencies at which they operate, RFID systems can be classified into four frequency bands:

1. **Low Frequency (LF)**: 100 - 500 kHz, the shortest-range signal and the lowest reading speed.
2. **High Frequency (HF)**: 10-15 MHz most commonly 13.56 MHz. Their abilities are between low frequency and high frequency tags. Consequently, data transmission is moderate and ranges are limited to 3-4 m.
3. **Ultra High Frequency (UHF)**: 433-915 MHz and 2.45 GH, the largest range of signal and the highest data transfer speeds. These lower frequency waves pass through the obstacles and consume more power.
4. **Microwave (MW)**: 2.4 to 5.6 GHz and are used exclusively for active tags whose range may go up to several hundred meters, depending on the position of the antenna, energy and the environment.

Most countries use 135 kHz systems for low frequency, 13.56 MHz systems for high-frequency, 869 MHz systems that use ultra high frequency and 2.45 GHz up to 5.8 GHz for systems using micro-waves. This is schematically presented in Table 1.

Table 1 Comparative review of the bands and their range

No.	Frequency	Typical operation range	Typical max range in open space
1.	LF 135 kHz	near field	50 cm
2.	HF 13.56 MHz	near field	3 m
3.	UHF 433 MHz	near/ far field	9 m
4.	MW 2.4 GHz	far field	20 m
5.	MW 5.6 GHz	far field	100 - 300 m

4. THE APPLICATIONS OF RFID SYSTEMS IN PORT OPERATIONS

4.1. Problems with the previous practice in container terminal

When a container ship arrives in port, and comes to anchor, it usually gets a permit for cargo handling, specifically container. Then the workers who work at the terminal must manually enter the number of containers and the contents of the goods in it. In some cases, employees have even to climb the containers to determine the exact number of containers. Thereupon inform the operator who is responsible for unloading via radio, when all containers are logged. Then the operator enters the data he received from workers and which is already in the system into the database of the port terminal: how many containers, their serial numbers, content, place of departure, place of destination, etc.. This is shown schematically in Figure 1, in the event of disagreement between the entered data and data that have already been entered, it must go through corrections and re-inspection of each container individually to determine the fault. This system is very slow and requires a lot of HUMAN resources and time.

4.2. Fully integrated operations with RFID technology

Unlike traditional approaches to container handling and tracking tags on them at the container terminal, the use of RFID systems have made port operations much easier and more simple, and thus reduced the human resources need for this type of operation and reduced the risks of occupational injuries and increased protection of the environment. With strategically deployed RFID systems, the entire port terminals would virtually be presented to the operator who would at any time have access to the existing deployment of containers, their condition, number and a plan by which to operate on transshipment. When the ship arrives in port and starts handling of containers by means of port cranes with RFID reader, scanning would automatically identify data that are essential for each container individually and in a very small unit of time. Then the data from each container would automatically transfer via intranet to the main server and to the operator on the panel screen, comparing existing data within the system and thereby the operation of control would be completed (Figure 2). Physical access of workers for operations related to the transfer of containers is required, but control segment which would require additional manpower would be avoided.

4.3. Software assistance in container terminal

As it can be seen in Figure 3, the container terminal is displayed on the display screen which sits on the operator terminal. All parameters such as: the total number of containers in the terminal, the number of columns and rows of container blocks, control number of containers, the contents of the container, position, time of transshipment, etc., are directly available to the operator in real time. The click on the desired container and all the information about it are available: the country of shipment, country of destination, arrival time, departure time, the contents of the container, check the number of containers, the state seal, etc.., Were provided to RFID technology and sensors located on the tag.

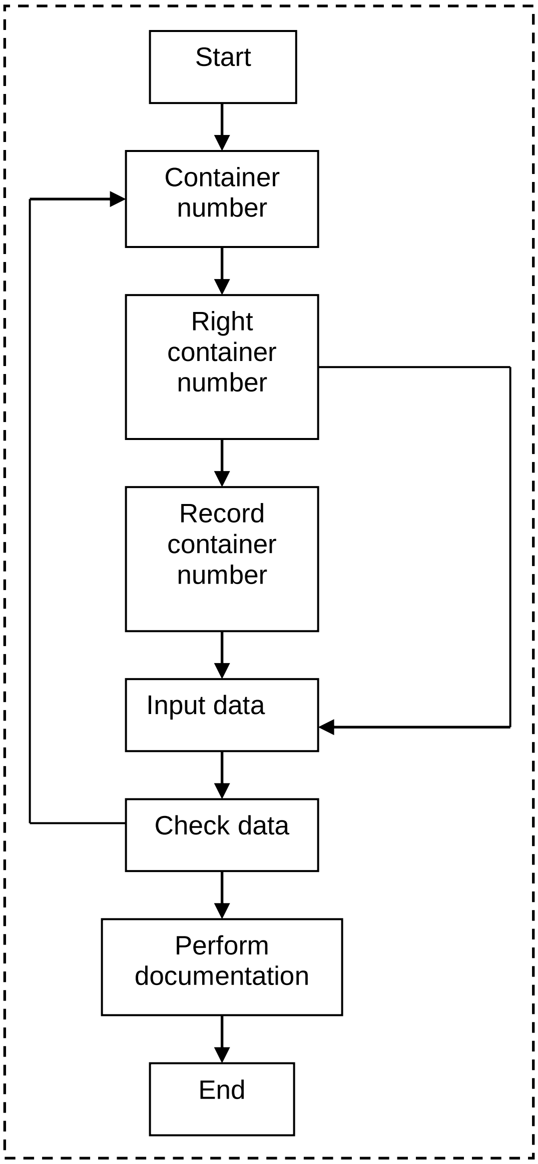


Figure 1 Manual container tracking

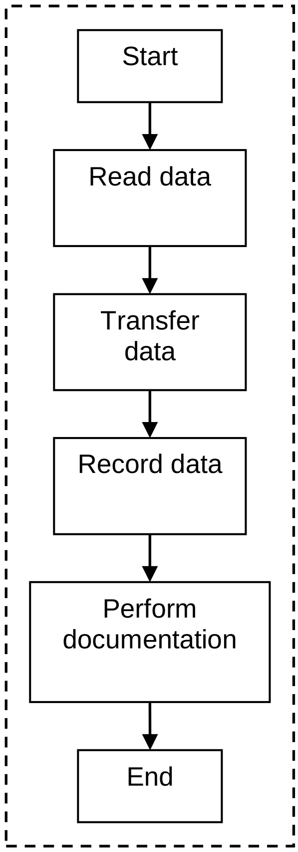


Figure 2 Automatic (based on RFID) container tracking

Source: Authors' drawing

Introducing RFID systems in ports, developing countries could be a step closer to the world's great ports that already have this type of system and are far ahead of countries that are still in the traditional and much slower way of managing port operations [1, 7]. Given that today the safety and efficiency in transport are key factors, the development of the port must be quick in adapting standards applied in the ports of developed countries.

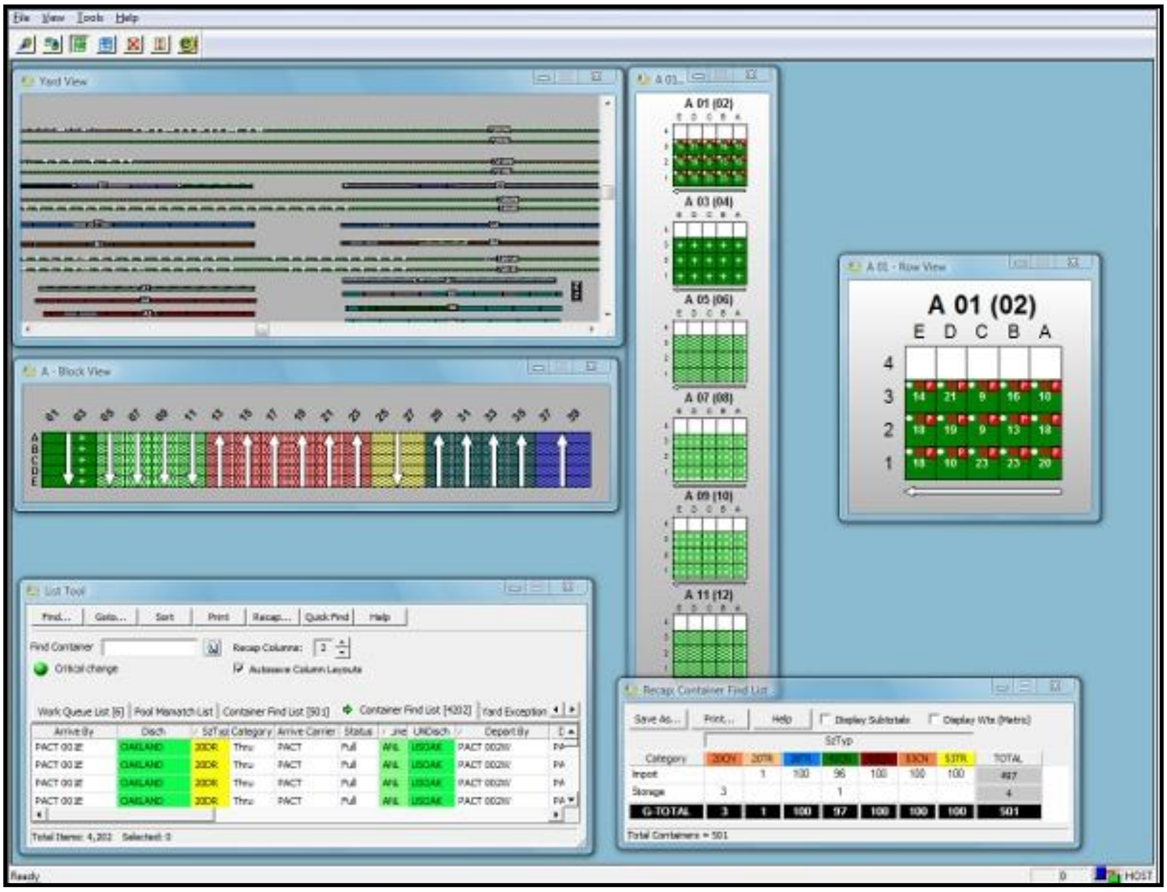


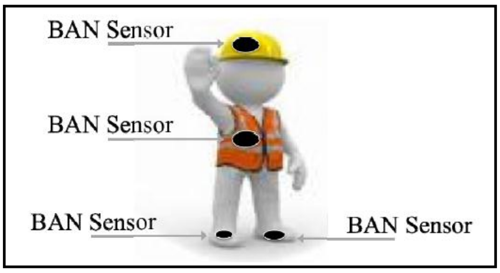
Figure 3 A display of special software for tracking containers at the terminal
Source: http://www.tideworks.com/products/spinnaker/

5. RFID IN THE SUPERVISION OF THE WORK AT THE TERMINAL

Wireless body area network (WBAN) allows more innovative ways of applying the RFID system in monitoring the health of workers, pollution of land and sea within the container terminal. This system is designed to transmit data from sensors located on the workers via transmitter to the receiver which forwards data to the server and to the operator. Here the operator is a key milestone as an employee who provides information for worker in case they are located in an area where there is danger of injury due to some external factors, in the event when the sensors read high fever workers, workers without protective equipment, when there are toxic substances in the air and so on. The energy required for the transmission of sensor data is obtained by using the electromagnetic field generated by the reader. Until now, the most researches have been done with tags that operate at 900 MHz and 2.4 GHz. The antenna in this case works as a receiver of data from the sensor and as a transmitter which sends data to the operator via Wi-Fi network.

5.1. RFID tags on the body of workers

The RFID system on the body is designed to monitor all vital functions of the worker by placing sensors for monitoring biometric data on key positions of his body. However, it is important to be careful that the same sensors are not a burden or a nuisance to the worker. Therefore, three key places on equipment where employees are able to place and thus monitor positioning of protective equipment of workers are selected. By positioning the sensor on the shoe, belt (where transmitter would be located and gather data from sensors) and the helmet as shown in Figure 4 the weight of sensors is negligible and does not represent an obstacle while the transmitter which functions as a receiver for the data from the sensor would be located on the belt workers.



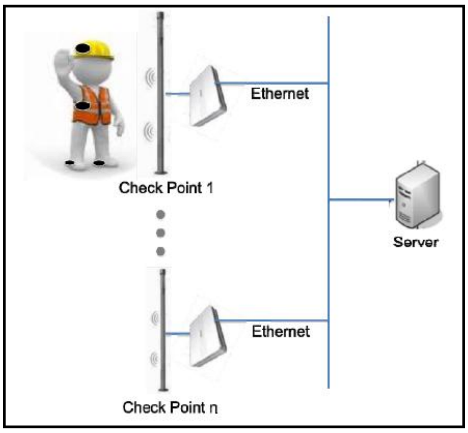


Figure 4 WBAN sensor network for workplace safety management
Source: Ref. [10]

Readers who receive data from transponders are strategically placed to port cranes, forklifts, within container terminal etc., so that the entire container terminal is covered. Thus, the operator has complete visibility of the terminal on the screen of his computer, his PC workstation that is, and is able to warn workers and give them guidance in operations with containers via radio. Backed by CCTV cameras operator also has a photo of the area that he is directed at.

5.2. RFID tags for monitoring environmental impacts

The second part of this system that is still in its infancy is monitoring of land and water ports. The RFID transponders send information on: water temperature, heavy metals, radiation, toxic substances in the water, toxic substances in the air of toxic substances in the country etc, to the reader which forwards it to the server of Wi-Fi network which sends it via Internet to the server. From the server the data is forwarded to a multidisciplinary team of experts who compare data and takes certain steps in the prevention of environmental disasters and the adverse impacts on the environment.

However, in order to gain insight into the state of land, water and air, that is what chemical and structural changes are happening due to harmful effects from vessels and port machinery (especially CO_2, since it is known that harbors are large emitters of this harmful gas), substantial resources and time to collect data over a period of ten years are required. Also one of the obstacles is a need for engaging a large number of experts from various professions who would compare the data and warn of the risks [2-10].

6. CONCLUSION

The RFID technology is already widely accepted in almost all areas of industry and business. This paper provides a brief overview of some of the technical specifications of individual RFID tags, including especially their power and frequency (the range) that have been designed. In addition, it points out the advantages of this technology when it comes to IT integration of logistics processes in port operations, and increases occupational safety in the harbor. The big savings in money and time are achieved using this technology in container terminals. Also, it is evident that RFID technology can greatly enhance the safety of port workers, and to play a key role in risk prevention and environmental protection in the port area. Further research in this area should go in two directions: (a) adaptation of RFID technology to track cargo and increase the safety of workers at the port terminals; and (b) exploring the possibility of using RFID technology in establishing correlations between indicators of environmental factors related to the degree of contamination of the sea, air and soil of ports and professional health of workers directly employed at the port terminals. These studies, especially the last mentioned one, require a multidisciplinary approach and the involvement of experts in the fields of biology, medicine, environmental management, etc, apart from those in the maritime sector. In addition, it is necessary to establish a system for monitoring and acquisition of relevant environmental data. Of course, it should be noted that in these studies, the focus should be on developing container ports that have not yet implemented RFID technology within their regular on port operations.

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AN APPROACH TO IMPROVING WORKING AND ENVIRONMENTAL SAFETY IN THE EXAMPLE OF THE PORT OF BAR

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ABSTRACT
The paper shows how it can be done the assessment of investments in equipment and staff training at the port container terminal, in order to increase the efficiency and safety at work. For this purpose, Pareto principle has been used. The suggestions and calculations are arising from the empirical data and they can give guidance to improve operational processes and safety at work in the Port of Bar, including the indirect positive effects in terms of providing the environmental protection and conservation.

KEYWORDS
working efficiency and safety, environmental protection, Pareto principle, container terminal, Port of Bar

JEDAN PRISTUP POBOLJŠANJU BEZBJEDNOSTI RADNE I ŽIVOTNE SREDINE NA PRIMJERU LUKE BAR

APSTRAKT
U radu je pokazano kako se može uraditi procjena ulaganja u opremu i obuku zaposlenih na kontejnerskom terminalu u luci, s ciljem povećanja efikasnosti i bezbjednosti na radu. U tu svrhu je korišćen Pareto princip. Prijedlozi i izračunavanja proizilaze iz empirijskih podataka i trebali bi da daju smjernice za poboljšanje operativnih procesa i bezbjednosti na radu u luci Bar, uključujući tu i pozitivne indirektne efekte u smislu zaštite i očuvanja životne sredine.

KLJUČNE RIJEČI
radna efikasnost i bezbjednost, očuvanje životne sredine, Pareto princip, kontejnerski terminal, Luka Bar

1. INTRODUCTION

The questions of safety at work and environmental protection are now-a-days actual in almost all economic and industrial spheres, as well as in the ports. Working directly on a port is a very dangerous occupation. Unfortunately, there is no available statistical data on this topic in developing countries' ports (due to the authors best knowledge), neither for the Port of Bar.

However, two extensive surveys of port employment and accident rates have been carried out in UK [1] in 2004 and 2009, in order to estimate the number of jobs that depend directly or indirectly on port activities and to provide estimates of accident rates. The estimated annual accident rate for all direct on-port employees was 1.1%, or 1,100 per 100,000 employees in 2009/10 [2]. The key conclusion from the above mentioned analysis was: An employee of a direct on port company is more than fifty times more likely to have an accident (across all severities) in comparison to an employee based in office [3].

Unlike the question of safety at work, some environmental protection analyses have been done in the Port of Bar, for the needs of two recently developed and implemented ecological and environmental management system (EMS) projects [4,5].

This paper presents the idea of improving working conditions and environmental safety throughout certain investments in new port mechanization at the container terminal, as well as throughout the investments in employees' trainings in EMS topics. In assessing these investments the empirical data and the Pareto principle are used. The results should provide an approximate overview in terms how many resources is necessary for improving significantly working and environmental conditions at the container terminal within the considered Port of Bar. The information of this kind can serve as an incentive for managers to invest into working efficiency and safety, as well as into the environmental conservation in the future.

1.1. Container terminal at the Port of Bar

In this paper the analyses of working safety and environmental preservation have been done for the container terminal at the Port of Bar (Figure 1). Therefore, within the next sub-section, it is given a short description of this terminal.

1.1.1. Container terminal and general cargo (CTGC)

"Container Terminal and General Cargo" (CTGC) JSC-Bar, is a terminal operator in the Port of Bar, and its main activities are handling and storing of containers and general cargos[1]. The strategic geographical position of Bar gives a possibility for an efficient and effective connection with all logistics systems in the Mediterranean. Thanks to a good connectivity with various transport networks, an opportunity for establishing distribution centers for a range of product groups arose, in accordance to intermodal and services connectivity trends.

This terminal covers the area of approximately 60 ha (field 300 x 200 m) with wholly integrated infrastructure. Overall activity is carried out through three completely technology equipped segments: container terminal, terminal for general cargo, and timber terminal.

Container terminal is equipped for (un)loading and handling of containers, carried out in open storage and warehouses, depending on the goods and needed methods of manipulation, including the complete container service (washing, cleaning, etc).

General cargo terminal is equipped for acceptance and dispatch of all types of general cargoes (palletized goods, food products, various metal products, coils, slabs, strips, pipes, bundles, and other standard types of cargoes) by using specialized technologies. There are 71000 m^2 of warehouses on the terminal, along with other facilities in the port area.

[1] Available from: http://www.ctgc.me/#!about-us/c17b2 (access 22nd June 2014)

Timber terminal has 24 200 m^2 of constructed shed area, dedicated for storing and drying of timber, with ideal technological solutions in terms of handling, storing and functionality of the facilities, in accordance with microclimate impacts.

"Container Terminal and General Cargo" JSC-Bar is completely under Free Zone regime. It is connected with the global maritime corridor network through key transshipment centers in the Mediterranean by frequent container lines (with precise timetables) of leading world operators such as Mediterranean Shipping Company, Maersk Group, CMA CGM Group, Hapag Lloyd, etc[2].

In spatial terms, container and general cargo terminal includes the following (Figure 2):

- operational quay which length is 1445 m (composed of mole 1 and the mole 2, whose lengths are respectively: 660 m and 785 m);
- nine ships' berths (mole 2 with four berths, and mole 2 with 5 berths), whose detail technical and spatial features are given in Table 1.
- sea depth along the operational quay is from 10 m to 12 m, which can provide services to ships of 50 000 DWT capacity at mole 1, and ships of 20 000-25 000 DWT capacity at mole 2;
- system has 14 vertical transshipment mechanization structures which capacity is from 3 tons to 40 tons, etc.

Figure 1 Port of Bar layout
Source: A Google image

[2] Available from: http://serbiaopen4business.talkb2b.net/members/details/115/140 (access 31st May 2014)

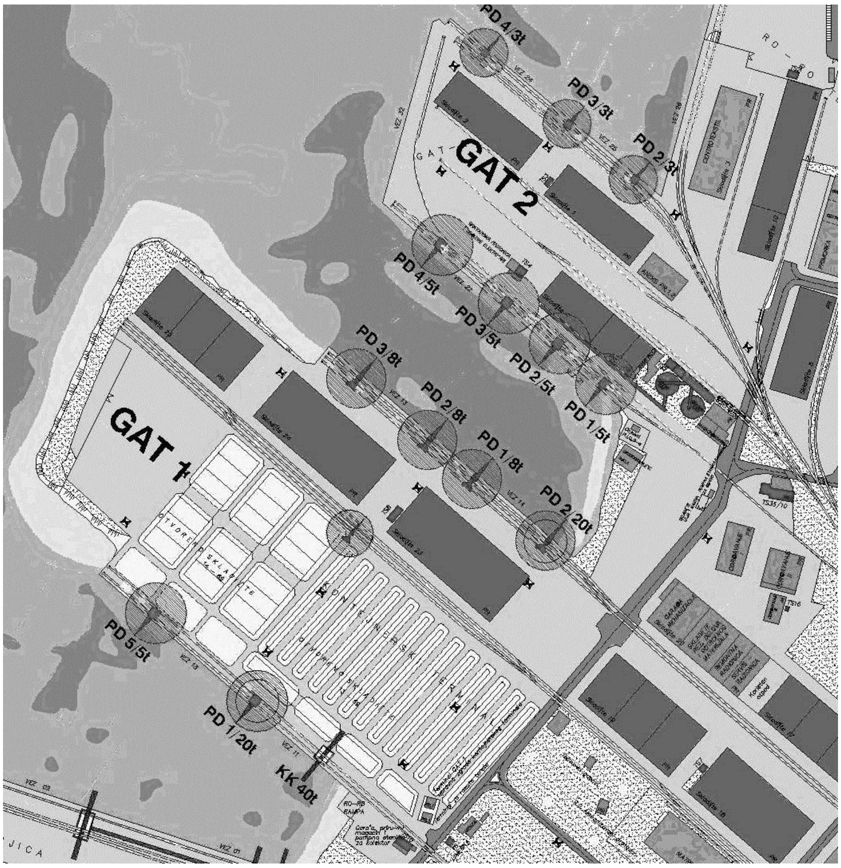

Figure 2 Container terminal layout (Legend: GAT 1=Mole 1, GAT 2=Mole 2)
Source: Feasibility Study for the purpose of TEN ECOPORT project [5]

The container terminal is located at mole 1 and occupies an area of 60000 m^2. The operative quay is 330 m length, and the depth of the sea water along it is 11 m. The terminal area is divided into zones, and the connections for fridge containers are provided, as well. At the terminal, there are: a plateau for temporary disposal of containers in the zone of the container crane (for 2 650 TEU), a plateau for containers storage, with 13 modular areas (for 2 320 TEU/area) and 6 areas for moving equipment and storage containers in stacks (for 6 320 TEU/area). At the container terminal, handling containers can be realized through the direct manipulation actions from railway wagons or other means of transportation.

The container terminal consists of:

- operative quay (330 m) with one berth for container ships;
- railway tracks - two tracks of 890 m, and one track of 550 m in the direction of closed storage, and two tracks of 730 m and of 500 m along the operational quay;
- road traffic artery of total area 9600 m^2 and a length of 1800 m;
- container storage plateau of 35 000 m^2;
- plateau for disposal of fridge containers;
- two closed storage facilities for containers loading and unloading operations (14 330 m^2);
- facilities for maintenance and repairing of containers;
- manipulative areas;
- administrative and operating system of the terminal, etc.

The functions of CTGC are as follows:

- shipping services for transportation devices of sea, rail and road traffic means;
- direct and indirect (un)loading of containers;

- disposal, storage and protecting containers;
- containers taking on and taking off;
- containers maintenance;
- providing variety of logistics services in the transportation logistics chain, etc.

Table 1 Basis spatial and infrastructural features of CTGC

No.	Object	Length (m)	Berth no.	Depth (m)
1.	South quay of mole 1	170	11	12.0
2.	South quay of mole 1	160	12	12.0
3.	North quay of mole 1	160	13	11.5
4.	North quay of mole 1	170	14	10.5
5.	South quay of mole 2	160	21	10.5
6.	South quay of mole 2	155	22	10.5
7.	West quay of mole 2	190	23	10.5
8.	North quay of mole 2	140	24	10.5
9.	North quay of mole 2	140	25	10.5

Source: Feasibility Study for the purpose of TEN ECOPORT project [5]

2. RISK ANALYSIS

The risks at the container and general cargo terminal in the Port of Bar are connected with technology of logistics processes, which belongs to the group of so-called „clean technologies“. Therefore, the greatest risks are associated with cargo handling, cargo damage, its spillage and/or breakage. Also injuries of workers on port are possible as a result of improper cargo manipulating or machinery improper maintenance and break down. However, the workers' injuries with tragic consequences rarely occur. The accidents like fire, explosion, discharge of fuel, or oil leaking from the port superstructures, etc. are also rare ones at this terminal.

Above adduced risks could be eliminated by purchasing and adapting new, cleaner and more reliable handling (manipulating) equipment, including vertical (containers and general cargo cranes), horizontal (trucks and forklifts), and auxiliary mechanization.

Warehousing capacities should be extended and improved, i.e. they are to be more protected from weather conditions as wind, rain, exposure to sunlight, extremely high or low temperatures, etc.

Additionally, employees should be periodically (re)trained in EMS in order to enrich level of their awareness and knowledge about the environmental issues and occupational safety. These trainings should be organized in the Port of Bar, in similar ports in the region, or in the specialized training centers in the country or abroad.

Unfortunately, in the Port of Bar there is no detailed evidence on the structure of risks (including environmental ones), as well as on the type and number of incidents that occurred in the port in the previous period. The way in which, by a reasonable certainty, can be assessed the risks intensity and the nature of incidents that may be caused by these risks is Pareto principle (80/20). According to this principle, all mechanization structures (vertical, horizontal, and auxiliary) are operational in 80% of the time, while they are not operational during the rest 20% of time. The approximation of nature and extent of risks is graphically presented in Figure 3.

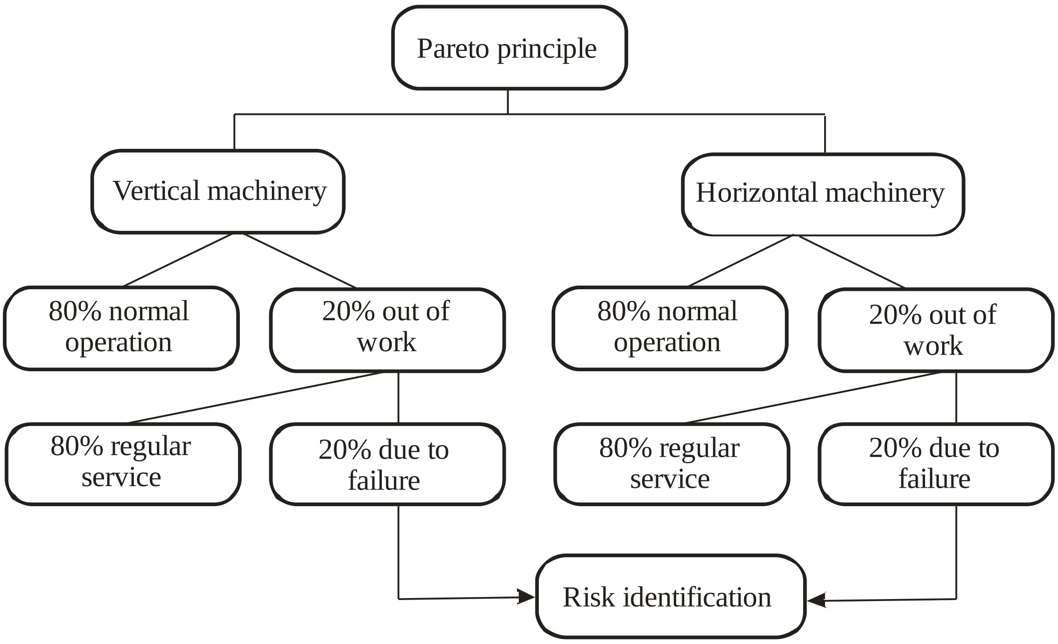

Figure 3 Pareto principle in assessing risks at CTGC
Source: Authors' drawing

Based on the degree of availability of equipment, according to the Pareto principle, it is taken that the equipment were 80% of the time working in a normal regime, and that 20% were in failure. The time of cancellation has been shared like: 80% on the cases for scheduled repairs and maintenance, and 20% on the risk of cargo handling.

3. POSSIBLE SAFETY IMPROVEMENTS

When it comes to improving safety in the Port of Bar, i.e. at its CTGC segment, well-known and frequently used Pareto principle (80/20) is applied, too. More precisely, we are using the assumption that by the 20% of investments in equipment and personnel (re)training should be achieved 80% of the improvements in terms of risk reduction, prevention of incidents and consequently environmental protection. The plan for purchasing new handling equipment for the CTGC needs is taken into consideration, and the assessment is made in terms how much will cost acquisition of 20% of the total planned procurement (Figure 4).

When the personnel is in matter, it is analyzed the number and the structure of employees, and calculated how much will cost (re)trainings for 20% of employees in key sectors for coping better with environmental issues in the future within the port, i.e. considered terminal (Figure 5). Also, we can assume that personnel training will require traveling to another more developed ports and learning on "the face of the place". These increasing of investments in both handling and transportation mechanization structures, and employees (re)training in the domain of environmental safety and improving working and health conditions, should result in multiple increasing of the positive impacts on the environmental protection and the ecosystem conservation. This should be achieved in 80/20 amount in accordance to here employed Pareto principle. Certain time interval, along with the permanent monitoring and controlling will be necessary to prove the validity of the proposed principle [6, 7, 8].

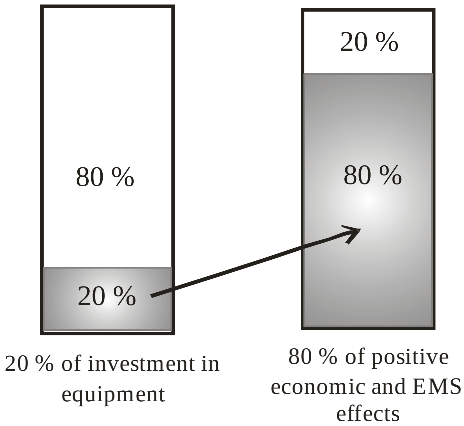

Figure 4 Pareto principle: new equipment vs. positive EMS effects
Source: Authors' drawing

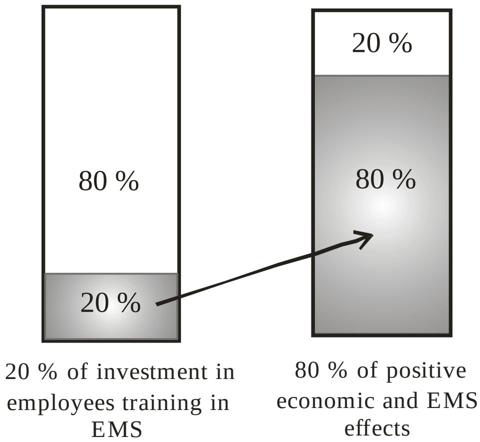

Figure 5 Pareto principle: employees (re)training vs. positive EMS effects
Source: Authors' drawing

Within the next section are given some quantitative indicators which are in accordance to the above presented methodology.

4. NUMERICAL RESULTS

4.1. On new equipment purchasing

There is a plan for purchasing new equipment for the container handling needs in the Port of Bar. This new machinery will be used in parallel with the existing, or currently exploited one. The information about the plan for purchasing new equipment we have received from the managers of the terminal, and they are given in Table 2.

The Port Authorities has had some preliminary talks with container equipment suppliers, so as the result of these negotiations, the approximate data on the cost of procurement of certain mechanization structures are available (Table 2). Otherwise, through the official web sites[3,4] of major suppliers of container equipment, it is not easy to obtain clear data on the costs of container handling structures.

[3] Available from: http://www.konecranes.com/equipment/container-handling-cranes (access 8th June 2014)
[4] Available from: http://www.liebherr.com/MCP/en-GB/products_mcp.wfw/id-11607-0/measure-metric (access 8th June 2014)

Table 2 Increasing environmental and working safety by purchasing new equipment

No.	Type of machinery	Costs (Euro)	20% of Costs (Euro)
1.	Container bridge crane (span 15 m)	7 800 000	1 560 000
2.	Container mobile crane	2 800 000	560 000
3.	Reach stacker	320 000	64 000
4.	Forklift (counterbalanced one)	280 000	56 000
5.	Forklift (empty containers stacker)	180 000	36 000
20% of total investment (Euro):			2 276 000

This newly purchased machinery should increase the container traffic in the port, create the conditions for hiring new workers, and reduce negative impacts on the environment. The purchase of new container and general cargo handling equipment will reduce the emission of toxic exhaust gases in the atmosphere (primarily CO_2). Also, new equipment will reduce the risks of brake downs and possible incidents that may occur as a result of machinery failures [9].

Since CO_2 is one of the major polluters of the atmosphere, it deserves in this context, as well, a particular attention. At the annual level 50 port container cranes emit CO_2 in the amount as a 5000 cars. World container equipment manufacturers intensively work on developing technological solutions that will minimize harmful environmental impact and increase the economic efficiency of port machinery. World container equipment manufacturers intensively work on developing technological solutions that will minimize harmful environmental impact and increase the economic efficiency of port machinery. Rubber Tired Gantry (RTG) crane in the port e.g. due to high average consumption of diesel fuel of 20-30 liters per hour, with an average working time of 14 hours, daily generated up to 1.2 tons of CO_2. In addition to CO_2 emissions, these machines emit significant amounts of other harmful exhaust gases. The average crane with load capacity up to 40 tons emits per day in the environment approximately 6.3 kg of NOx, 1.7 kg HC, 1.2 kg SO_2 and 0.7 kg of lampblack[5], what can be used as a particular curiosity.

Thus, to summarize above discussion, by using the Pareto principle, and preliminary set hypothesis, the investment of about 2 millions in new container handling vertical and horizontal equipment, the positive effects might be achieved to the extent of 80% when it comes to economic, occupational, and environmental issues.

4.2. On employees' (re)training in EMS

The people who should be involved in improving environmental conditions at CTGC EPO of the Port of Bar will be managers and employees at non-direct and direct on port vacations. Their number is given below in Table 3.

Thus, the Table 3 contains the calculus of 20% of total number of employees at different operations and management levels, what is sufficient number for achieving considerable economic and environmental positive effects due to Pareto principle. Namely, 20% of the employees are to be (re)trained in EMS in order to give their contribution later on to raising EMS quality and to provide environmental conservation and working safety.

Table 3 Structure of employees and number of those who need EMS (re)training

Structure of employees	No.	20% of No.
Port authorities	71	14
Non-direct on port	75	15
Direct on port	302	60
Total:	448	89

[5] Vujičić A., Zrnić N., Reducing the impact of port machinery on environment, Proc. of the 4th Symposium with International Participation – Transport and Logistics, 27th May, 2011.

The costs of (re)training of the employees in EMS are specified in Table 4. The calculus is made under the assumption that the average cost of EMS training is 700 euros and that the employees need to travel to another port (or other destination, where the training will be organized), and that they also need certain accommodation and per diem funds. The average traveling costs are taken as 600 euros per travel, while the accommodation and per diem costs are taken approximately as 100 euros per day. The related calculus is given in table below. In estimating these costs, the information available at the referred web locations are used[6,7].

Table 4 EMS (re)training costs for 20% of the employees

Structure of employees	Training	Traveling	Accommodation (5 days)
Port authorities	14x700=9800	14x600=8400	14x5x100=7000
Non-direct on port	15x700=10500	15x600=9000	15x5x100=7500
Direct on port	60x700=42000	60x600=36000	60x5x100=30000
Total (Euro):	62 300	53 400	44 500
		Total (Euro):	160 200

It is assumed that the employees will have training ones per year and due to the calculus present in Table 4 it is evident that the total amount of funds necessary for (re)training in EMS is 160 200 euro. However, if we take into consideration the fact that this investment will raise EMS quality of implementation for approximately 80% in comparison to present state, it is worth to be done. The previous stated is truth, especially if we consider that the investments in education and skills of employees have positive effects in the long run. Also, employees who attended the training will be later on in position to transfer their new-acquired knowledge and skills to their colleagues who did not have such opportunity.

In order to recapitulate the above presented data, here we have presented total amount of funds needed for both personnel (re)training in EMS and purchasing new handling equipment at the terminal (Table 5). It is obvious that for purchasing 20% of planned new equipment is necessary 2 276 000 euro, and for (re)training of 20% of employees in EMS is necessary 160 200 euro, what is in total 2 436 200 euro. These investments are justified if we bear in mind that they will cause, due to the Pareto principle, 80% improvements when it comes to economic and environmental factors related to successful and sustainable functioning of the terminal, and its optimal positioning at the permanently growing container transport (global) market [10].

These cost indicators (Tables 3, 4 and 5) can be used as a basis for improving operational processes at the CTGC EPO and thereby raise positive economic effects and reduce the risk of negative impacts to the environment. Adding a quantitative dimension in analyzing such problems, it is always indicative and may support port managers in making right decisions in terms of preserving the ecosystem and improving the safety in the port, health conditions of workers, and preventing consequently occupational diseases in the long term.

Table 5 Total investments in improving EMS facilities

New equipment costs (Euro)	2 276 000
Employees (re)training costs (Euro)	160 200
Total (Euro):	2 436 200

[6] Available from: http://www.uvcs.uvic.ca/Program/Certificate-Program-in-Environmental-Occupational-Health/HPEO/ (access 10th June 2014)

[7] Available from: http://www.cput.ac.za/academic/faculties/appliedsciences/prospectus/course?i=94&seo=TkQ6IEVOVklST05NRU5UQUwgSEVBTFRI (access 10th June 2014)

Undoubtedly, the actions towards modernizing the equipment and training staff in EMS are of importance to the institution, in this case to the analyzed external port operator "Container Terminal and General Cargo" JSC at the Port of Bar. Bearing in mind that it is difficult to determine exactly the effects on the environment and health of employees, it is opted here for the use of Pareto principle. Generally speaking, in accordance to this principle, 20% of investments will result in the increase of 80% in efficiency. This works for both machinery park renewing and for employees (re)training in the domain of EMS. So, investments in terms of buying new machinery in the amount of 20% of the planed one to be bought will result in uprising operational efficiency and reliability in the approximate amount of 80%. Similarly, by investing in 20% of number of employees (re)training in EMS, 80% better working conditions and effects when occupational safety and environment conservation are in matter will occur. This looks quite as a lump sum, but it is entirely consistent with the Pareto principle, or Pareto optimum, and can be applied in situations when it is difficult to handle with exact amounts of money.

5. CONCLUSIONS

In this paper applied research methodology is based on the well-known and structured Pareto principle, or Pareto optimum, which means that there are no obstacles in applying it to other external port operators in the Port of Bar, and to other similar ports in the region, as well. There is no doubt that the proposed investments in equipment and knowledge of employees will result in multiple positive effects on business, environmental conservancy, and occupational safety in the port. In situations where it is not easy to calculate the direct material benefits of some investments, employing the Pareto principle has been proved as a suitable optimization method. Thus, the proposed solution for realizing this feasibility study for "Container Terminal and General Cargo" JSC at the Port of Bar might be used like a general model for realizing similar studies in other ports of the South Adriatic, the Aegean and/or the Black Sea regions in the future.

The research work of such kind might encourage port authorities to take into consideration, more intensively, investment opportunities in the ports' equipment and personnel, which would have positive economic effects, as well as positive effects on the preservation of the environment in the national context and beyond it, because the ports are usually of strategic importance for the overall economic growth and development of a country and the whole region. More generally, implementing proposed environmental management system measures i.e. investing in equipment and employees EMS knowledge refreshment, will undoubtedly increase chances of cutting energy bills, reducing waste and winning customers confidence in the way the port operates responsibly[8].

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ORGANIZATION OF MARITIME TRAFFIC IN SPLIT CITY PORT

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ABSTRACT
Split city port is the busiest passenger ferry port in Republic of Croatia. Port is situated on the eastern part of the city port basin and is managed by Split port authority. At the top of passenger terminal building at pier St. Duje is located Port control center of Split port authority. It is controlling body responsible for organization of maritime traffic within the port area. Maritime traffic in Split City port is organized by the support of different system that uses port control center. In this paper systems CIMIS, PCS and AIS are analyzed.

KEYWORDS
port, management, traffic, PCS, CIMIS

ORGANIZACIJA POMORSKOG PROMETA U SPLITSKOJ GRADSKOJ LUCI

SAŽETAK
Splitska Gradska luka je najprometnija putnička luka linijskog prometa u Republici Hrvatskoj, koji se nalazi unutar lučkog bazena Gradska luka. Luka se rasprostire duž istočnog dijela luke i pod upravom je Lučke uprave Split. Na vrhu zgrade putničkog terminala na gatu Sv Duje smješten je Lučki operativni centar Lučke uprave Split. Lučki operativni centar zadužen je za organizaciju pomorskog prometa u lučkom području. Pomorski promet u splitskoj Gradskoj luci organizira se uz podršku različitih sustava. U ovom radu analizirani su sustavi CIMIS, PCS i AIS.

KLJUČNE RIJEČI
luka, upravljanje, promet, PCS; CIMIS

1. INTRODUCTION

City port Split is the busiest passenger ferry port in Republic of Croatia. Maritime traffic inside the port area and in the approach to the port is regulated by the port control center of Split port authority together with harbormaster office. Different IT systems help in facilitation of the work in order to provide on-time information to port stakeholders, e.g. custom, police, harbormaster office, port authority, etc.

Organization of maritime traffic in Split City port in this paper is analyzed through five chapters. After introduction in second chapter characteristic of Split City port are analyzed followed by the analysis of main activities of Port control center of Split port authority. In fourth chapter special emphasis is given to overview of CIMIS, PCS and AIS system and their use in organization of maritime traffic in Split city port. Analysis of future development is given within conclusion.

2. SPLIT CITY PORT

Split city port is the busiest passenger ferry port in Republic of Croatia and is one of six ports of international economic importance to the Republic of Croatia. In 2013, according to the Eurostat [7], port had annual turnover of 3.77 mil passengers or 28.46% of total Croatian passenger maritime transport. Port is open for public international and national traffic of ferry and cruise ships. Prevalence in the port has ferry traffic (i.e. liner traffic). Except ferry and cruise ships port also services smaller passenger tourist ships, navy ships and ships of official purposes. National traffic is dominated in the port. International ferry transport is carried within City port of Split and Italian port Ancona during the whole year and with port of Pescara during summer months.

Port is situated within City port basin, on the eastern part of the basin, around 500 m from city center (city of Split) and is managed by Split port authority. It covers an area from eastern operational breakwater to the junction of Obala Lazareta, Mandrač and Obala hrvatskog narodnog preporoda (also known as Riva). Within the port there are three operational piers (St. Nikola, St. Petar and St. Duje) and one operational breakwater which are interconnected with four quays (Obala Lazareta, Obala Kneza Domagoja I, II and III). Total length of the port quays (including piers and breakwater) is 2,807 m, with a total of 28 berths. Pier St. Nikola is used mostly by fast ferries, tenders and security vessels, while other two piers as well as breakwater are mostly used by ro-ro ferries.

Sea depth within port ranges from 6 to 7.8 m with berths able to service ships up to maximum length of 220 m. Small sea-level fluctuations are observed in the port ranging from 0.2 to 0.4 m. Port entrance, from eastern breakwater to western breakwater of marina is 315 m wide. Port can simultaneously service up to four cruise ship inside the port basin and two on anchorage.

Wind speed and direction, based on the records of the meteorological station Split-Marjan which is the closest to the port, are shown in next figure (Figure 1).[1]

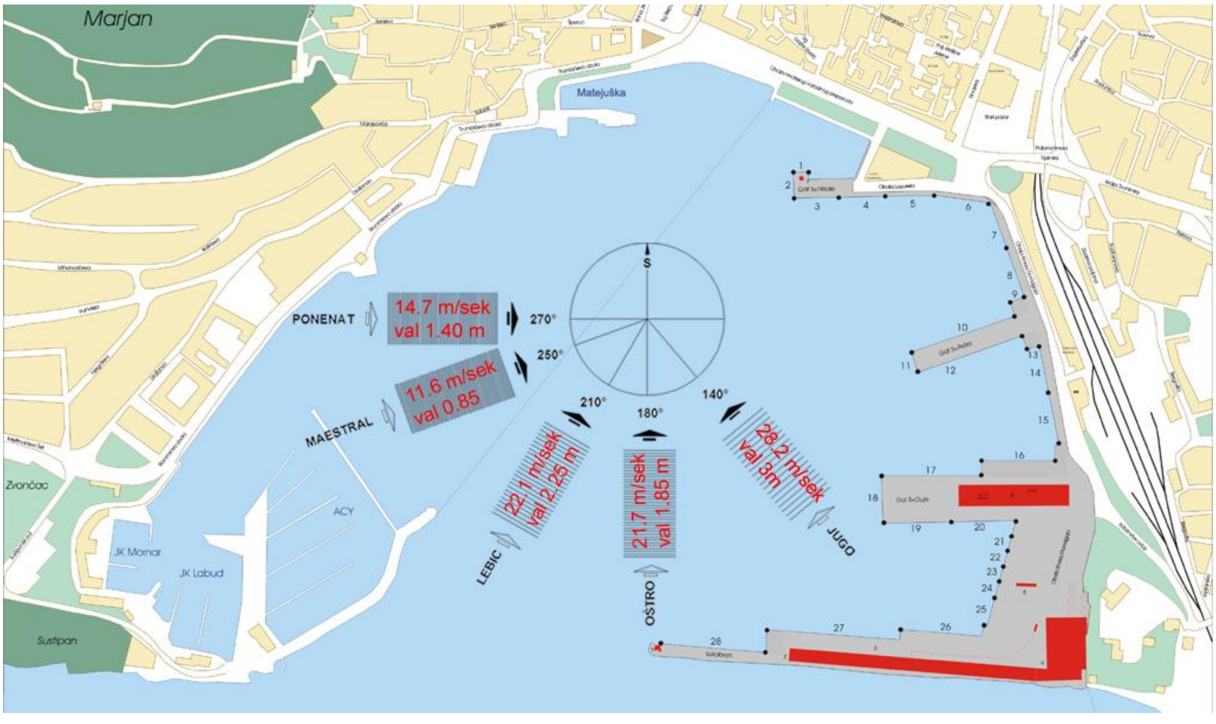

Figure 1 Winds in the City port of Split
Source: [1]

Areas of permanent international maritime border crossing of first category are located at two sites in the port, on the pier St. Duje and on the eastern operational breakwater at berth number 28.

By sea port can be approached by four channels: channel Brač, Split gate, channel Šolta and channel Drvenik. Split Gate is mainly used by passengers' ships. By land port can be approached by road and by rail.

3. PORT CONTROL CENTER OF SPLIT PORT AUTHORITY

Port control center of Split port authority (hereinafter: PCC) is located at the top of passenger terminal building at pier St. Duje. It is controlling body responsible for organization of maritime traffic within the port area. PCC organizes entering, leaving as well as berthing, un-berthing and mooring within port area. Except ship information PCC also disposes with current meteorological information such se sea condition, wind speed and direction and has access to port video surveillance cameras. All conversations between ship and PCC is performed via VHF Ch 9 and all conversations are recorded for safety reasons.

PCC creates weekly and daily berth schedules. These schedules provides information about the port basin name, berth number, expected time of berthing and un-berhing, ship name and also can contain name or code of the ship line as well as additional remarks (eg. ship is staying overnight in the port, ship will be refueled while in the port, etc.). Schedules and schedule modifications are approved by harbormasters' offices. All modification in the schedules PCC has to inform the ship agent.

Main communication that have to be performed before passenger ship can enter or leave the Split City port are shown in figure below (

Figure 2).

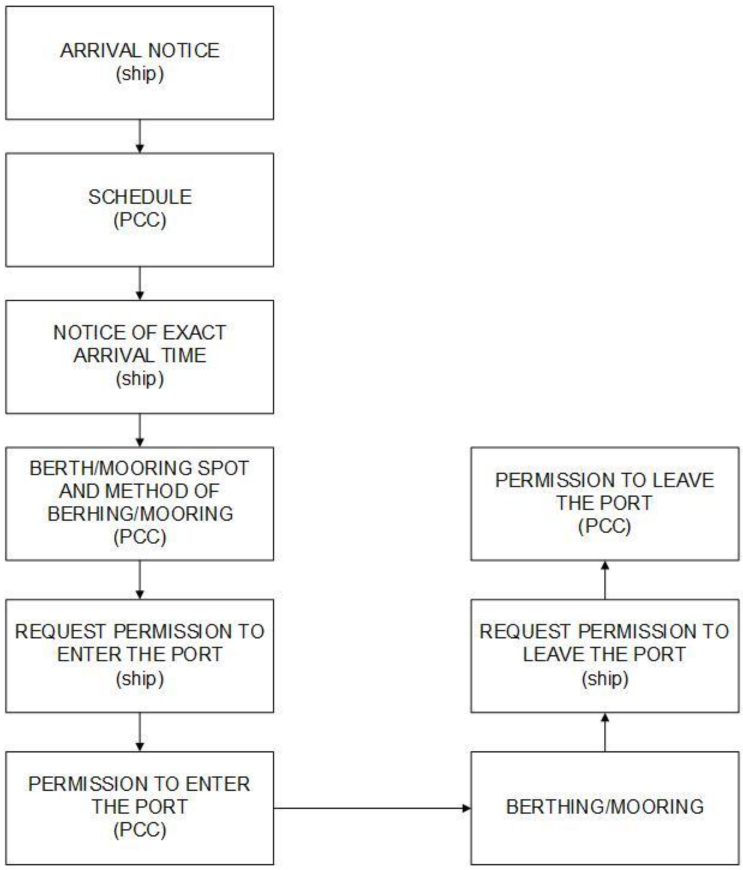

Figure 2 Main communication between passenger ship and PCC

Source: Authors according to the data provided in [2]

PCC and harbormaster office receives an arrival notice from ship agent: [2]

- 24 hours prior to arrival, or,
- upon ship leaving the previous port, if in the journey from previous port to City port Split is shorter than 24 hours, or

- upon learning of such data, if the information about the destination was unknown at the time of leaving previous port or the change was performed during the trip.

Master of a vessel has to request permission to enter a port 0.5 NM before port entrance, while permission to leave the port has to be requested before un-berthing. While entering and leaving port master of the vessel has to listen to the VHF Ch 9. Exact time of the ship arrival has to be reported at least one hour before port berthing. Speed allowed in port is six (6) knots. cf. [2]

Following actions can be performed in the port area only after permission, consent or notification of PCC: cf. [2]

- ship entering and leaving the port,
- berthing and un-berthing,
- any delay of the ship – eg. longer time needed for a ship to perform all the necessary action while in the berth,
- ship retention in the port,
- ship relocation from one berth to another upon the request of harbormaster officer due to the security reasons,
- minor repairs on ship, welding etc. – all fire precautions need to be executed,
- running of ship's propeller while moored along quay,
- actions necessary for keeping out immediate and obvious damage or moving/removing berths, anchors or equipment from other vessel for the purpose of other vessel berthing,
- unloading ballast water,
- use of ship's siren for greeting or to test the sirens work,
- supply of ship with fuels,
- degassing, fumigation and pest control,
- sport and other activities within the port area,
- extraordinary events (accidents, fire, port pollution) on the vessel during his staying in port.

4. SYSTEMS IN THE PORT

Port control center of Split port authority uses different systems which facilitate organization of maritime traffic, e.g. radio stations, video surveillance, CIMIS, PCS and AIS system. Last three systems will be further analyzed below.

Automatic Identification System (AIS) is a transponder system for ships which transmits the ship's position, heading, speed and MMSI (the unique maritime identification number) using VHF band. Information's are transported to other ships and to coastal authorities automatically. The data can also be automatically plotted on a digital map or radar screen. Seventeen (17) shore-based base stations ensure coverage with AIS signal in the exterritorial, territorial and internal Croatia maritime waters. These stations are connected to national control center in Rijeka where data are collected, processed, saved and stored as well as distributed to other users. AIS main purpose is to increase safety at sea and in Croatia is used by all government bodies with jurisdiction at sea. All ships calling at ports or in passage through Croatian waters must be fitted with AIS.

Port Community System (PCS) of Split port is internal system that uses Split port authority and also other participants of service provision inside the port. PCS is information solution for management of commercial activities within the port. The system supports data distribution, management of structured and unstructured documents, task management as well communication between department's port authorities. It can be integrated with other port services as well with other IT applications such as CIMIS system. PCS also contains ship arrival and departure information.

Croatian Integrated Maritime Information System (CIMIS) is Croatian national SafeSeaNet system which became operational on the day that Croatia became member country of EU. CIMIS encompasses all the administrative business processes of Croatian Ministry of maritime affairs, transport and infrastructure as well as coastal and port administration in maritime transport. Every ship arriving in and departing from the Croatian ports is obliged to provide all required information in the system, usually through ship agent. Upon enter these data becomes available to all participants in the process (master, health inspectorate, harbor master, port authority, police, custom) which can be used for planning and determination of individual activities. Through CIMIS port authority approves a declaration on hazardous substances. Also, through this system port authority, taking into account the proposal of terminal operator, defines location of berthing/mooring and confirms ETA for that spot about 24 hours to 2 hours prior the ETA. Assigned berth and associated ETA can be changed afterwards. This information, upon enter, becomes available to harbor master officers which can approve or allocate berth as well as can change ETA.

5. CONCLUSION

Use of different IT solution helps in organization of the maritime traffic that is approaching or taking places within the port basin enabling reception of required information to the different stakeholders at the same time, less use of paper, earlier receipt of information and facilitation of work.

On national level establishment of National Single Window (NSW) is planned which should further reduce the exchange of information with multiple users and eliminate error and "unburden" the VHF working channel. Aim of the platform is to act as connection point with other national systems (police, customs, health inspector, etc.) which will enable submission of same data into the system only once. Also, platform will be used to exchange data between local PCS and CIMIS system. Start of operational use of NSW is planned by June 1, 2015.

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ESTIMATING AND CALCULATING THE SPEED, POWER AND FUEL CONSUMPTION OF LNG CARRIERS

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ABSTRACT
As seaborne trade is an international business and its economic structure is highly complex, it is rather demanding to produce forecasts and estimates of the maritime shipping market. However, these tools are considered necessary to assist in making decisions influencing the performance of the shipping business in future. There are a number of elements affecting both the cost and the safety of transporting energy-generating products by sea. They include the ship's size and price, consumption and price of fuel, the ship's daily fuel consumption, crew wages, costs of maintenance of the ship and her equipment, etc. Hence it is necessary to know the main features of a vessel. This paper presents the main characteristics of two different designs of ships built for transporting liquefied natural gas (LNG) – Moss type LNG carrier and SPB type LNG carrier – providing the estimation of their speed, power and fuel consumption over a one-year period, including the monthly breakdown, which is of great importance given the climate conditions in which these carriers may operate.

KEYWORDS
LNG carriers, speed, power, fuel consumption

PROCJENE I IZRAČUNI BRZINE, SNAGE I POTROŠNJE GORIVA LNG PRIJEVOZNIKA

SAŽETAK
Djelatnost brodarstva međunarodnog je karaktera, a njegova ekonomska struktura visokog stupnja složenosti, te su predviđanja i projekcije pomorskog tržišta vrlo zahtjevne naravi. Od njih se očekuje pomoć pri donošenju odluka koje će utjecati na poslovanje brodarstva u budućnosti. Poznate su mnogobrojne komponente koje utječu kako na cijenu, tako i na sigurnost prijevoza energenta brodom. Neke od njih su: veličina i cijena broda, potrošnja i cijena goriva, dnevna potrošnja broda, plaće za posadu, cijena održavanja broda i brodskih uređaja, i sl. U tu svrhu potrebno je poznavati glavne karakteristike samoga broda. Ovaj rad upravo daje glavne karakteristike različito dizajniranih tipova brodova i to onih koji služe za prijevoz ukapljenog prirodnog plina (LNG) pomorskim putem. U pitanju su LNG prijevoznici tipova Moss type LNG Carrier i SPB type LNG Carrier. Za navedene tipove procijenjena je brzina, snaga i potrošnja goriva tijekom jedne pune godine plovidbe, gledano iz mjeseca u mjesec što je od velike važnosti s obzirom na različite klimatske uvjete u kojima se prijevoznik može naći.

KLJUČNE RIJEČI
LNG prijevoznici, brzina, snaga, potrošnja goriva

1. INTRODUCTION

Oil is the world's prime source of energy. It is used for propulsion of almost 95 % means of transport. Just like the other ways of transportation, maritime transportation heavily depends on the propulsion fuel oil. The dependence of the maritime means of transport on the energy source may considerably affect the cost of transport by sea. Nowadays these facts give serious cause for concern as almost 80 % of global cargo is carried by sea.

Sea routes feature changeable aspects that differ in the length of voyage and the season. The overall number of ships necessary for conveying cargo often varies by ship design, fuel consumption and days needed to complete the voyage. Therefore, maritime shipping companies are committed to making the right choices considering the design, size and number of vessels making up the overall fleet required to transfer nominal cargo, in this case liquefied natural gas (LNG), from the port of loading to the port of discharge. However, the issues regarding necessary storage capacities at LNG import terminals depend to a large extent on weather conditions affecting the ship's approach to the terminal, as well as on sea conditions and ice conditions on a given shipping route. Heavy weather and harsh ice conditions may cause considerable delays in scheduled deliveries. The time loss caused by adverse weather conditions can be compensated for by using sea margin power when the ship's speed is increased in order to make up for the time loss and keep up with the schedule.

For that reason, it is essential to select the optimum type of ship for a specific trade. There is a wide range of LNG carriers on the market and the shippers have to choose the designs meeting their specific requirements. The purpose of this research has been to analyse and compare the Moss and SPB designs, to calculate and estimate their speed, power and fuel consumption over a one-year sailing period, including the monthly breakdown, which is of great importance given the various climate conditions in which these carriers may operate.

2. LNG CARRIERS

2.1. General description, Moss type LNG Carrier

2.1.1. *Main dimensions*

Nominal size:	205,000 m^3	
Ice-going hull concept:	Double Acting Ship (DAS) with hybrid propulsion	
Bow form:	Ice bulbous bow	
Cargo containment system:	Spherical aluminium tanks 1 * 42.6 m inner diam.	
	Stretched al. tanks 4 * 42.6 m inner diam + 1.40 m extension.	
	98.5 % filling volume 205,040 m^3 (at -163°C)	
	100 % filling volume 208,160 m^3 (at -163°C)	
Boil-off-Rate (B.O.R.):	0.13 % per 24 h	
Main dimensions:	Length over all (LOA) about	342 m
	Length between perpendiculars	327.6 m
	Breadth	50.4 m
	Depth, to upper deck	23.6 m
	Draught, design (T_D)	11.8 m
	Draught, scantling	12.5 m
	Draught, ballast (terminal/sea-going)	10.8 m /10 m
Deadweight:	Abt. 95,900 t at T_D	
Service speed:	19.5 kn at T_D (including sea-margin 21 %)	
Propeller units:	Two azimuthing podded propellers, FPP 2 * 6.0 m	
	One centre propeller, FPP 1 * 7.8 m	

Installed propulsion power: 2 * 13.5/15 MW (open/ice) + 15/12 MW (open/ice) = 42/42 MW

	Bow thruster unit, about 2.0 MW
Main electric power:	Four dual fuel diesel generator sets, Installed MCR power 51.3 MW [Eg. 4 Wärtsilä 12V 50DF + 1 * 6L 50DF engines]
Gas oxidizer unit:	Capacity 5,800 kg/h (acc. to max. B.O.R.)
Cargo & spray pumps:	Cargo: 10 * 1,700 m^3/h. Spray pumps 5 * 60 m^3/h
Unloading/loading time:	12 h (theoretical design value)
Other cargo handling:	HD Compressors 2 * 34,000 m^3/h – 51,000 kg/h
	LD Compressors 2 * 8,000 kg/h (acc. to 100 % fuel gas)
	LD and HD heaters acc. to compressors
	LNG Vaporiser/Forcing vaporiser 12 000/8 000 kg/h
	Inert gas plant 20,000 Nm^3/h
	Nitrogen generator plant 2 * 90 Nm^3/h
Auxiliary steam boilers:	2 * 10 t/h
Emergency diesel genset:	560 kW (S = 700 kVA)
Main voltage/frequency:	6.6 kV - 60 Hz (450 V, 230 V)
Mooring:	8 stern + 8 bow mooring lines
Complement/cabins:	max. 46 persons (40 + 6 temporary workers), 42 cabins
Class:	LR (or equivalent) + RMRS-dual class
Ice class:	RMRS “Arc7”

Deadweight (an example):	Cargo (205,040 m^3, 0.451 t/m^3)		92,470 t
	Consumables		
	Marine Diesel Oil	2,400 t	
	Marine Gas Oil		60 t
	Lubricating Oil	150 t	
	Fresh & Feed Water	200 t	
	Miscellaneous tanks	100 t	
	Crew, stores, spares	120 t	
	Water ballast	400 t	
	TOTAL		95,900 t

The “Integrated Hull Structure” (IHS) concept has been applied. The tank cover is one continuous entity and is structurally an essential part of the hull strength.

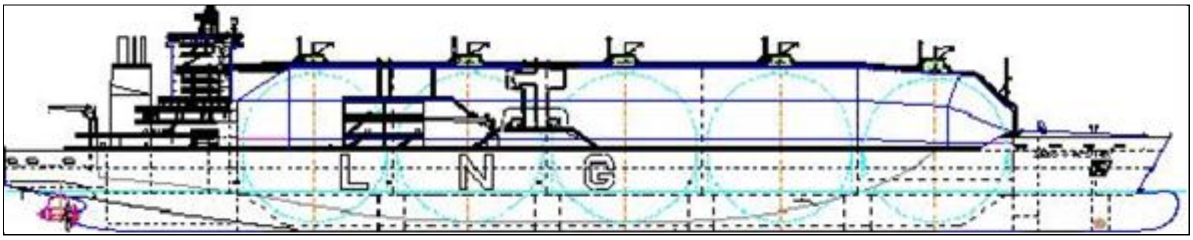

Figure 1. Appearance of the Moss type ship
Source: [13]

2.1.2. *Speed performance predictions and fuel consumption tables*

The mechanical losses of the azimuthing propulsion units as well as those of the centre shaftline have been regarded in the below estimates.

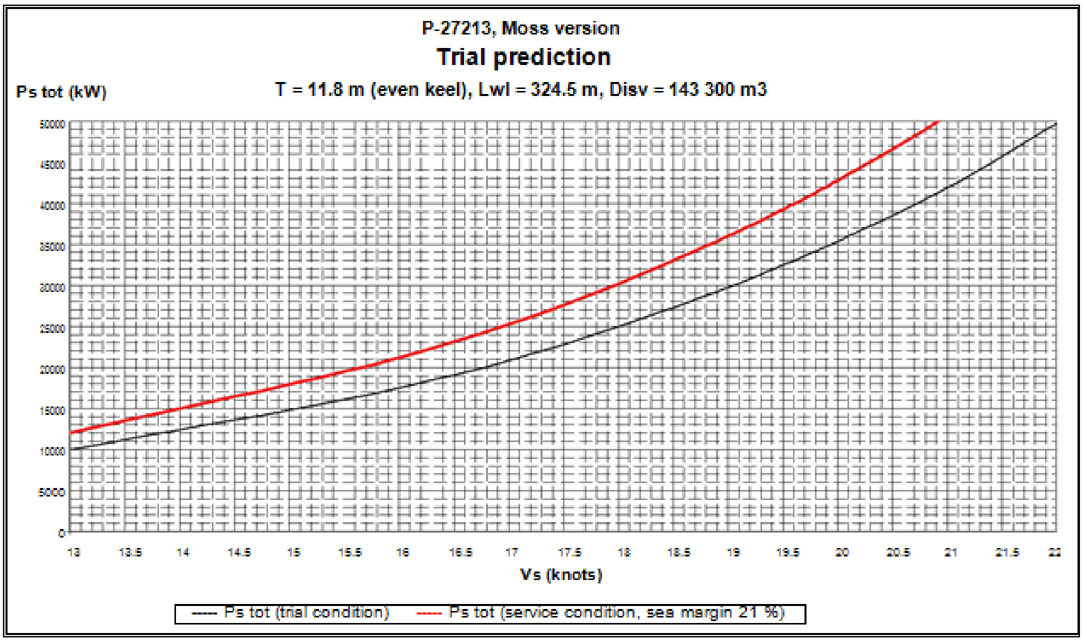

Figure 2. Speed performance predictions
Source: Author

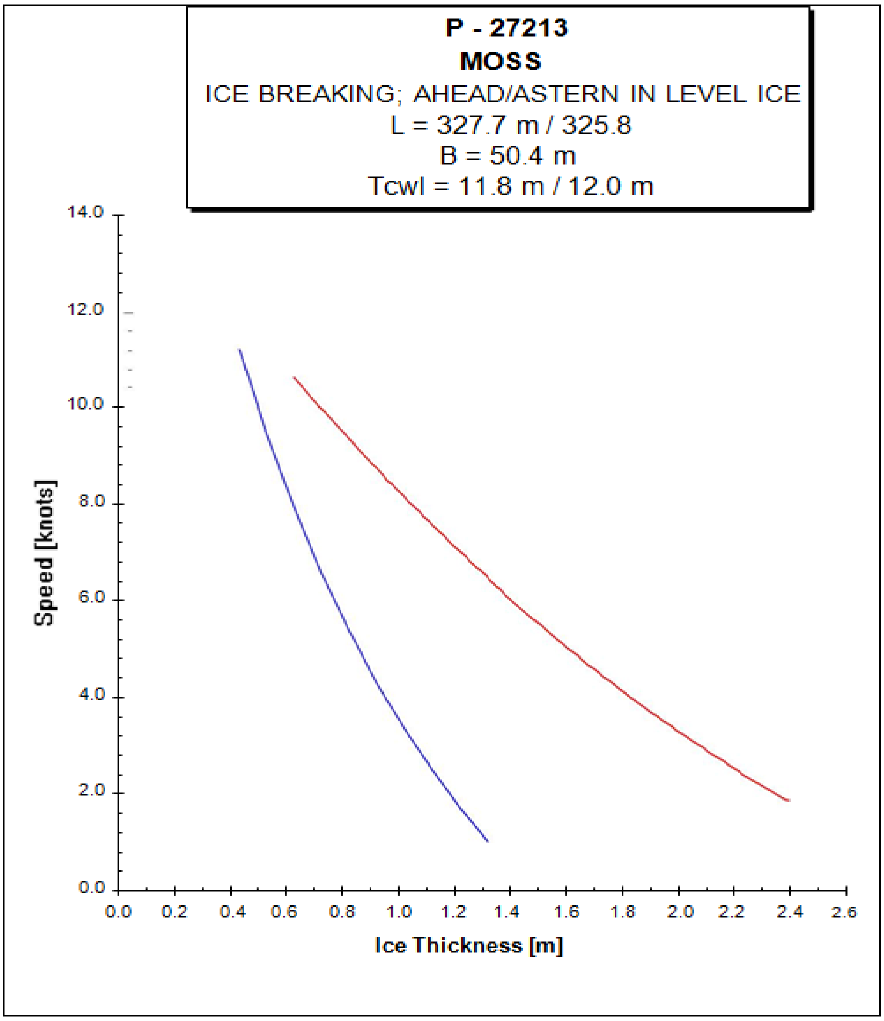

Figure 3. Ice breaking prediction at full nominal shaft power of 42,000 kW
Source: Author

Table 1. Fuel consumption

Moss, Wärtsilä	**At Sea** Ahead / Ballast	**At Sea** Ahead / Loaded	**Port** Unloading cargo	**Port** Loading cargo	**Port** idle
Boil-off gas (BOG) – availability [%]	43	56	100	100	100
Heat value [MJ/kg]	48.57	48.44	48.00	46.00	47.00
Pilot fuel [ton/day]	1.49	1.35	0.22	0.14	0.12
BOG + LNG [ton/day]	163.20	178.90	21.70	9.30	7.30
BOG + LNG [t/h]	6.80	7.45	0.90	0.39	0.30

Source: [13]

2.2. General description, SPB type LNG carrier

2.2.1. *Main dimensions*

Nominal size: 205,000 m^3
Ice-going hull concept: Double Acting Ship (DAS) with hybrid propulsion
Bow form: Ice bulbous bow
Cargo containment system: Prismatic aluminium tanks, 4 rectangular + 1 wedged.
98.5 % filling volume 205,080 m^3 (at -163 °C)
100 % filling volume 208,200 m^3 (at -163 °C)
Boil-off-Rate (B.O.R.): 0.15 % per 24 h (in IMO specified conditions)
Main dimensions: Length over all (LOA) about 343 m
Length between perpendiculars 325.8 m
Breadth 50.4 m
Depth, to upper deck 28.0 m
Depth, to trunk deck 34.7 m
Draught, design (T_D) abt. 12.0 m
Draught, scantling 12.7 m
Draught, ballast (terminal/sea-going) 11.0m/10.2m
Deadweight: About 96,000 t at T_D
Service speed: 19.5 kn at T_D (including sea-margin 21%)
Propeller units: Two azimuthing podded propellers, FPP 2 * 6.0 m
One centre propeller, FPP 1 * 7.8 m
Installed propulsion power: 2 * 13.5/15 MW (open/ice) + 15/12 MW (open/ice) = 42/42 MW
Bow thruster unit abt. 2.0 MW
Main electric power: Four dual fuel diesel generator sets, installed MCR power 54.1 MW [Eg. 4 Wärtsilä 12V 50DF + 1 * 9L 50DF engines]
Gas oxidizer unit: Capacity 6,000 kg/h (acc. to max. B.O.R.)
Cargo & spray pumps: Cargo: 10 * 1,700 m^3/h. Spray pumps 5 * 60 m^3/h
Unloading/Loading time: 12 h (theoretical design value)
Other cargo handling: HD Compressors 2 * 34,000 m^3/h – 51,000 kg/h
LD Compressors 2 * 8,000 kg/h (acc. to 100 % fuel gas)
LD and HD heaters acc. to compressors
LNG Vaporiser/Forcing vaporiser 12,000/8,000 kg/h
Inert gas plant 20,000 Nm^3/h
Nitrogen generator plant 2 * 90 Nm^3/h
Auxiliary steam boilers: 2 * 10 t/h
Emergency diesel genset: 560 kW (S = 700 kVA)
Main voltage/frequency: 6.6 kV - 60 Hz (450 V, 230 V)
Mooring: 8 stern + 8 bow mooring lines
Complement/cabins: max. 46 persons (40 + 6 temporary workers), 42 cabins
Class: LR (or equivalent) + RMRS-dual class

Ice class:	RMRS “Arc7”		
Deadweight (an example):	Cargo (205,040 m^3, 0.451 t/m^3)		92,490 t
	Consumables		
	Marine diesel oil	2,480 t	
	Marine gas oil	60 t	
	Lubricating oil	150 t	
	Fresh & feed water	200 t	
	Miscellaneous tanks	100 t	
	Crew, stores, spares	120 t	
	Water ballast	400 t	
	TOTAL		96,000 t

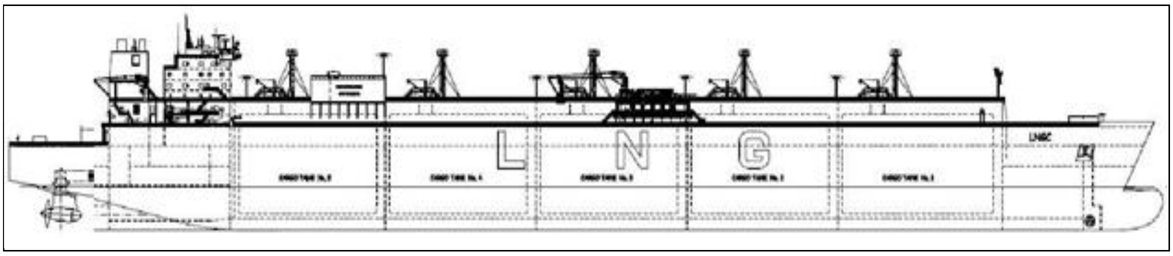

Figure 4. Appearance of the SPB type ship
Source: [1]

2.2.2. *Speed performance predictions and fuel consumption tables*

The mechanical losses of the azimuthing propulsion units as well as those of the centre shaftline have been regarded in the below estimates.

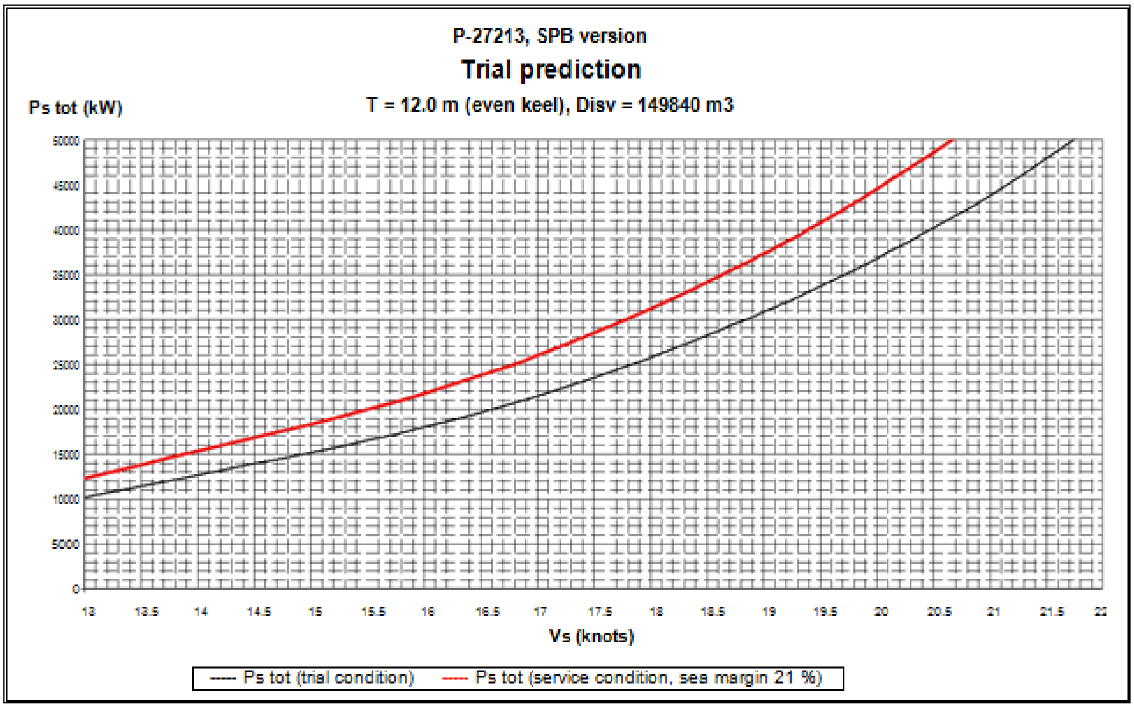

Figure 5. Speed performance predictions
Source: Author

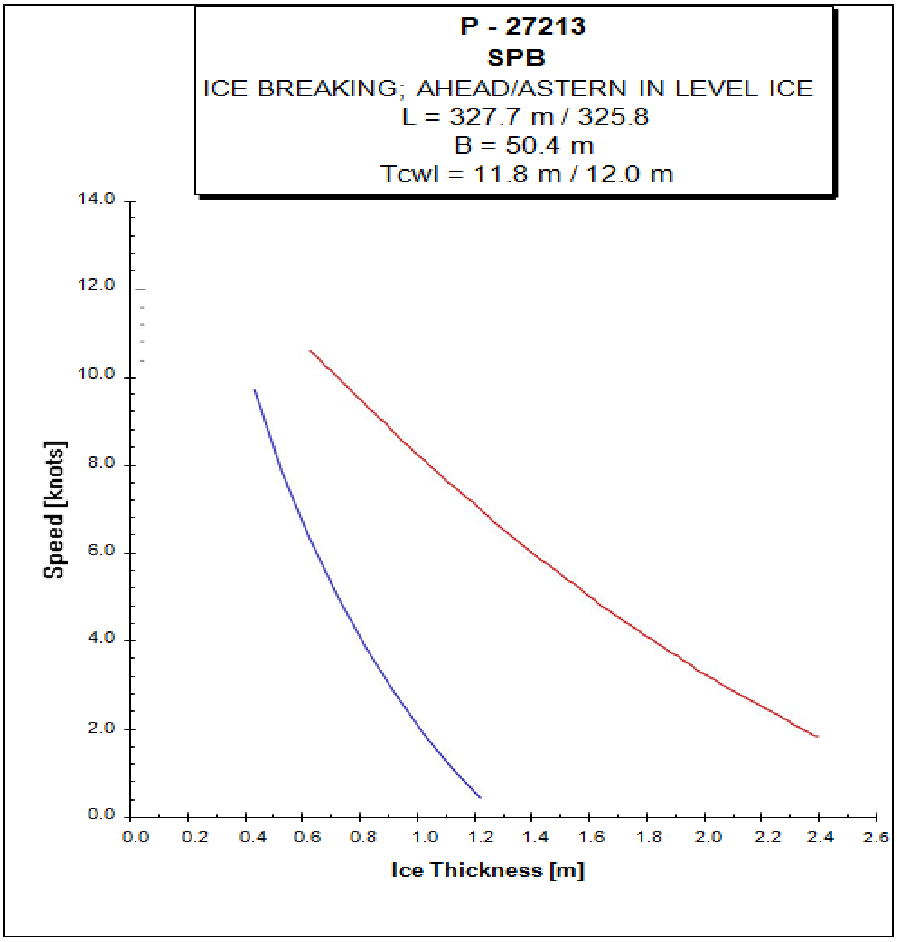

Figure 6. Ice breaking prediction at full nominal shaft power of 42,000 kW.
Source: Author

Table 2. Fuel consumption

SBP, Wärtsilä	**At Sea** Ahead / Ballast	**At Sea** Ahead / Loaded	**Port** Unloading cargo	**Port** Loading cargo	**Port** idle
BOG – availability [%]	42	54	100	100	100
Heat value [MJ/kg]	48.58	48.46	48.00	46.00	47.00
Pilot fuel [ton/day]	1.49	1.33	0.26	0.15	0.12
BOG + LNG [ton/day]	168.80	185.10	22.20	9.40	7.40
BOG + LNG [t/h]	7.03	7.71	0.92	0.39	0.31

Source: [13]

3. SPEED, POWER AND FUEL CONSUMPTION CALCULATIONS

3.1. Monthly ice conditions over the route

3.1.1. *Ice condition in the Ob area*

Ice in the Ob region of the shipping route will stay broken all time by the activity of icebreakers, the LNG carriers and other ships operating in the fairway. As the air temperatures in the region are very low and breaking of the ice occurs repeatedly the thermodynamic ice formation is intensive.

In this calculation it is assumed that controlling the channel ice is done by icebreakers jointly with LNG carriers operating in the sea route. The purpose is to minimize the ice mass freezing and to prevent extremely thick brash ice formation. [10, 11]

The distance of this brash channel ice is also increasing during the winter with the following assumption.

Table 3. Distance of Ob ice channel

DISTANCE OF OB ICE CHANNEL [nm]	
January	30
February	30
March	30
April	30
May	30
June	0
July	0
August	0
September	0
October	6
November	18
December	24

Source: Author

3.1.2. *Ice conditions in the Kara Sea, Barents Sea and Northern Sea Route (NSR)*

In order to analyse the operative speed of the LNG carrier, the effective ice thickness parameter is used together with ice concentration value. The effective ice thickness is determined based on real-life experiments with independently operating ships in ice conditions. [12]

The natural ice thickness is obtained from statistical values and can also be obtained from thermo-dynamical calculation models.

The effective ice thickness is expressed as follows:

Ice_eff = Ice_nat * coefficient

The coefficient is dependent on the ship operation, safety of structures, tactical ice navigation, ice thickness distribution, leads in ice and ice ridging condition.

The ice concentration for the different sea areas is obtained from statistical satellite analysis. The average value of last five years has been used. [3]

The following tables present the ice conditions for the shipping analysis. Two columns on the right represent channel ice and the other columns the effective level ice thickness in metres. [3, 14]

Table 4. Ice conditions in the Kara Sea and Barents Sea

EFFECTIVE ICE [m]	Barent Sea	Kara Gate	Kara Sea	North Kara	Ob area	Approach
January	0.20	0.32	0.40	0.40	1.63	1.63
February	0.28	0.44	0.55	0.55	2.11	2.11
March	0.30	0.48	0.60	0.60	2.62	2.62
April	0.35	0.56	0.70	0.70	3.02	3.02
May	0.35	0.56	0.70	0.70	3.30	3.30
June	0.35	0.56	0.70	0.70	0.70	0.70
July	0.00	0.00	0.00	0.00	0.00	0.00
August	0.00	0.00	0.00	0.00	0.00	0.00
September	0.00	0.00	0.00	0.00	0.00	0.00
October	0.00	0.00	0.00	0.00	0.26	0.26
November	0.05	0.08	0.10	0.10	0.65	0.65
December	0.10	0.16	0.20	0.20	1.12	1.12

Source: Author

Table 5. Ice conditions in the Kara Sea and Barents Sea

CONCENTRATION [%]	Barent Sea	Kara Gate	Kara Sea	North Kara	Ob area	Approach
January	20	90	80	90	100	100
February	40	90	90	90	100	100
March	70	90	90	90	100	100
April	90	95	90	95	100	100
May	90	90	80	70	100	100
June	0	0	40	40	0	0
July	0	0	0	0	0	0
August	0	0	0	0	0	0
September	0	0	0	0	0	0
October	0	0	10	10	20	20
November	0	0	40	80	60	100
December	0	0	70	90	80	100

Source: Author

Table 6. Ice conditions in the Northern Sea Route (NSR)

EFFECTIVE ICE [m]	Chucki Sea ice	East-Sib Sea ice	Laptev Sea ice	Vilkitsky Sea ice	North Kara Sea ice	Ob area Channel	Approach Channel
January	0.55	0.70	0.50	0.75	0.65	2.31	2.31
February	0.65	0.85	0.60	0.85	0.75	2.98	2.98
March	0.75	0.90	0.65	0.95	0.85	3.70	3.70
April	0.85	0.95	0.70	1.00	0.85	4.27	4.27
May	0.85	0.95	0.70	1.00	0.85	4.66	4.66
June	0.80	0.95	0.65	0.95	0.75	3.80	3.80
July	0.25	0.65	0.30	0.75	0.60	0.00	0.00
August	0.00	0.25	0.00	0.40	0.25	0.00	0.00
September	0.00	0.00	0.00	0.00	0.00	0.00	0.00
October	0.00	0.00	0.00	0.15	0.15	0.36	0.36
November	0.15	0.20	0.20	0.40	0.35	0.92	0.92
December	0.40	0.45	0.35	0.60	0.50	1.58	1.58

Source: Author

Table 7. Ice conditions in the NSR

CONCENTRATION [%]	Chucki Sea ice	East-Sib Sea ice	Laptev Sea ice	Vilkitsky Sea ice	North Kara Sea ice	Ob area Channel	Approach Channel
January	98	98	98	98	98	100	100
February	98	98	98	98	98	100	100
March	98	98	98	98	98	100	100
April	98	98	98	98	98	100	100
May	98	98	98	98	98	100	100
June	95	95	95	95	95	80	90
July	30	80	70	80	80	0	0
August	0	30	0	50	40	0	0
September	0	0	0	0	0	0	0
October	0	0	0	90	80	20	20
November	85	85	85	98	95	60	100
December	95	90	90	98	98	80	100

Source: Author

3.2. Consideration of safe and attained speed

The speed of the ship strongly affects the structural loads exerted on the ship's hull and its propulsion system. Therefore in practice the speed of the ship shall always be adjusted to the prevailing weather and ice conditions. [4, 5]

Ships with capability to sail at high speed or using strong manoeuvres often exceed the limits of safe operation. This happens especially in changing and partly open ice conditions where the ice is not limiting the speed of the ship.

In the below graph this is illustrated by curves representing the safe speed, attained speed and admissible speed, where the admissible speed is always lower than the safe or the attained speed.

In this transport analysis it is assumed that in normal winter ice conditions the maximum safe speed criteria is recognised. However, it shall be pointed out that a specific design study and dimensioning of the hull structure shall always be carried out to confirm the hull strength and safety. [16]

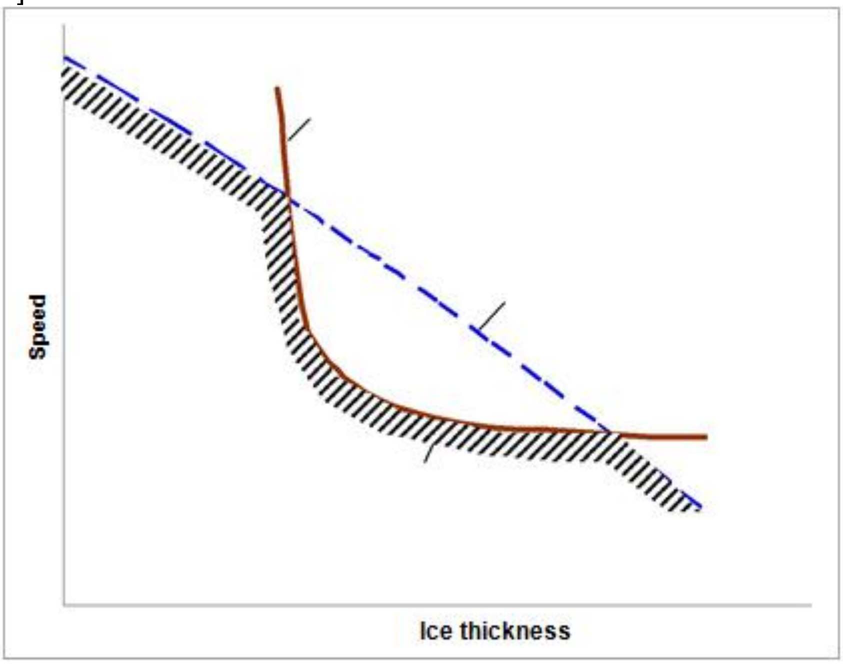

Figure 7. Schematic illustration of the safe speed and attained speed

Source: Author

3.3. Attained speeds of the ships over the route

The ice channel thickness in the Ob region increases over the winter due to continuous traffic in the channel width-limited area. The more often the ships make passages the more the ice mass accumulates. A specific method to calculate the ice growth is used and the estimate for the speed of LNG carriers over the season is shown below. [12] Two cases are shown, one with the 205,000 m^3 and the other with the 183,000 m^3 ship size.

With smaller ships the passages take place more often.

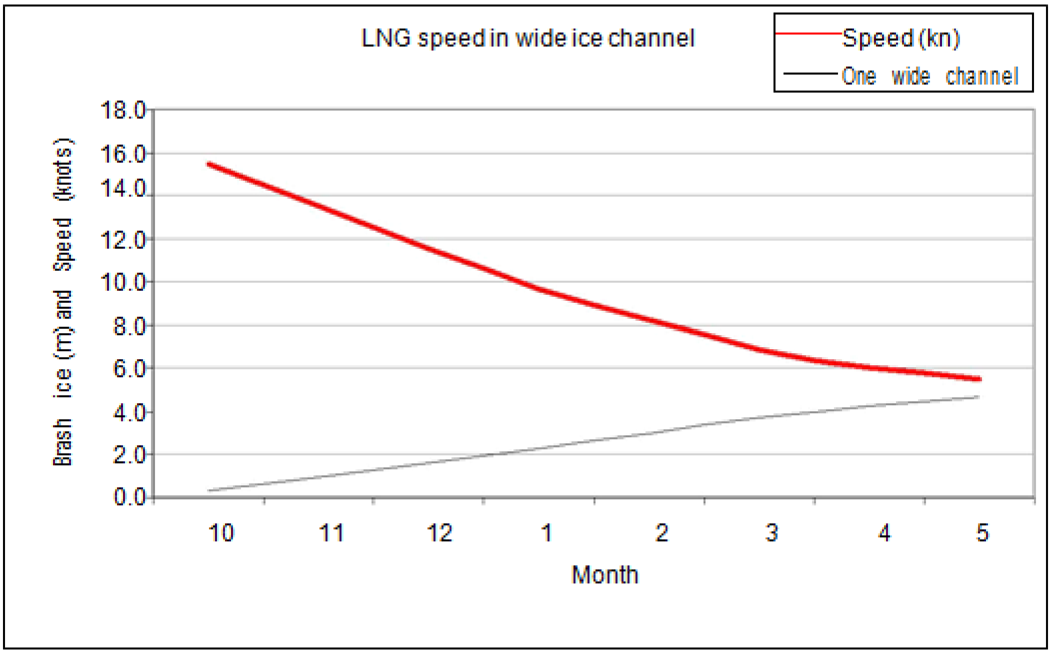

Figure 8. Speed of LNG carrier in the Ob channel and brash ice growth (205,000 m^3)
Source: Author

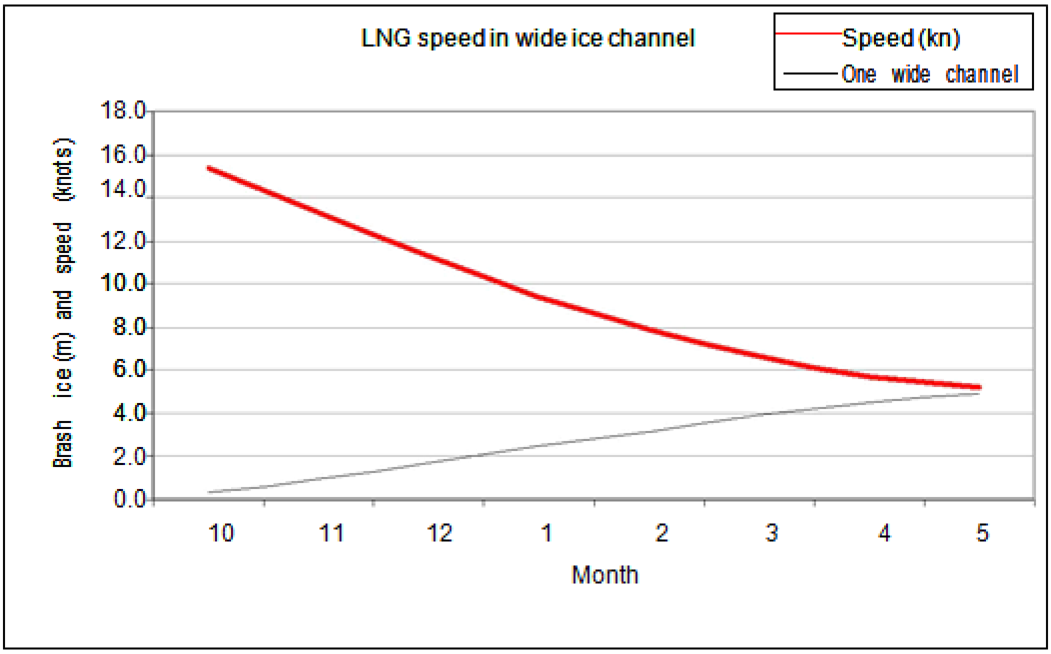

Figure 9. Speed of LNG carrier in the Ob channel and brash ice growth (183,000 m^3)
Source: Author

The navigation in sea ice is divided to sea areas for the Barents Sea, Kara Gate, Southern Kara Sea and Ob area. The monthly speeds estimated in knots for the ships are shown in the table below.

Table 8. Average speed of independent LNG carriers in Barents Sea, Kara Sea and Ob area (* Moss type)

SPEED IN ICE [kn]	Barents Ice	Kara Gate Sea ice	South Kara Sea ice	North Kara Sea ice	Ob area Channel	Approach Channel
January	14.29	9.90	11.17	11.17	10.61	8.00
February	12.96	8.56	10.21	10.21	9.46	8.00
March	12.53	8.14	9.90	9.90	8.36	8.00
April	11.69	7.32	9.30	9.30	7.59	7.59
May	11.69	7.32	9.30	9.30	7.10	7.10
June	11.69	7.32	9.30	9.30	7.62	7.62
July	18.19	18.19	18.19	18.19	12.00	8.00
August	18.19	18.19	18.19	18.19	12.00	8.00
September	18.19	18.19	18.19	18.19	12.00	8.00
October	18.19	18.19	18.19	18.19	12.00	8.00
November	17.17	15.22	16.18	16.18	12.00	8.00
December	16.18	12.53	14.29	14.299	12.00	8.00

Source: Author

4. CONCLUSION

The estimates of LNG carriers' fuel consumption are based on the overall daily consumption under various operating conditions. It is important to point out that the real costs (costs occurring in practice) are always higher than the theoretical, previously assumed costs. This is explained by a number of factors, e.g. adverse weather conditions over the sailing route or speed reduction during voyage at high seas.

The sailing routes of LNG carriers are exceptionally long. For this reason, all LNG tankers are designed, as a rule, with additional sea margin power amounting to 21 %. The purpose of the margin is to ensure that the vessels sail without delays, regardless of adverse phenomena that may include heavy weather, ice, hull fouling or ship aging. It is worth emphasising that the propulsion power in ice conditions is essential for the ships analysed in this research. The use of the 21 % sea margin power enables these vessels to sail faster in order to compensate for the time lost in adverse operating conditions, e.g. in heavy weather and ice sea areas. Naturally, the use of maximum power implies higher fuel consumption, higher engine loads and, consequently, higher structural loads exerted on the ship's hull. On longer passages (10,000 nm and more) it is possible to make speed adjustments in order to keep up with the schedule, by using combined sailing speeds on the high seas during a particular season.

When considering the passages on the high seas and speed limitations, it should be pointed out that the average service speed of loaded and non-loaded vessels is 19.5 knots on average.

As for the fuel consumption and hull preservation, the best time for LNG transport is during summer season, i.e. when ideal weather conditions prevail and the sea is ice-free. On the other hand, this is the period when the demand for LNG is decreased, resulting in the surplus of cargo space across the LNG fleet. In order to achieve optimum booking of the LNG storage capacity onboard ships during winter, when the demand for cargo space reaches its peak and the transportation of LNG is the slowest and most difficult due to the climate, weather and ice conditions under which the ships operate, it would be essential to predict the ideal speed, required power and fuel consumption of LNG carriers in advance.

The calculations and estimates performed in this paper represent a step forward towards this goal.

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IMPLEMENTATION AND OPERATION OF THE SAFESEANET NETWORK

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ABSTRACT
The European Maritime Safety Agency (EMSA) has been established for the purpose of ensuring a high, uniform and effective level of maritime safety, maritime security, prevention of, and response to, pollution caused by ships as well as response to marine pollution caused by oil and gas installations. SafeSeaNet (SSN), a European Platform for Maritime Data Exchange between Member States' maritime authorities, is a network/Internet solution based on the concept of a distributed database. In this paper mision, origin and tasks of the EMSA are emphasized. The focus of research is given to the presentation of SSN background, its architecture, mode of operation, management and the participants. For illustration of its operations, SSN in action is presented as well as its key performance indicators. In the last part an assessment on the application of SSN in Croatia is given.

KEYWORDS
SafeSeaNet, maritime safety,maritime security, maritime data exchange

IMPLEMENTACIJA I DJELOVANJE SAFESEANET MREŽE

SAŽETAK
Europska agencija za pomorsku sigurnost (EMSA) osnovana je u svrhu osiguranja visoke, jedinstvene i djelotvorne razine sigurnosti na moru, sigurnosne zaštite u pomorstvu, prevencije i odgovora na onečišćenje uzrokovano brodovima, kao i odgovor na onečišćenja uzrokovana postrojenjima nafte i plina. SafeSeaNet (SSN), europska platforma za pomorsku razmjenu podataka između pomorskih vlasti država članica, predstavlja mrežu/internet rješenje koje se temelji na konceptu distribuirane baze podataka. U ovom su radu predstavljeni misija, porijeklo i zadaci EMSE.Fokus istraživanja je dan na prikaz sustava SSN s osvrtom na njegovu pozadinu, arhitekturu, način rada, upravljanje i sudionike. Za ilustraciju predstavljeni su primjeri funkcioniranja SSN-a u praski kao i ključni pokazatelji uspješnosti, te se na kraju daje osvrt na SSN u Hrvatskoj.

KEYWORDS
SafeSeaNet sustav, sigurnost na moru, sigurnosna zaštita u pomorstvu, razmjena podataka u pomorstvu

1. INTRODUCTION

The European Maritime Safety Agency (EMSA) is one of the EU's decentralised agencies. Based in Lisbon, the Agency provides technical assistance and support to the European Commission and Member States in the development and implementation of EU legislation on maritime safety, pollution by ships and maritime security. It has also been given operational tasks in the field of oil pollution response, vessel monitoring and in long range identification and tracking of vessels.

As a body of the European Union, the Agency sits at the heart of the EU maritime safety and pollution response network and collaborates with many industry stakeholders and public bodies, in close cooperation with the Commission and the Member States.

Agency develops and operates maritime information capabilities at EU level. One of the significant example is SafeSeaNet SafeSeaNet that represents the vessel traffic monitoring system to enable EU-wide tracking of vessels and their cargoes, and accidents and incidents.

SafeSeaNet was established as a centralised European platform for maritime data exchange, linking together maritime authorities from across Europe. It enables European Union Member States, Norway, and Iceland, to provide and receive information on ships, ship movements, and hazardous cargoes. Main sources of information include Automatic Identification System (AIS) based position reports, and notification messages sent by designated authorities in participating countries.

2. EMSA

2.1. Mision

A major political impetus to the setting up of EMSA in 2003 was the fallout from the Erika (1999) and the Prestige (2002) accidents and their resulting oil spills. These incidents resulted in huge environmental and economic damage to the coastlines of Spain and France. They also acted as a reminder to decision-makers that Europe needed to invest in better preparation for a large-scale oil spill, i.e. above-and-beyond the resources available at individual Member State level.

EMSA undertakes a number of mainly preventive, but also reactive tasks, in certain key areas in order to meet its objectives.

The European Maritime Safety Agency has been established for the purpose of ensuring a high, uniform and effective level of maritime safety, maritime security, prevention of, and response to, pollution caused by ships as well as response to marine pollution caused by oil and gas installations.

The Agency provides the Member States and the Commission with the technical and scientific assistance needed and with a high level of expertise, in order to help them:

- apply EU legislation properly in the field of maritime safety and prevention of pollution by ships;
- monitor its implementation;
- evaluate the effectiveness of the measures in place.

The Agency also provides operational means, upon request, as well as technical and scientific assistance, to help Member States and the Commission respond to marine pollution by ships within the EU. With the revision of the Founding Regulation, a new objective related to the response to marine pollution caused by oil and gas installations has been introduced by the co-legislators.

2.2. Origin

The idea of a European Maritime Safety Agency (EMSA) originated in the late 1990s along with a number of other important European maritime safety initiatives. EMSA was set up as the regulatory agency that would provide a major source of support to the Commission and the Member States in the field of maritime safety and prevention of pollution from ships. The Agency was established by Regulation (EC) No 1406/2002 and subsequent amendments[1] have refined and enlarged its mandate.

The last amendment[2] has further finetuned the Agency's mandate, enabling EMSA to better assist the Commission and the Member States in its core tasks and make broader use of its resources to help EU Member States respond to pollution caused by ships as well as response to marine pollution caused by oil and gas installations. Moreover, ancillary tasks have been introduced, with the possibility for the Agency to use its expertise and tools for other EU activities related to the Union maritime transport policy.

[1] http://eur-lex.europa.eu

[2] Regulation (EU) No 100/2013.

2.3. Tasks

The Agency's tasks are broadly divided into four key areas in line with its Founding Regulation and relevant EU legislation. Firstly, the Agency assists the Commission in monitoring the implementation of EU legislation relating, among others, to ship survey and certification, the certification of marine equipment, ship security, the training of seafarers and port State control.

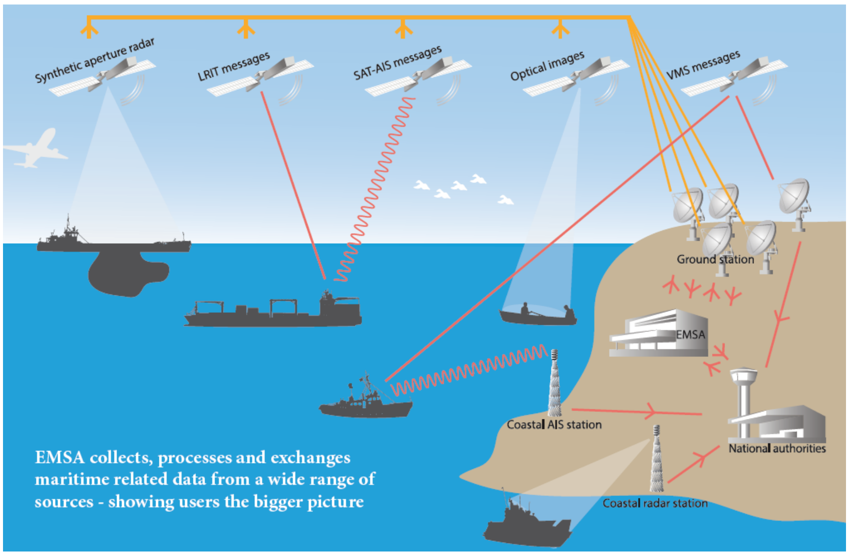

Figure 1 Integrating Data for a more Safe, Secure and Clean Maritime Environment
Source: http://www.emsa.europa.eu

Secondly, the Agency develops and operates maritime information capabilities at EU level. Significant examples are SafeSeaNet, the vessel traffic monitoring system to enable EU-wide tracking of vessels and their cargoes, and accidents and incidents; the EU LRIT Cooperative Data Centre (Long – Range Indetification and Tracking System Data Centre), to ensure the identification and tracking of EU flagged ships worldwide; and THETIS (The Hybrid European Targeting and Inspection System), the information system to support the new port State control regime. In parallel, marine pollution preparedness, detection and response capability is provided by EMSA to coastal States. This includes a European Network of Stand-by Oil Spill Response Vessels as well as a European satellite oil spill and vessel detection service (CleanSeaNet), contributing to an effective system for protecting EU coasts and waters from pollution at sea.

Finally, the Agency provides technical and scientific advice to the Commission in the field of maritime safety and prevention of pollution by ships in the continuous process of evaluating the effectiveness of the measures in place, and in the updating and development of new legislation. It also provides support to, and facilitates cooperation between, the Member States and disseminates information on best practice.

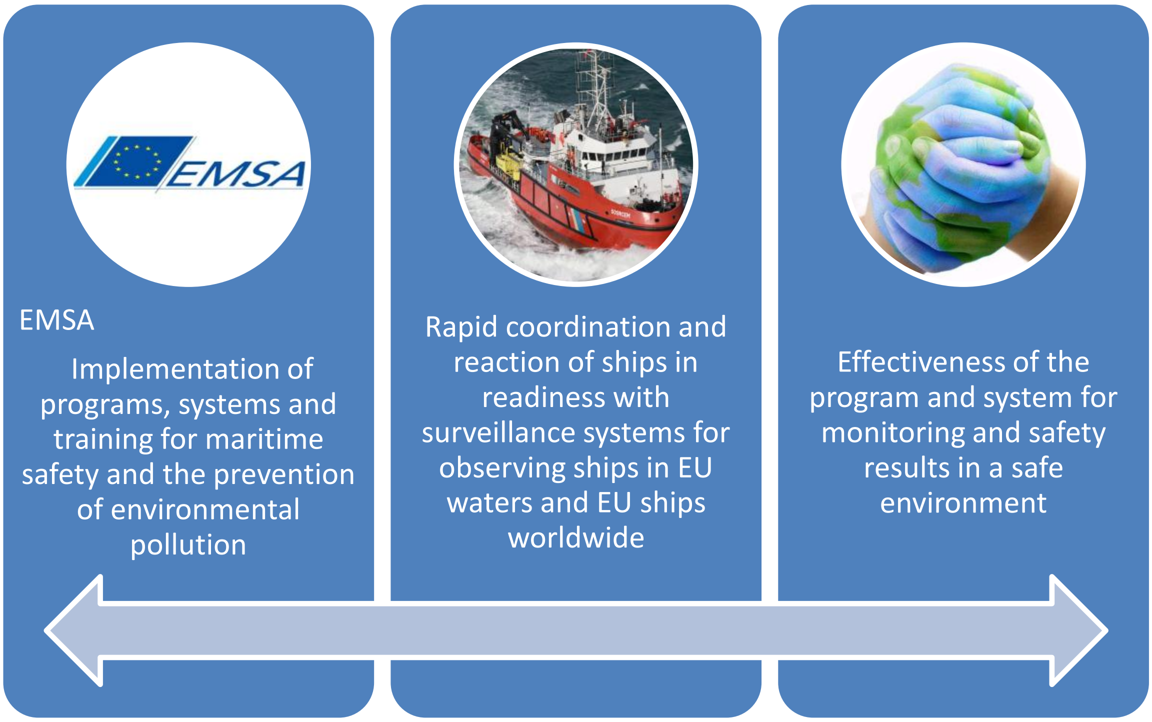

Figure 2 Objectives of the EMSA
Source: Source: http://www.emsa.europa.eu

3. SAFESEANET (SSN)

SafeSeaNet, a vessel traffic monitoring and information system, is based on monitoring AIS (radio) broadcasts from ships and covers all European coastal waters (over 20,000 vessels). 12,000 ships/day are tracked in EU waters with 100,000,000 AIS positions recorded per month. SSN uses traffic management, search-and-rescue and banned vessel tracking.

SafeSeaNet is established in order to enhance:

- maritime safety
- port and maritime security
- marine environment protection
- efficiency of maritime traffic and maritime transport.

SafeSeaNet supports safer seas and better protection of seafarers through:

- early identification of high-risk vessels
- earlier precautionary actions and risk mitigation
- improved emergency response to incidents or pollution.

It also supports more efficient operations by:

- standardising access to data
- helping users to respect their legal obligations
- increasing the efficiency of port logistics (e.g. providing more accurate estimated times of arrival, details of waste handling, etc.),

as well as high quality EU level monitoring by providing:

- accurate, up-to-date information on the location of ships and their cargoes
- reliable statistics for EU MemberState and EFTA bodies.

Prevention of accidents at sea and marine pollution is an essential component of the European Union's transport policy. Since 1993, the Commission has initiated over 15 proposed Directives or Regulations concerning passenger vessels' safety, prevention of pollution, port state control, requirements for seafarers, etc. Their implementation includes the collection and dissemination of maritime data which SafeSeaNet supports.

SafeSeaNet's main objective is to aid the collection, dissemination and harmonised exchange of maritime data. The network assists communication between authorities at local/regional level and central authorities thus contributing to prevent accidents at sea and, by extension, marine pollution, and that the implementation of EU maritime safety legislation will be made more efficient.

The SafeSeaNet network involves many maritime authorities across Europe, each with their own IT infrastructure and objectives. This invariably leads to varying data formats distributed across different systems throughout Europe.

Consequently SafeSeaNet has implemented a Central Index System that stores only references to the data locations and not the actual data itself. It functions as a central hub for all communication between data requesters and data providers - somewhat like a telephone switchboard. The Central Index needs to know what information each data provided holds. Data providers connected within the SafeSeaNet network send information by means of a notification mechanism. The data provider, upon receiving queries from the data requester routed through the Central Index, retrieves the data from their local database. In this way the Central Index acts as the sole point of contact.

SafeSeaNet has developed a Community vessel traffic monitoring and information system according to Directive 2002/59/EC.[3] In addition, it incorporates data exchange requirements from other EU Directives such as those relating to:

- port reception facilities for ship waste
- port state control inspections in ports of the European Union.

SafeSeaNet covers EU Member States plus Iceland and Norway and involve a number of different authorities per country, both at local and central level. The system uses new IT technologies, but is flexible enough to cope with possible future technological developments as well as new categories of users.

The following subjects benefits from this system:

Public Administrations: Through the use of SafeSeaNet, and its linked legislation, maritime authorities are able to improve controls of vessels in ports and produce statistics for the European Maritime Safety Agency (EMSA), Member States and the European Commission. In addition, the once-only data collection process and a 'one-stop shop' for data provision simplify procedures and, consequently, increase the overall competitiveness of European ports by minimizing their administrative overheads.

Navigation survey services: This group is set to benefit by being able to increase efficiency of port logistics such as accurate Expected Times of Arrival, waste handling etc.

Search and rescue services: This group can better react in case of threat to maritime safety and the environment.

Anti-pollution services: These agencies aim to improve emergency responses in case of incidents or pollution at sea.

Others: Information contained in the SafeSeaNet system and mandated by the control and safety at sea legislation, is often similar or even identical to information requested by other authorities. This could lead to a broadening of the SafeSeaNet scope which could include information of interest to other bodies or administrations such as Customs and Border Police.

3.1. SafeSeaNet Background

Following the loss of the tanker Erika off the French coast in 1999, the European Union adopted several directives aimed at preventing accidents at sea and marine pollution.

Directive 2002/59/EC adopted by the Parliament and the Council on 27 June 2002 (later amended by Directive 2009/17/EC)[4] established a Community vessel traffic monitoring and

[3] http://eur-lex.europa.eu

information system "with a view to enhancing the safety of efficiency of maritime traffic, improving the response of authorities to incidents, accidents or potentially dangerous situations at sea, including search and rescue operations, and contributing to a better prevention and detection of pollution by ships".[5]

At the same time, the European Maritime Safety Agency (EMSA) was also being established (Regulation 1406/2002/EC of 27 June 2002). When EMSA became operational in 2003, it was decided that the Agency should be responsible for setting-up and operating the new vessel traffic and monitoring system, which would be called SafeSeaNet. The process for setting-up SafeSeaNet was initiated in October 2004. The procedure had several stages, and the system finally became fully operational in 2009.

A major advance in 2010 was the development of a graphical interface. This allows information to be displayed on nautical charts, making it easier for users to quickly get an overview of activities in their areas of interest.

3.2. SafeSeaNet Architecture

The participants to the SafeSeaNet network operate on various locations throughout Europe. Moreover, they have a diversity of IT infrastructure in place (if at all), and they each have very different objectives. The data that is involved in their activities, and that is of interest to the general functioning of SafeSeaNet, is therefore located at various places, in various formats.

Due to the sheer volume of it, and the fact that most of it is (also) operational data, it is not considered feasible (or even desirable) to consolidate this data in a central store. By leaving it at the location where it is gathered, another type of problem occurs, namely that it must be made public that this information exists, and where. A central index store handles this problem, as it provides a transparent way of locating data.

All participants that store data must now notify the central index store whenever they come in possession of new data. For this, a messaging protocol is needed. When a SafeSeaNet participant needs information, a request is submitted to the central index store. The central index locates the owner of the requested data, and asks for the specific information. Upon reception, the central index store uses this to construct the reply that is then returned to the requester.

The data flows that are defined through the legislation need to be covered by the possibilities of the messaging structure. The messages that can be sent over the network are structured, so a defined number of different messages exist. Their content is flexible, allowing for exchange of many different types of information. This allows for a 'lightweight' approach that can easily be extended. XML is the basic carrier for data transfer, using the SOAP-protocol for inter-platform communication.

In terms of security, a basic security for the networking is required. However, application level security is needed, to make sure that an actor in the system has only access to data he is entitled to see. This is particularly important in view of the commercial aspects of some data.

The participants to the system will need to make adaptations to their current IT systems, to make the data they possess available for SafeSeaNet. As already many of these systems exist today, it is vital for the success of SafeSeaNet that as little investment as possible (or any other type of costs incurred) should be made. A well-defined interface for the participants' IT systems will make this possible. An implementation guide that describes the steps needed for such an implementation will be of great help to the participants.

For the participants that are not in a position to give access to the information they possess (either because of technical limitations, or because the basic environmental requirements cannot be met), a SafeSeaNet framework application that implements data capture for the messages that are implemented within SafeSeaNet will be made available.

[4] Ibidem
[5] http://www.emsa.europa.eu

This application will represent a local database, with manual data entry functionality on the data associated with the SafeSeaNet messages, and complete integration in the SafeSeaNet messaging structure.

In order to make an optimal use of the data already available, and to limit as much as possible the administrative actions that are needed for the participants, the use of AIS must be considered. Also, the system must be flexible enough to support (at a later stage) the one-stop-shop concept, where a participant (most likely a ship master or shipping agent), only needs to provide its information once. All the participants should then be able to have access to this data and use it for their purpose. In a future scenario, this data could even be exchanged to authorities that are currently outside the maritime 'loop' (customs, immigration…).

Most messaging systems are re-active by nature. The SafeSeaNet system must however also support pro-active messaging. The centralised reporting needs of the SafeSeaNet are implemented through the development of a number of central applications that are capable of storing or retrieving the data from the SafeSeaNet network. This data is then compiled into the desired form. The actual requirements and the possible ways of implementing these will need to be decided upon. This is the specification refinement objective.

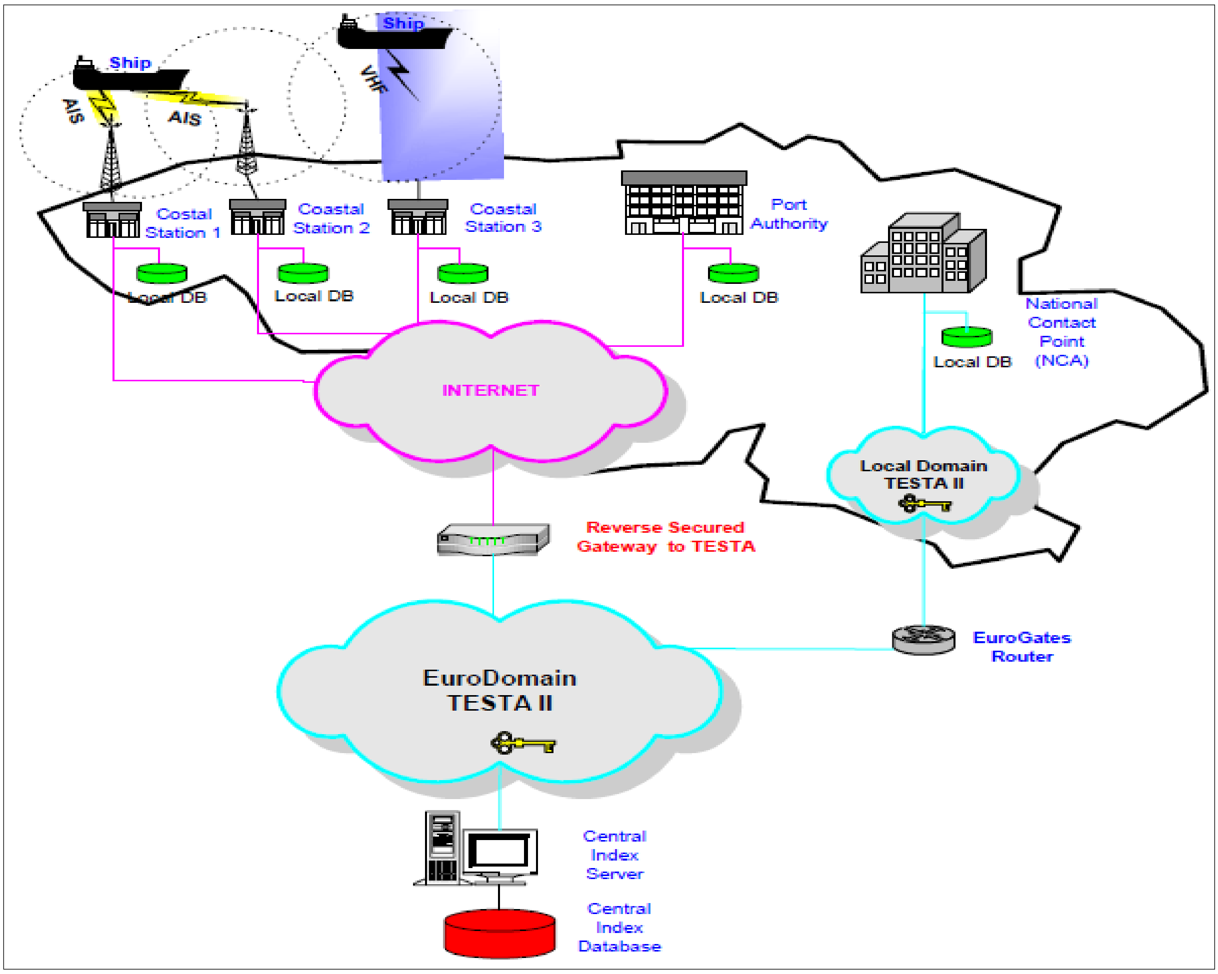

Figure 3 Architecture Overview

Source: http://ec.europa.eu/idabc/servlets/Doc378c.pdf?id=1883

3.3. Mode of SSN operation

The core of the SafeSeaNet architecture is the EIS (European Index Server). This acts as a secure and reliable index system within a "hub and spoke" network (including authentication, validation, data transformation and logging) which sends requests to, and receives notifications and responses from, approved users. Users can provide and/or request data.

The EIS is able to locate and retrieve information on vessels related to one Member State in response to a query or request made by another. The information exchanged is extensive. The main notification reports submitted to SafeSeaNet are:

- Ship Notification: This is used to provide SafeSeaNet with details of a ship's voyage and cargo information. Notifications are based on two types of message. Automatic Identification System (AIS) messages are sent automatically by the ships through very high frequency (VHF) radio signals, and received by coastal stations within range. Mandatory ship reporting systems (MRS) can be established by governments, with approval from the International Maritime Organization, for certain types of vessel transiting through defined areas. MRS messages are sent by ship masters to coastal stations. Information includes ship identification, course, speed, and cargo.
- Port Notification: This is used to notify SafeSeaNet that a specific vessel is bound for a particular port. The Estimated Time of Arrival (ETA) and the number of persons on board are included in the message.
- Hazmat Notification: This is used to notify SafeSeaNet that a given vessel carries hazardous materials - dangerous or polluting goods - on board, and that the data provider has detailed information on these goods.
- Incident Report: This is used to notify SafeSeaNet that the data provider holds information on a specific incident. Incidents might be related to ship safety and seaworthiness (e.g. collisions), the environment (e.g. pollution incidents), or other pre-defined categories (e.g. banned ships, ships not reporting according to rules).

The EIS provides two different interfaces to enable users to exchange messages: 1) the XML message-based interface, which enables the applications of Member States to communicate programmatically with the SafeSeaNet system (i.e. information is automatically exchanged between systems); and 2) the browser-based web interface, which provides a pan-European vessel traffic image and enables users to visualise information stored in the EIS.

The SafeSeaNet web interface represents a significant advance in terms of making SafeSeaNet user-friendly. It is a map-based graphical interface (GIS) and displays information visually in a way which makes it possible for users to quickly obtain what they need. Users have the capability to zoom in and out to display the images from EU-level to individual quays in ports. They can view historical vessel positions and obtain selective information on ships/cargoes in a number of different ways. The information is presented on high-quality nautical charts containing a range of maritime information (e.g. traffic separation schemes, recommended routes, location of lighthouses and other navigational aids, etc).

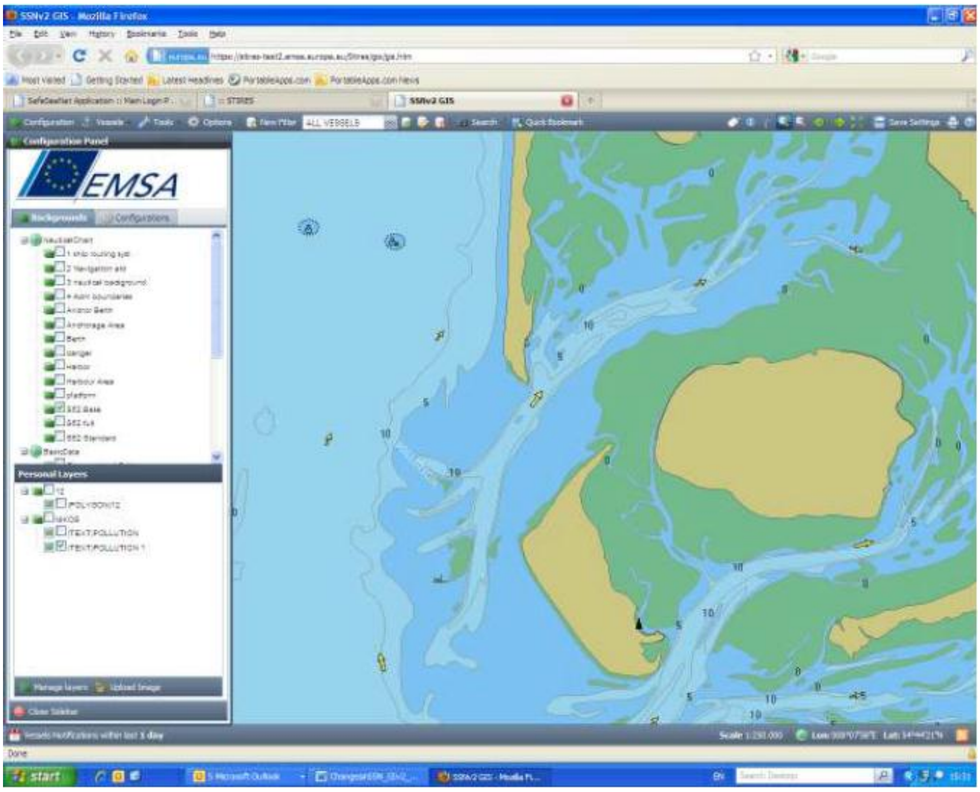

Figure 4 Graphical interface of the SSN system
Source: http://www.emsa.europa.eu

3.4. SSN Management

SafeSeaNet has been developed and implemented under the leadership of the European Commission (Directorate-General for Mobility and Transport - DG MOVE), which retains overall responsibility for the system. EMSA is responsible for its development, operation and maintenance, and interacts with users on an operational basis. The Member States, as data providers, are recognised as the owners of the data.

Following a Commission decision in July 2009, the SafeSeaNet High Level Steering Group was established to manage and develop policies related to the system. The High Level Steering Group comprises one representative per Member State and one representative from the Commission. EMSA attends meetings of the group as an observer.

The group has been tasked with:

- making recommendations to improve the effectiveness and security of the system;
- providing appropriate guidance for its development
- assisting the Commission in reviewing its performance
- approving the interface and functionalities control document (IFCD).

The IFCD describes the performance requirements and procedures applicable to the different elements in SafeSeaNet, and addresses:

- access rights guidance for data quality management
- security specifications for data transmission and exchange
- the archiving of information at national and central level.

3.5. Participants of the SSN system

The participants directly concerned by and involved in the set up of the SafeSeaNet network, are the following:

- All Local Competent Authorities (LCA) designated by the Member States before or during the requirements study as being in possession of any relevant data concerning the SafeSeaNet network. Examples of these are: port authorities, bodies responsible for waste control, ship inspection bodies, etc…
- All National Competent Authorities (NCA) being in possession of relevant data for the SafeSeaNet network.
- Bodies acting as a central storage point for data that is gathered by LCAs but not stored with the LCAs[6].
- National bodies in possession of or responsible for a TESTA connection (or a national network giving access to TESTA)
- Shore based coastal stations, notably those involved in the AIS network (as these stations possess data that is relevant to SafeSeaNet)
- The EMSA, as the proposed host of the central index application.
- Ports, as major stakeholders in the information process.
- In a future setup, shipping agencies and shipmasters could be involved too.

3.6. SSN Case Studies and the Efficiency Indicators

SafeSeaNet can:

- show the current positions of all ships in and around EU waters in a single picture.
- zoom in and out to show the situation at all levels, from the full EU picture to individual quays in ports.
- display selected types of ships (e.g. tankers, banned vessels, single hulled tankers, ships carrying hazardous goods, etc.).
- select other map data (e.g. depths/positions of AIS stations).
- show the historical positions of ships and track the full positional details of their voyages.
- find a specific ship using the name or IMO number.

Case study 1: Port Authorities

Here is an example of supporting the management of port entries: There is a queue of vessels to a particular terminal and the port officer would like to confirm the order of arrivals in order to organise the incoming traffic and arrange cargo transhipments. The port officer can enter SafeSeaNet and search, not only for the port arrival information, but also for the latest position of the vessels. The latest positions are based on the ship notification messages gathered in the MRS or by means of the AIS. After obtaining the data, the port officer may decide on the order of port entries.

Case study 2: Vessel Traffic Service (VTS) Centres

Cross-checking Hazmat information:

A vessel entering a VTS area, such as a port or harbour, reports that it has dangerous or polluting goods on board. To check the information, the VTS searches SafeSeaNet for the latest notifications by the vessel identifier and retrieves up-to-date information on the dangerous or polluting goods carried on board.

Vessel posing a risk:

A vessel leaving a VTS area was involved in a collision. The VTS supervisor needs to send a warning that the vessel may pose a potential risk to other Member States along the route and to the destination port. This can be done using the SafeSeaNet Incident Report

[6] This is typically the situation when at a local level it is decided that a number of LCAs will not store any data themselves, but rather centralise this data storage at one place. This place is then in possession of relevant data, without actually producing any of this data.

Distribution function. The operator enters SafeSeaNet, completes the details in the "send information" menu and sends the information to the Member States concerned.

Case study 3: Maritime/Marine Rescue Coordination Centres (MRCC)

Number of persons on board for Search and Rescue (SAR) operation:
An emergency has been reported to an MRCC. The position and name of the affected vessel are known, but there is no data on the number of persons on board. This is crucial information for the SAR operation. The MRCC duty officer can search SafeSeaNet for the vessel's latest notifications. Information on the planned port call, or notification of hazardous or polluting goods, also has data on the number of persons on board.
Estimation of potential pollution:
An emergency has been reported at sea. A vessel has sunk and the SAR operation is still in progress. After dispatching teams to the scene, the evaluation team wants to know the risk of pollution. The MRCC duty officer can search SafeSeaNet for the vessel's latest notifications. Using the details in the Hazmat notification, the MRCC can properly assess the related risk.

Case study 4: Maritime Assistance Services (MAS)

Hazmat information and incident history:
There is a vessel adrift at sea due to engine failure. The weather has started to deteriorate and there is a danger that the vessel may run aground within 12 hours. The MAS officer needs to evaluate the situation using information on dangerous and polluting goods carried on board. He/she is aware that information on previous such incidents may also be of importance. The MAS officer enters SafeSeaNet, searches in the latest notifications by the vessel identifier and retrieves the latest information on dangerous or polluting goods as well as information on the latest incidents/accidents relating to the vessel.

Performance indicators and annual targets of the SSN service are set in Tabel 1 and 2.

Table 1 Average annual expenditures for maintenance and operation of the SSN in EUR

Financial and Human Resources	Input
Commitment appropriations	7,630,770
Paymant appropriations	7,802,660

Source: EMSA Work Programme 2014

Table 2 Key Performance Indicators of the SSN – Target 2014

<table>
<tr><td rowspan="4">SafeSeaNet system operational</td><td>availability of central SSN system</td><td>99 % per year</td></tr>
<tr><td>maximum continuous downtime of central SSN system</td><td>12</td></tr>
<tr><td>reports per year (AIS)</td><td>1800 million</td></tr>
<tr><td>notifications per year (Port +, Incident reports, MRS)</td><td>3.5 million</td></tr>
<tr><td>SafeSeaNet system reporting performance</td><td>Member States' requests to SSN delivered on time according to SSN</td><td>99 %</td></tr>
<tr><td>SafeSeaNet client satisfaction</td><td>number of requests for information to SSN</td><td>3.5 million</td></tr>
</table>

Source: EMSA Work Programme 2014

Activity based budgeting overview based on commitment appropriations for 2014 is presented in figures 5-7.

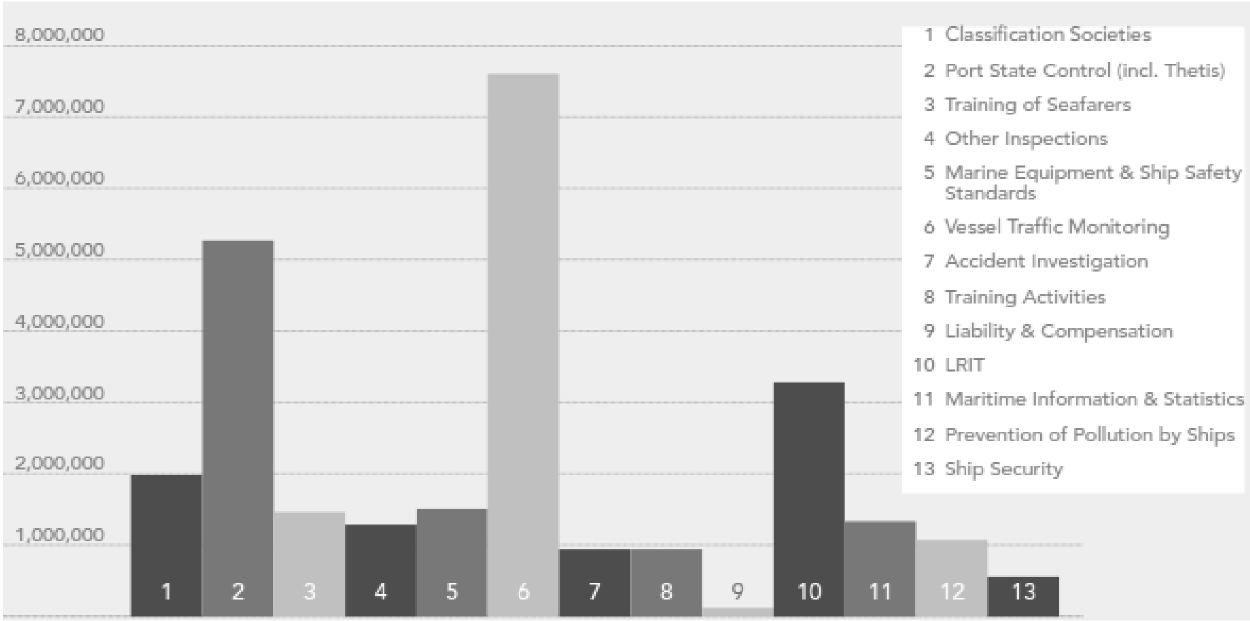

Figure 5 Operational Activities in the Field of Maritime Safety and Prevention of Pollution by Ships (Commitment appropriations 2014)
Source: EMSA Work Programme 2014

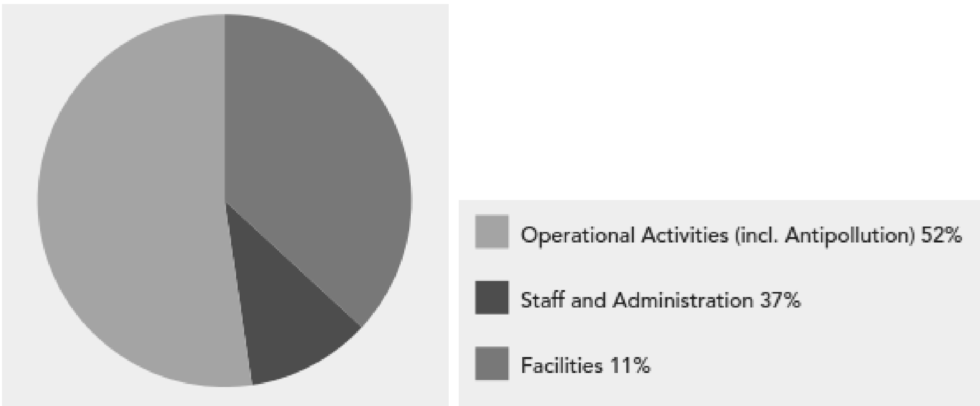

Figure 6 Budget 2014 – EUR 52.9 million
Source: EMSA Work Programme 2014

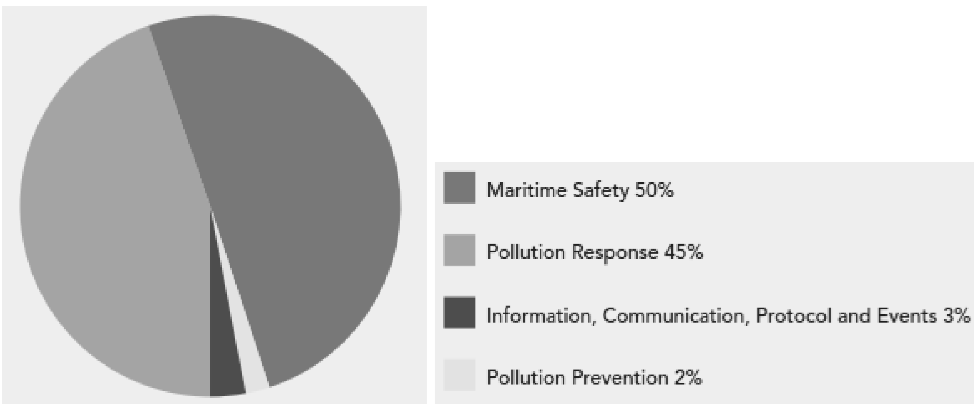

Figure 7 Use of resources by group of Activities
Source: EMSA Work Programme 2014

4. SSN IN CROATIA

On 1 July 2013 the Republic of Croatia became the 28th European Union member country, and further to this has to fully implement the provisions of the Directive 2002/59/EC as amended and Directive 2010/65/EU regarding reporting formalities for ships arriving in and departing from ports of the EU Member States, with an emphasis on electronic maritime information exchange.

The official procedure for electronic exchange of maritime information fot ships arriving in and departing from the Croatian ports has been normalized by the Ordinance on documents and data in maritime transport, their delivery, collection, exchange and conditions and method of issuing permission for communication with the shore.

The Republic of Croatia has developed and implemented the national SafeSeaNet system named Croatian Integrated Maritime Information System (CIMIS) which became operational on 1 July 2013 and as from that date every ship arriving in and departing from the Croatian ports is obliged to provide CIMIS with the required information, normally through authorized ship agent, by which her reporting formalities are considered to be fulfilled by local port authorities and Harbour Master's Offices. In order to facilitate delivery of information to CIMIS, relevant .xls tables have been structured.[7]

The Republic of Croatia endeavours to harmonise its legislation with that of the European Union. With regard to arrangements of maritime law we must point out that those have for the most part been adopted as an implementation of a series of international sources regulating such a transport activity characterised by a pronounced international element.

Acquis communautaire in the Republic of Croatia in the sector of maritime transport is covered by the provisions related to traffic safety, freedom of services and international relations. Major part of the activities is based on the acts of International Maritime Organisation (IMO), but legal sources influenced by the European Maritime Safety Agency (EMSA) are becoming all the more significant.

In the Republic of Croatia there is presently a significant disparity between the data contained in plans and other sources and the reality, while substantial imbalances in terms quality and quantity may be noted. The organisational structure itself is formally balanced at the highest level, but the plans have in principle not been updated from the date of their enactment. Furthermore, the funds that such plans count on as available are very often insufficient, inapplicable or use for other purposes, while the same is valid for human resource whose effectiveness often does not suffice. [8]

5. CONCLUSION

When the Erika incident occurred in 1999, exact information concerning her cargo was not known. With so many vessels loading and unloading in Europe's ports, information about cargo, ship safety records and port destinations is of vital interest for safety at sea, protection of the marine environment and for economic actors. Yet this information is dealt with by a myriad of actors at local and national level. Very often, exchanging information is difficult because such bodies as port authorities use different ways to collate, store and transfer data, and many have incompatible IT systems. Information is transmitted in different ways, often by fax, phone or email. That is why, since 2002, Member States and the European Commission have been working together to develop a solution to these information exchange problems and to implement EU Directive 2002/59/EC, which establishes a Community vessel traffic monitoring and information system (VTMIS). The result was a European network called SafeSeaNet, which is managed by EMSA, to harmonise the way in which maritime data is exchanged. SafeSeaNet links together a large number of maritime authorities across Europe. The information contained in the messages is gathered from a

[7] http://www.mppi.hr
[8] Luttenberger, A., Harmonizing the EU Standards Concerning Ship Waste Reception Facilities in the Republic of Croatia (March 25, 2013). Available at SSRN: http://ssrn.com/abstract=2239325

variety of local sources, known as local competent authorities (LCAs), such as coastal stations and port authorities. This information is provided in near real time to public authorities around Europe. The European Union has the best-covered coastline with AIS (Automatic Identification System) receiving stations, picking up signals at all times from ships passing by. The Agency cooperates with Member States to improve the receiving range of these stations, with a view to achieving complete coverage of the sea areas surrounding Europe. More accurate ship tracking will help prevent pollution incidents through early identification of vessels posing a risk. SafeSeaNet can provide reports on a vessel's behaviour (accident, pollution, infringement of navigation rules etc.) or details of hazardous materials being carried by a ship. Knowing where that ship is going and what it is carrying will improve emergency response times should the worst happen. SafeSeaNet also streamlines cargo and position reporting processes in ports and on board ships which will reduce workloads and costs. 2009 will see the start of inspection visits to all coastal Member States, including the national competent authority, commercial ports and coastal stations monitoring vessel traffic, with the aim of establishing the level of control of ships carrying dangerous or polluting goods in the seas around Europe.

SafeSeaNet is fully operational, covering the whole EU coastline and providing information as defined in Directive 2002/59/EC as amended. The information in the system covers four key areas: 1) ship position (e.g. AIS, LRIT, MRS); 2) ship pre-arrival, arrival and departure information (e.g. estimated time of arrival, actual time of arrival and departure, persons on board); 3) cargo (for vessel carrying dangerous or polluting goods); and 4) any accident or incident posing a potential hazard to shipping, threat to maritime safety, the safety of individuals or the environment.

This information system assists search and rescue bodies, pollution response centres and vessel traffic services in accessing information on the cargo (dangerous or polluting goods), and by providing information on the relevant incidents/accidents affecting ships navigating in EU waters. It facilitates port logistics and provides overall information on vessel traffic to public authorities, representing a fundamental tool to assist in vessel tracking, including information on possible incidents/accidents of ships as well as hazardous or polluting goods along the EU coastline.

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CONCESSIONS IN CROATIAN INLAND PORTS

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ABSTRACT:
At the end of 2012 Republic of Croatia had adjusted its regulations on concessions to the new frame of the EU. Concessions are now approved in accordance to the regulations of public procurement, but are also significantly linked to the model of public-private partnership. Introducing concession system into ports now became an obligation, due to which it was necessary to adjust the existing Navigation and Inland Ports Act from 2007. Due to important change of the concession paradigm itself, change of inland navigation regulations are wider than the replacement of up-to-date approvals of concessions. The changes include: planning of concessions, procedure of granting concessions, forms of concessions and investments within the model of public-private partnership. All of this will request appropriate scientific and expert's processing, in order to have the new model, at the moment unique in the EU, which would function lively.

KEYWORDS:
concessions, inland ports, regulations, procedure

KONCESIJE U HRVATSKIM LUKAMA UNUTARNJIH VODA

SAŽETAK:
Republika Hrvatska je krajem 2012. godine prilagodila svoje propise o koncesijama novom okviru Europske unije. Koncesije se sada daju sukladno pravilima o javnoj nabavi, a u velikoj mjeri su povezane i s modelom javno-privatnog partnerstva. Uvođenje koncesijskog sustava u lukama je postalo obveza, te je bilo potrebno bitno prilagoditi postojeći Zakon o plovidbi i lukama unutarnjih voda iz 2007. godine. Radi bitne promjene same paradigme koncesija, promjene propisa o unutarnjoj plovidbi su bitno šire od same zamjene dosadašnjih odobrenja koncesijama. Promjene uključuju: planiranje koncesija, postupak davanja koncesija, oblike koncesije i ulaganja u sklopu modela javno-privatnog partnerstva. Sve to, tražiti će odgovarajuću znanstvenu i stručnu obradu, kako bi novi model, za sada jedinstven u Europskoj uniji, kvalitetno zaživio.

KLJUČNE RIJEČI:
koncesije, luke unutarnjih voda, regulativa, postupak

1. RAZVOJ PRAVNOG OKVIRA LUKA UNUTARNJIH VODA U REPUBLICI HRVATSKOJ

U razdoblju od stjecanja svoje neovisnosti 8. listopada 1991. pa do danas Republika Hrvatska nekoliko puta je bitno mijenjala svoj pravni okvir kojim se uređuju luke unutarnjih voda i posebno pravna regulacija obavljanja različitih lučkih djelatnosti i pružanja lučkih usluga. Razlozi zašto se u manje od četvrt stoljeća pravni okvir u više navrata bitno mijenja, posljedica su niza pravnih i društvenih okolnosti – od promjene društvenog uređenja do ratne agresije na Republiku Hrvatsku, koja je bitno usporila razvoj unutarnje plovidbe, pa tako i luka unutarnje plovidbe.

Do 1998. godine za luke unutarnjih voda (koje su se u to doba nazivale općenito pristaništima) primjenjivao se *Zakon o pomorskom i vodnom dobru, lukama i pristaništima* [1]. Ovaj Zakon, donesen sedamdesetih godina prošlog stoljeća, nakon što je pravna regulacija luka i tadašnjih pristaništa unutarnje plovidbe došla u republičku nadležnost, poslije 1990. godine nije odgovarao novom političkom i društvenom okruženju. Međutim, kako su agresija na Republiku Hrvatsku, a poslije i rat u Bosni i Hercegovini praktično onemogućili unutarnju plovidbu, ti nedostaci se nisu ni zamjećivali. Tek je reintegracija Hrvatskog podunavlja 1997. godine omogućila razvoj ove prometne grane na hrvatskom dijelu Dunava, a smirivanje stanja u BIH i plovidbu na Savi.

Godine 1998. donesen je *Zakon o lukama unutarnjih voda* [2] koji na nov i suvremen način regulira upravljanje našim riječnim lukama (od tog Zakona imamo i podjelu na luke i pristaništa unutarnjih voda). Prema izričitoj odredbi čl. 17. navedenog Zakona, pravo obavljanja lučke djelatnosti stječe se temeljem koncesije. Zakon predviđa i postupak davanja koncesije, s time da se osobama koje obavljaju lučke djelatnosti u postojećim lukama, a ispunjavaju propisane uvjete, dala koncesija bez provođenja natječaja.

Zakon u lukama unutarnjih voda iz 1998. kao i drugi posebni (danas se sve više koristi izraz „sektorski") zakoni iz tog doba propisuje i način davanja koncesije. Naime, opći propis o koncesijama, *Zakon o koncesijama* iz 1992. godine [3] imao je svega 10-tak članaka i davao je tek osnove koncesijskih režima, pa su se postupci davanja koncesija morali razrađivati posebnim propisima. Tako primjerice Borković za Zakon o koncesijama iz 1992. navodi kako je taj Zakon "kratak, nedorečen u složenoj materiji koncesije i uvjetan" [4], a Žuvela: "Zakon o koncesijama ima 10 članaka i nedostatan je okvir za realizaciju ustavnih postulata o nepovredivosti i jamčenju prava vlasništva i prava nasljeđivanja, o poduzetničkim i tržišnim slobodama kao temelju gospodarskog ustroja Republike." [5] Ovakva praksa svakako nije bila dobra – svaki od dvadesetak sektorskih propisa razvijao je svoj koncesijski model, pa nije moglo doći ni do ujednačenja upravne prakse, važne za sigurnost razvoja i ulaganja.

Ono što je za svrhu ovog rada važno zamijetiti da su tada dane brojne dugoročne koncesije u lukama unutarnjih voda, a koje su još uvijek na snazi.

Godine 2007. stupa na snagu *Zakon o plovidbi i lukama unutarnjih voda* [6] (dalje: ZPLUV) koji uvodi novi institut – odobrenja za obavljanje lučke djelatnosti. Tim institutom željelo se dijelom liberalizirati vrlo strogi sustav koncesija, a i izbjeći probleme koje je donosio vrlo nesustavno izgrađen model koncesija. Ovaj Zakon je lučke djelatnosti definirao bitno šire, uključivši u njih i određene industrijske djelatnosti vezane uz lučke kapacitete. Prema čl. 143. ZPLUV-a, na lučkom području lučki korisnici smiju obavljati lučke djelatnosti na temelju odobrenja. Navedeno odobrenje je upravni akt koji donosi lučka uprava, uz prethodnu suglasnost nadležnog ministarstva. Protiv tog akta žalba nije dopuštena, ali se može pokrenuti upravni spor. Novo pravno rješenje se uvelo je i izravnu korelaciju između duljine trajanja odobrenja i investicija u luku: što veća ulaganja, to je bilo moguće dulje trajanje koncesije. [7] Nedugo nakon donošenja ovog Zakona, počela je globalna ekonomska kriza koja se u Hrvatskoj pretvorila u dugogodišnju recesiju, što je uvelike imalo posljedice i na unutarnju plovidbu, koja na Dunavu ima značajan pad prometa, što se odražava i na naše luke. Tako je Luka Vukovar d.o.o., naš najznačajniji koncesionar na unutarnjim vodama imala 2006. rekordni prekrcaj od 915.758 tona, koji je 2010. pao na samo 193.482 tona, nakon toga se kreće između 300.000 i 400.000 tona. [8]

ZPLUV iz 2007., s izmjenama i dopunama je još uvijek na snazi. Međutim, u zakonodavnom postupku su vrlo opsežne *Izmjene i dopune Zakona o plovidbi i lukama unutarnjih voda* [9], koje napuštaju sustav odobrenja i vraćaju, ali na sasvim novi i bitno drugačije razrađen način sustav koncesija. Prihvaćanje novog zakonskog rješenja, a koje je sukladno novom europskom modelu ugovora o koncesiji, očekuje se u jesen 2014. godine.[1]

2. PRIMJENA EUROPSKOG MODELA KONCESIJA NA HRVATSKE LUKE UNUTARNJIH VODA

Republika Hrvatska je reformu svog koncesijskog modela započela 2008. godine, donošenjem novog *Zakona o koncesijama* [10], a koji je bio usklađen s tadašnjim pravnim okvirom Europske unije i koji je uostalom i donesen tijekom postupka pregovora o pristupanju Republike Hrvatske Europskoj uniji. No, kako smo prethodno rekli, nešto prije donošenja navedenog Zakona, koncesijski model je napušten u unutarnjoj plovidbi.

Bitne promjene su nastale krajem 2012. godine, donošenjem ponovno novog *Zakona o koncesijama* [11] (dalje: ZOK). ZOK je u odnosu na dotadašnju regulativu toliko drugačiji da se može govoriti o novoj paradigmi koncesija u Republici Hrvatskoj [12]. Posebno je zanimljivo kako je ZOK donesen usklađivanjem s aktima Europske unije koji još nisu bili na snazi, konkretno s *Prijedlogom direktive Europskog parlamenta i Vijeća o dodjeli ugovora o koncesijama* [13]. Prilagodba zakonskog akta prijedlogu direktive zasigurno je zanimljiva sa stanovišta proučavanja europskog prava, pri čemu treba napomenuti da je Prijedlog direktive donesen temeljem vrlo detaljne analize [14], no za potrebe ovog rada ograničiti ćemo se na najvažnije. Koncesija se jednostavno definira kao „pravo koje se stječe ugovorom" (čl. 1. st. 2. ZOK-a), a propisi o koncesijama sada čine funkcionalnu i zaokruženu cjelinu s propisima o javnoj nabavi i javno-privatnom partnerstvu, čime smo dobili složen, no ipak jasan i transparentan novi sustav koncesioniranja.

Zanimljivo je primijetiti kako se definicija koncesije iz ZOK-a veže uz ugovorni odnos, a ne za javnopravni segment koncesije (zakoni iz 1992. i 2008. nisu sadržavali opću definiciju koncesije). Naime, doktrina je do sada koncesije uvelike vezivala uz njihov javnopravni značaj, a nije se posebno naglašavao ugovorni odnos koji koncesija stvara. Primjerice, Gorenc je pisao: „Koncesija predstavlja akt, (grant, odobrenje, dozvola, razrješenje Erlaubnis) vlasti jedne države kojom se građanima te države, drugoj državi ili stranim državljanima dopušta na njenom području obavljanje određenih djelatnosti za koje si inače pridržava pravo pojedinačne dodjele dozvola." [15]

ZOK detaljno regulira i odnos koncesije i javno-privatnog partnerstva, opet na temelju Prijedloga direktive i njenih pratećih dokumenata. Tako se u navedenim pratećim dokumentima navodi i slijedeće: „Koncesije su partnerstva između javnog sektora i većinski privatnih kompanija, gdje isključivo ovi drugi rade, održavaju i nose teret razvitka infrastrukture (luke, vodovodne mreže, parkirne garaže, naplatne kućice) ili pružaju usluge od općeg gospodarskog interesa (struja, voda i odvoz smeća, na primjer)." [16] Naglasak na primjeni modela javno-privatnog partnerstva je razumljiv – nakon globalne ekonomske krize koja se pojavila i u državama Europske unije 2008.-2009. jače se uvode modeli temeljem kojih će se infrastruktura razvijati i uključivanjem privatnog kapitala, a ne samo financiranjem od strane države.

Prema ZOK-u, sukladno Prijedlogu direktive o koncesijama[2], poznajemo tri vrste koncesija (čl. 1., st. 3. ZOK), a to su:

- koncesija za gospodarsko korištenje općeg ili drugog dobra,
- koncesija za javne radove,

[1] Prijedlog Zakona o izmjenama o dopunama Zakona o plovidbi i lukama unutarnjih voda prošao je prvo saborsko čitanje. Na stranicama Hrvatskoga sabora je objavljeno: „Rasprava je zaključena 15. svibnja 2014. Na 13. sjednici 30. svibnja 2014. donesen je zaključak da se prihvaća Prijedlog zakona. Sve primjedbe, prijedlozi i mišljenja uputit će se predlagatelju radi pripreme Konačnog prijedloga zakona (87 glasova "za", 28 "suzdržanih")." http://www.sabor.hr/sjednica (9. srpnja 2014.)

[2] U Prijedlogu direktive o koncesijama navodi se: „'concessions' means public works concessions, works concessions or services concessions" (Article 2.)

- koncesija za javne usluge.

Iznimnu važnost za razvoj modela upravljanja lukama unutarnjih voda imao je čl. 5. st. 2. ZOK-a, koji propisuje da ukoliko tijela, odnosno pravne osobe koje mogu biti davatelji koncesije sklope pravni posao s gospodarskim subjektom, u područjima i za djelatnosti navedene u popisu iz st. 1. istog članka, a koji ima bitne sastojke ugovora o koncesiji, smatrat će se da je sklopljen ugovor o koncesiji. U popisu iz čl. 5. st. 1. izričito su navedene i luke.

Time je propisana obveza uključivanja u koncesijskih sustav svih pravnih odnosa gdje se koncesije izričito ne spominju, a imaju bitne sastojke ugovora o koncesiji. Time su nesporno obuhvaćena i odobrenja propisana ZPLUV-om, jer imaju veliku sličnost s koncesijama; odobrenje je upravni akt koji donosi lučka uprava uz prethodnu suglasnost ministarstva nadležnog za unutarnju plovidbu. Odobrenjem se određuju zahtjevi u pogledu obveze obavljanja lučke djelatnosti, zahtjevi u pogledu sigurnosti, redovitosti, kontinuiteta i kvalitete usluge, obveza poštivanja lučkih tarifa, obveza plaćanja lučke pristojbe, rok na koji se daje odobrenje te drugi uvjeti pod kojima se obavlja lučka djelatnost. Na temelju odobrenja lučka uprava potpisuje ugovor s lučkim korisnikom. Jasno je – ove odredbe su se morale uskladiti sa ZOK-im i ZPLUV je morao vratiti koncesijski model za obavljanje lučkih djelatnosti.[3]

Tako je sredinom 2013. godine krenula prilagodba ZPLUV-a novom koncesijskom modelu. Izrađen je opsežan nacrt, obavljena je javne rasprava i nacrt je upućen u saborsku proceduru. Prvo čitanje prijedloga Zakona je prošlo bez značajnijih stručnih ili političkih primjedbi,[4] te se prihvaćanje ovih opsežnih izmjena i dopuna očekuje u jesen 2014. godine.

3. NOVE ODREDBE O KONCESIJAMA ZAKONA O PLOVIDBI I LUKAMA UNUTARNJIH VODA

Kako je do sada ZPLUV imao institut odobrenja za obavljanje lučkih djelatnosti nužno je bilo prilagoditi ga odredbama ZOK-a koji je nedvosmisleno definirao u čl. 5. st. 2. da ako tijela ovlaštena za davanje koncesija sklope pravni posao s gospodarskim subjektom u područjima i za djelatnosti iz čl. 5. st. 1. ZOK-a, gdje se u t. 8. navode i luke, a koji ugovor ima bitne sastojke ugovora o koncesiji, smatrat će se da je sklopljen ugovor o koncesiji. Isti članak ZOK-a u st. 4. određuje kako će se posebna pitanja vezana za davanje koncesija za pojedina područja odnosno djelatnosti urediti posebnim zakonom.

Odredbe ZOK-a znače niz izmjena ZPLUV-a ne samo s obzirom na naziv instituta kojim se dodjeljuje pravo obavljanja djelatnosti u lukama unutarnjih voda iz „odobrenje" u „koncesija" već s obzirom na vrste koncesija koje se definiraju, regulaciju imovinsko-pravnih odnosa i ostalih preduvjeta za dodjelu koncesija koje je propisao ZOK kao što je uvažavanje sinergije ZOK-a sa *Zakonom o javno-privatnom partnerstvu* [17] i *Zakonom o javnoj nabavi* [18]. Istovremeno, dodjelu koncesija je, kao i ostale oblike poslovanja, nužno sada promatrati u svjetlu načela slobode kretanja robe, načela slobode poslovnog nastana, načela slobode pružanja usluga, načela učinkovitosti, kao i ostalih temeljnih načela iz *Ustava Republike Hrvatske* [19] te *Ugovora o funkcioniranju Europske unije* [20], kao i načela navedenih u općem propisu o koncesijama i javnoj nabavi. Ovakva odredba je dio Zakona o izmjenama i dopunama ZPLUV-a, čl. 70. st. 5. kojim se mijenja dosadašnji čl. 146. Strogo je propisan postupak dodjele koncesija koji je u pravilu javni natječaj te samo u iznimnim situacijama postoji mogućnost dodjele koncesije na zahtjev.

U cilju usklađivanja odredbi ZPLUV-a sa odredbama ZOK-a izrađene su Izmjene i dopune ZPLUV-a. Budući da ZOK sadrži niz procesno-pravnih odredbi, koje ujedno predstavljaju *ius strictum*, ZPLUV-om su se samo regulirala materijalno-pravna pitanja specifična za koncesije u lukama unutarnjih voda.

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[3] Spomenimo i kako je ministarstvo financija pismenom od 24. travnja 2013. Klasa: 011-01/13-01/65, Ur.broj: 513-06-02-13-27 izričito zatražilo od Ministarstva pomorstva, prometa i infrastrukture usklađenje Zakona o plovidbi i lukama unutarnjih voda sa Zakonom o koncesijama.

[4] Videosnimka rasprave dostupna je na stranicama Hrvatskoga sabora: http://www.sabor.hr/prijedlog-zakona-o-izmjenama-i-dopunama-zakona0009 (12.7.2014.)

U čl. 56. ZOK je propisao obvezu za davatelje koncesija da izrade srednjoročni (trogodišnji) plan davanja koncesija. S tim u skladu je i odredba čl. 36. Zakona o izmjenama i dopunama ZPLUV-a kojom se mijenja dosadašnji čl. 103. ZPLUV-a i određuje da Srednjoročni plan razvitka vodnih putova i luka unutarnjih voda mora sadržavati elemente potrebne za izradu srednjoročnog (trogodišnjeg) plana davanja koncesija. Prijedlog Srednjoročnog plana, kako stoji u čl. 52. Izmjena i dopuna gdje se u čl. 127. ZPLUV-a dodaje st. 2, mora obuhvatiti dijelove lučkih područja, lučke djelatnosti i lučke građevine za koje se planira dati koncesija, planirane prihode od koncesija i rashode za koncesije, ocjenu očekivane gospodarske koristi od planiranih koncesija, te druge elemente prema propisu koji uređuje koncesije. Lučka uprava pokreće postupak davanja koncesije za lučke djelatnosti sukladno srednjoročnom (trogodišnjem) planu davanja koncesija i drugim planskim dokumentima (čl. 71. Izmjena i dopuna ZPLUV-a). Ovakvi strateški planovi predstavljaju definiranje vođenja lučke politike u razdoblju za koje se donose. U tom smislu je i odredba čl. 71. st. 2. Izmjena i dopuna ZPLUV-a u kojoj se kaže kako nadležno ministarstvo može na temelju Strategije razvitka riječnog prometa Republike Hrvatske i Srednjoročnog plana razvitka vodnih putova i luka unutarnjih voda ograničiti broj koncesija koje se izdaju za privatne luke i pristaništa u slučaju da te koncesije mogu bitno narušiti poslovanje koncesionara u javnim lukama. Ova odredba je logična s obzirom na osnovnu zadaću ZPLUV-a koja je zaštita javnog interesa u javnim lukama te je stoga i razumljivo da će si javna tijela zadržati pravo da procjene u kojoj mjeri će razvijati privatne luke odnosno da će imati na umu i interes koncesionara u javnim lukama.

Izvršene su izmjene odredbi kojima se regulira razvrstaj luka unutarnjih voda gdje se luke prema namjeni dijele na javne i privatne (čl. 72. Izmjena i dopuna ZPLUV-a). Javne luke su definirane kao luke unutarnjih voda koje pružaju javne usluge te u koje može uploviti plovilo u domaćem ili međunarodnom prometu dok privatne luke ne obavljaju javne usluge, već služe lučkom korisniku za obavljanje njegove osnovne gospodarske aktivnosti. Svrha ovih odredbi je zaštita javnog interesa u javnim lukama odnosno jasno razgraničenje od privatnih luka s čim je u konačnici i dodjela koncesija u izravnoj vezi. Spomenimo i kako se dalje u čl. 44. Izmjena i dopuna ZPLUV-a javne luke dijele u luke od državnog značaja i luke od županijskog značaja.

Važne su i izmjene ZPLUV-a koje se odnose na imovinsko-pravne odnose u lukama od državnog značaja. Tako se čl. 48. Izmjena i dopuna ZPLUV-a u dosadašnji čl. 123. dodaju novi stavci 5. i 6. kojima se propisuje kako u javnim lukama nekretninama u vlasništvu Republike Hrvatske upravljaju lučke uprave dok će se za sve nekretnine u sastavu lučkog područja javne luke od državnog interesa a koje nisu u vlasništvu Republike Hrvatske uknjižiti pravo prvokupa u korist Republike Hrvatske. Cilj je ovih odredbi pojednostaviti postupak dodjele koncesija, odnosno što više nekretnina staviti u nadležnost Republike Hrvatske odnosno pod upravljanje lučkim upravama kao davateljima koncesija. Važna izmjena odnosi se na upravljanje javnim vodnim dobrom koje je do sada bilo pod upravljanjem Hrvatskih voda no *Zakonom o vodama* [21], čl. 15a. propisano je kako se upravljanje i korištenje javnog vodnog dobra u lučkom području uređuje propisima o plovidbi i lukama na unutarnjim vodama. S tim u skladu, čl. 54. Izmjena i dopuna ZPLUV-a propisano je kako lučke uprave upravljaju javnim vodnim dobrom na lučkom području.

Izmjene i dopune ZPLUV-a poznaju tri vrste koncesija koje se mogu obavljati u javnim lukama i pristaništima a što je izričito propisano u čl. 66. st. 1. Izmjena i dopuna ZPLUV-a kojim se mijenja čl. 143:

- koncesije za javne usluge, za obavljanje lučkih usluga,
- koncesije za gospodarsko korištenje općeg ili drugog dobra na lučkom području,
- koncesije za javne radove, za građenje lučkih građevina, prema propisima o javno-privatnom partnerstvu.

U privatnim lukama i pristaništima, prema st. 2. istog čl. lučke usluge se obavljaju temeljem koncesije za gospodarsko korištenje općeg ili drugog dobra.

Člankom 55. Izmjena i dopuna ZPLUV-a, kojim se mijenja dosadašnji čl. 131. ZPLUV-a, propisuju se javne ovlasti[5] lučkih uprava. Između ostalog, u javne ovlasti se ubraja i upravljanje nekretninama u vlasništvu Republike Hrvatske koje se nalaze u sastavu lučkih područja javnih luka, davanje prava najma, zakupa, osnivanja prava služnosti ili prava građenja na javnom vodnom dobru u lučkom području, davanje koncesija za javne usluge, za obavljanje lučkih usluga, davanje koncesije za gospodarsko korištenje općeg ili drugog dobra na lučkom području, davanje koncesije za javne radove, za građenje lučkih građevina, prema propisima o javno-privatnom partnerstvu, sklapanje ugovora o koncesiji, ubiranje naknade za koncesiju, potvrđivanje i objava lučkih tarifa, uvid u poslovnu i financijsku dokumentaciju lučkih korisnika.

Vrste koncesijskih naknada propisane su u čl. 61. Izmjena i dopuna ZPLUV-a kojim se dodaju novi članci 136a. i 136b. Naknade za koncesiju nešto se razlikuju u javnim i privatnim lukama. U javnim lukama postoje stalni i varijabilni oblik naknade kao što je postojao dok je na snazi bio koncesijski sustav prema Zakonu o lukama unutarnjih voda iz 1998. no isti je oblik naknada postojao prema ZPLUV-u iz 2007. koji se odnosio na odobrenja i spadao je u vrstu lučkih naknada – naknada za korištenje luke. Čl. 136a. navodi u st. 3. kako se stalni dio naknade za koncesiju za obavljanje lučkih usluga plaća s naslova korištenja lučkog područja i to u jednokratnom godišnjem iznosu. Promjenjivi dio koncesijske naknade plaća se u ovisnosti o ostvarenoj poslovnoj aktivnosti koncesionara u postotku od ostvarenog prihoda. Pravilnik kojim se određuju kriteriji za naknade za koncesiju donijeti će ministar nadležnog ministarstva u roku od šest mjeseci od stupanja Izmjena i dopuna ZPLUV-a na snagu sukladno čl. 117. U Čl. 136b. kaže se kako se naknada za koncesiju za gospodarsko korištenje općeg ili drugog dobra na lučkom području privatnim lukama i privatnim pristaništima plaća kao stalan dio jednak osnovici za obračun naknade za koncesiju čiju visinu propisuje ministar. Temeljni kriterij za određivanje osnovice za obračun naknade za koncesiju su troškovi upravljanja lukom ili pristaništem koje u okviru svojih nadležnosti ima lučka uprava.

Člankom 62. kojim se mijenja dosadašnji čl. 138. ZPLUV-a izmijenjen je opis djelatnosti lučkih uprava gdje se u st. 1. t. 7. i 8. navode obavljanje stručnih poslova u vezi s davanjem koncesija te nadzor nad radom koncesionara i izvršavanjem obveza iz ugovora o koncesiji.

4. POSTUPAK DODJELE KONCESIJA U LUKAMA UNUTARNJIH VODA

Budući da je ZOK dao niz postupovnih odredbi za dodjelu koncesija Izmjenama i dopunama ZPLUV-a propisane su samo minimalne specifičnosti ovog sektorskog zakona. U tom smislu se u čl. 66. st. 3. navodi da se koncesije u javnim i privatnim lukama daju temeljem propisa o koncesijama i propisa o javnoj nabavi, osim ako je ZPLUV-om izričito drugačije određeno. Koncesije daje lučka uprava, uz suglasnost Ministarstva.

Za obavljanje špediterske usluge i lučke agenture nije potrebna koncesija budući da su to djelatnosti kojima se ne stječe veliki prihod i nisu vezane za prostor u luci te se smatra kako iste donose posao lukama te ih je u tom smislu potrebno poticati.[6] Za obavljanje navedenih usluga na lučkom području potrebno je upisati se u popis pružatelja navedenih usluga kojeg vodi i javno objavljuje lučka uprava sukladno čl. 68. Izmjena i dopuna ZPLUV-a uz predočenje dokaza koji su: registracija za obavljanje navedenih djelatnosti, odgovarajuća ovlaštenja po posebnim propisima, nepostojanje poreznog duga i da nije u postupku stečaja ili likvidacije, izjava kako će obavljati djelatnost sukladno pozitivnim zakonskim propisima, uzancama, običajima i pravilima struke. Lučka uprava može naložiti brisanje gospodarskog subjekta ukoliko kasni s plaćanjem obveza lučkoj upravi dulje od 30 dana, ne obavlja djelatnost iz popisa pružatelja navedenih usluga dulje od dvije godine. Na ovaj način

[5] Sukladno Zakonu o sustavu državne uprave, „Narodne novine“ broj: 150/11 i 12/13 čl. 2. st. 2. posebnim zakonom određeni poslovi državne uprave mogu se povjeriti tijelima jedinice lokalne i područne (regionalne) samouprave ili drugim pravnim osobama koje na temelju zakona imaju javne ovlasti.

[6] Još je davno Borčić pisao za morske luke, a u potpunosti se može primijeniti i na luke unutarnjih voda: “Neprihvatljivo je da trgovačka društva koja obavljaju pomorsko-agencijske ili otpremničke djelatnosti i koja mogu bitno utjecati na promet brodova i tereta u luci plaćaju naknadu za obavljanje poslova.” [22]

pojednostavljena je procedura za stjecanje prava na obavljanje djelatnosti u luci, no ipak su uvedeni nekakvi instrumenti kontrole rada društava koja obavljaju ove djelatnosti.

S obzirom na vrste koncesija u lukama unutarnjih voda propisani su i maksimalni rokovi na koje se iste mogu dodijeliti. Tako se za javne usluge, za obavljanje lučkih usluga koncesija može dati za nautičke usluge na rok do 5 godina a za transportne usluge na rok do 15 godina. Koncesije za gospodarsko korištenje općeg ili drugog dobra, za ostale gospodarske djelatnosti koje se obavljaju na lučkom području mogu se dati na rok do 25 godina. Koncesije za javne radove, kada se koncesija daje za građenje lučkih građevina, prema modelu javno-privatnog partnerstva mogu se dati na rok do 30 godina, a uz suglasnost Vlade Republike Hrvatske do 50 godina. Rok za davanje koncesije za lučke usluge u privatnim lukama i privatnim pristaništima određuje se prema trajanju gospodarske aktivnosti koja je osnova za davanje koncesije, a najduže do 50 godina.

Sukladno čl. 70. st.1. Zakona o izmjenama i dopunama ZPLUV-a koncesija se daje temeljem javnog nadmetanja. Iznimno od ove odredbe koncesija za privatnu luku i privatno pristanište daje se neposredno na zahtjev gospodarskog subjekta, ako postojeća i/ili planirana gospodarska aktivnost gospodarskog subjekta na određenoj lokaciji čini s predmetom koncesije za koju se zahtjev podnosi, neodvojivu tehnološku ili funkcionalnu cjelinu, te koncesija služi isključivo za obavljanje te gospodarske aktivnosti (čl. 70. st. 2. Izmjena i dopuna ZPLUV-a). U tom slučaju rješavanje imovinskopravnih odnosa u privatnoj luci prepušteno je podnositelju zahtjeva koji mora dostaviti dokaze da ima riješene imovinskopravne odnose na području za koje traži koncesiju (čl. 70. st. 3.). Radi provedbe ugovora o koncesiji za obavljanje lučkih usluga, može se neposredno na zahtjev koncesionara dodijeliti koncesija za gospodarsko korištenje općeg ili drugog dobra (čl. 70. st. 4.). U slučaju podnošenja zahtjeva za gospodarsko korištenje općeg ili drugog dobra u privatnim lukama i privatnim pristaništima radi obavljanja lučkih usluga, osim uvjeta sukladno općem propisu o koncesijama i javnoj nabavi podnositelj zahtjeva mora dostaviti i slijedeću dokumentaciju: dokaze da je registriran za obavljanje lučkih usluga, dokaze da posjeduje odgovarajuće kadrove i financijsku sposobnost, sukladno obujmu i vrsti usluge za koje traži koncesiju, rok na koji traži koncesiju sukladno rokovima iz članka 144. ovog Zakona, plan i program rada za razdoblje za koje se daje koncesija, analizu gospodarske opravdanosti, studiju ispunjavanja tehnoloških i sigurnosnih uvjeta za luku, analizu utjecaja na okoliš, predloženu naknadu za koncesiju čija visina ne smije biti manja od osnovice za obračun naknade za koncesiju kako stoji u čl. 74. Zakona o izmjenama i dopunama ZPLUV-a.

Za obavljanje lučkih djelatnosti u pristaništima potrebno je ishoditi koncesiju (čl. 83. kojim se dodaje novi čl. 159 b). Iznimka od obveze ishođenja koncesije je obavljanje privremenih prekrcajnih operacija za vlastite potrebe izvan lučkog područja na rok do godinu dana (npr. ukrcaj/iskrcaj pijeska, šljunka, građevnog materijala, drvne građe) a koje mogu uključivati i privremeno odlaganje materijala. U tom će slučaju pravna osoba ili fizička osoba – obrtnik zahtjevom upućenom nadležnoj lučkoj upravi zatražiti otvaranje tovarišta[7] uz predočenje odgovarajućeg prethodno dobivenog odobrenja sukladno propisima o vodama.

5. ODREDBE KOJE SE ODNOSE NA RANIJE SKLOPLJENE UGOVORE O KONCESIJAMA I ODOBRENJA

S obzirom da su pojedini ugovori o koncesiji odnosno ugovori o dodjeli odobrenja i dalje ostali na snazi do roka na koji su sklopljeni, bez obzira na izmjene propisa, bilo je potrebno regulirati kada se odluke o dodjeli[8] takvih koncesija odnosno odobrenja mogu odnosno moraju ukinuti. Tako u čl. 111. Izmjena i dopuna ZPLUV-a stoji kako se odobrenja mogu ukinuti u slijedećim slučajevima: lučki operater ne pridržava se tarifa, lučki korisnik ne pridržava se odredbi o redu u luci, lučki korisnik ne provodi plan i program rada, lučki korisnik

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[7] Tovarišta su po Prijedlogu zakona definirana kao dio vodnog puta i s njim neposredno povezani kopneni prostor izvan područja luke ili pristaništa koji je namijenjen privremenom obavljanju prekrcajnih operacija za vlastite potrebe.

[8] Budući da se koncesije i odobrenja dodjeljuju u upravnom postupku odluka o dodjeli odobrenja predstavlja konstitutivan upravni akt.

obavlja lučku djelatnost za koju nije dobio odobrenje, lučki korisnik nije započeo s obavljanjem lučke djelatnosti u roku određenom odobrenjem. Odobrenja se moraju (dakle obvezno!) ukinuti ako:

- lučki operater primjenjuje diskriminacijske mjere prema korisnicima,
- lučki korisnik je prestao obavljati djelatnost za koju je dobio odobrenje,
- lučki korisnik ne plaća ili neuredno plaća lučku pristojbu.

ZOK je čl. 39. st. 2. al. 3. dao mogućnost da se posebnim propisom propišu mogućnosti za izmjene postojećih ugovora o koncesiji. Tako je u čl. 111. st. 10. propisano da se koncesije i odobrenja mogu izmijeniti u slijedećim slučajevima: ukoliko su nastupili poremećaji na tržištu koje korisnik koncesije u trenutku sklapanja ugovora nije mogao predvidjeti; ukoliko se u razdoblju od najmanje godinu dana promjene uvjeti plovnosti; ukoliko se zbog sigurnosnih, ili razloga zaštite okoliša pojavi potreba za dodatnim ulaganjima od strane koncesionara.

Na postojeće ugovore odnosi se i odredba čl. 62. st. 3. ZOK-a kojom se obvezuje davatelj koncesija koji je sklopio ugovor o koncesiji prije stupanja na snagu Zakona o koncesijama iz 2008., a koji ne sadrži odgovarajuće instrumente osiguranja, zatražiti od koncesionara dostavu odgovarajućeg instrumenta osiguranja provedbe ugovora o koncesiji u preostalom razdoblju trajanja koncesije. Ova obveza trebala se izvršiti u roku od 60 dana od stupanja na snagu ZOK-a, dakle do kraja veljače 2013. godine. Ovlaštenici koncesije trebali su dostaviti navedeni instrument osiguranja u roku od 60 dana od dana primitka zahtjeva davatelja koncesije (čl. 62. st. 4. ZOK-a). Ukoliko to ne učine u navedenom roku ugovor o koncesiji se raskida (čl. 62. st. 5. ZOK-a).

6. ZAKLJUČNO

Prilagodba ZPLUV-a novom pravnom okviru koncesija predstavlja na neki način pionirski postupak – hrvatski ZOK donesen je temeljem Prijedloga direktive Europskog parlamenta i Vijeća o dodjeli ugovora o koncesijama [13], dakle još ne postoji europska pravna praksa na koju se Republika Hrvatska može ugledati.

Sama *Direktiva 2014/23/EU Europskog Parlamenta i Vijeća o dodjeli ugovorâ o koncesiji* [23] donijeta je 26. veljače 2014., a rok njene implementacije u nacionalna zakonodavstva nešto preko dvije godine.[9] Obzirom da Direktiva ima određene dopune u odnosu na Prijedlog direktive, to naravno može značiti i daljnje prilagodbe ZOK-a, međutim kako je sada postupovni propis (ZOK) odvojen od materijalnog, sektorsko propisa (ZPLUV), manje promjene u regulaciji koncesija ne moraju više značiti potrebu za promjenama sektorskog propisa. To je, uz ujednačavanje upravne i sudske prakse, velika prednost nove pravne regulacije.

Do poteškoća u praksi može dovesti činjenica da će u Republici Hrvatskoj, prihvaćanjem navedenih opsežnih izmjena i dopuna ZPLUV-a na snazi biti tri modela obavljanja lučkih i drugih djelatnosti u lukama unutarnjih voda: model koncesija sukladan Zakonu o lukama unutarnjih voda iz 1998., model odobrenja sukladno ZPLUV-u, te novi koncesijski model. To od predlagatelja traži precizno definiranje prijelaznih i završnih odredbi Izmjena i dopuna ZPLUV-a, ali i daljnje praćenje stanja te koordinaciju između lučkih uprava i nadležnog ministarstva, te drugih nadležnih tijela državne vlasti, posebno ministarstva nadležnog za područje koncesija.

Novi model, koji se uvodi izmjenama i dopunama ZPLUV-a, osim prilagodbe ZOK-u, snažno otvara i mogućnosti javno-privatnog partnerstva u razvoju luka unutarnjih voda. Razvoj javno-privatnog partnerstva zasigurno je važan odmak od dosadašnje paradigme primarno državnog ulaganja u razvoj luka. Nakon višegodišnje recesije, i naraslog državnog duga, u Republici Hrvatskoj nije realno očekivati nastavak dosadašnjeg razvojnog modela, stoga je sustav javno-privatnog partnerstva dobrodošao.

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[9] Prema čl. 51. st. 1. Direktive o ugovorima o koncesiji, države članice donose zakone, propise i upravne odredbe potrebne za usklađivanje s ovom Direktivom najkasnije do 18. travnja 2016.

Novi zakonski okvir, kada bude zaokružen (što uključuje ne samo Izmjene i dopune ZPLUV-a nego i podzakonske propise) svakako će zahtijevati detaljno znanstveno i stručno praćenje, kako bi uspješno zaživio u praksi i ispunio svoje razvojne potencijale.

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TONNAGE QUALITY AS A CRITERION FOR CHOOSING THE CARRYING CAPACITY OF BARGE CONVOY

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ABSTRACT
The tonnage quality – k_T is very important parameter for determining transport efficiency which is used to determine the degree of use of all types of transport vessels including pushboats as well. The complexity of this parameter can be observed in the fact that it expresses the amount of transported cargo in relation to the speed of transport and, during it, resistance of the water that is created.
The most reliable way to determine the tonnage quality parameter is to conduct measurements in real navigating conditions, which is done in order to determine exact (real) technical characteristics of propelling devices installed on push boats, to reveal flaws in their work and to increase pushingand speed characteristics. This paper will present how to choose optimal speed of navigation and optimal carrying capacity of barge convoy based on experiments which have been done on a push boat with the total power of propelling engines 3×809,6 *kW* (3×1100 *HP*).

KEYWORDS
tonnage quality parameter, push boat, convoy, pushed convoy, pushing (propulsion) force, resistance during navigation of pushed convoy

KVALITET TONAŽE KAO KRITERIJUM PRI IZBORU NOSIVOSTI POTISKIVANOG SASTAVA

APSTRAKT
Kvalitet tonaže - k_T veoma je važan parametar za ocenu transportne efikasnosti kojim se utvrđuje stepen korišćenja svih vrsta transportnih plovila, pa i brodova-potiskivača. Kompleksnost ovog pokazatelja ogleda se u tome što on izražava veličinu prevezene količine tereta u odnosu na brzinu transporta i, pri tom, nastalog otpora.
Najpouzdaniji način za određivanje pokazatelja kvaliteta tonaže je metoda ispitivanja u realnim uslovima plovidbe, koja se sprovode u cilju utvrđivanja tačnih (stvarnih) tehničkih karakteristika pogonskih uređaja na brodovima-potiskivačima, otkrivanja nedostataka u njihovom radu i povećanja potisnih i brzinskih karakteristika. U radu biće izložen način izbora optimalne brzine plovidbe - v_{opt} i optimalne nosivosti potiskivanog sastava – $Q_{e(opt)}$ na osnovu eksperimentalnih ispitivanja koja su izvršena sa brodom-potiskivačem snage pogonskih uređaja 3×809,6 *kW* (3×1100 *HP*).

KLJUČNE REČI
pokazatelj kvaliteta tonaže; brod-potiskivač; potiskivanisklop; potiskivanisastav; potisna (propulzivna) sila; otporpriplovidbipotiskivanogsklopa

1. INTRODUCTION

As an objective criterion of accuracy of theoretical calculations during determination of navigational characteristics of ships-pushboats experiments conducted in real conditions are used, especially dynamometric and torsionmetric measurements together with measurements of speed of navigation. These experimental measurements are conducted for the highest draught of barges, for different working regimes of propelling engines and different shapes of pushed convoys, as well as for stationary measurements. In order to conduct the measurements of already built ships in real conditions it is necessary to choose measuring track (measuring mile) of substantial length which needs to meet the following conditions:

1. speed of river flow should be neglectable
2. depth in the measuring track (*H*) should be chosen from the simultaneous fulfillment of the following equations $\frac{H}{T} \leq 7$ and $\frac{v}{\sqrt{g \cdot H}} \leq 0{,}5$ where the following are: *H* – depth of water in measuring track (m); *T* – draught of vessels-barges during experiments (m);
3. length of measuring track should contain part whose length is sufficient for measurements, as well as approaching sections on both ends of the track.

In the moments before the beginning of measuring it is necessary to precisely determine the value of draught of each individual barge in a convoy and their real amounts of loaded cargo.

Technical parameters of ship's work that are being determined in real navigating conditions for push-boats include: number of rotations per minute and power on coupling of propelling engines, pressures and temperatures in each cylinder in each propelling engine, total and specific consumption of fuel, number of rotations and power measured on the propeller shaft. This data on propelling engines, during analysis of the results, is compared to the results determined by measurements on the testing table.

2. TONNAGE QUALITY – BASIC CHARACTERISTICS

Tonnage quality parameter, k_T [8],[9], determines the degree of harmonization between the shape of pushed convoy and its total carrying capacity with the speed of navigation of the convoy. At the same time it is known that the speed of navigation of pushed convoy depends not only on the shape of of the convoy, number of barges in it and their draughts but on technical condition of the propelling and propulsion complex of push boats.

Tonnage quality parameter is calculated according to the expression:

$$k_T = \frac{\sum Q_i}{\overline{R}} \text{ [t·m}^2\text{/N·s}^2\text{]} \tag{1}$$

where the following are:

ΣQ_i – total carrying capacity of all the barges that make a pushed convoy, t;

$\overline{R}$ – reduced resistance of pushed convoy, [8],[9], it considers the resistance of pushed convoy in relation to speed of 1 m/s, and is is calculated according to the following expression:

$$\overline{R} = \frac{R_S}{v^2} \text{ [N·s}^2\text{/m}^2\text{]} \tag{2}$$

where R_S – is the total resistance of pushed convoy (N), and v – speed of navigation of observed pushed convoy (m/s).

To determine exploitation properties of single barges and pushed convoys the parameter of specific resistance can be used as well r, [8],[9], which considers the total resistance of pushed convoy per one ton of its carrying capacity and it is calculated according to the following expression:

$$r = \frac{R_S}{\sum Q_i} \text{ [N/t]} \qquad (3)$$

The calculation of optimal carrying capacity of pushed convoy and its optimal speed of navigation with the use of the tonnage quality will be shown on example of the „K“ series pushboat of the Jugoslovensko Rečno Brodarstvo-JRB (Yugoslav River Shipping), based on experimental measurements realized in real navigating conditions in a waterway.

3. BASIC CHARACTERISTICS OF PUSHBOATS OF THE „K“ SERIES

Pushboats of the „K“ series (which includes ships („Kumanovo“, „Kragujevac“ and „Kadinjača“) have the total power of propelling engines 3×809,6 kW (3×1100 HP) and their basic characteristics are shown in the table 1.

Table 1. Basic characteristics of pushboats of the „K“ series 3×809,6 kW (3×1100 HP)

Characteristic	Abbreviation	Unit	Value
Length over all	L_{oa}	m	34,32
Length at the constructive water line	L_{CWL}	m	33,20
Beam	B	m	11,00
Maximal drought	T_{max}	m	1,80
Displacement	D	t	505,50
Block coefficient	δ	-	0,76898
Total power of propelling engines	N	kW	3×809,6

Characteristics of the propelling engines of the „K“ series push boats:

factory: MAK; type of the engine: 8 M 281 AK – four stroke; number of cylinders: 8; total displacement of the cylinders: 101,4 l; permanent power of the engine: 809,6 kW (1100 HP) at 750 rpm; reduction rate 2,526:1.

Characteristics of the propulsion complex propeller-nozzle of the „K“ series push boats:

propeller diameter D = 1800 mm; number of wings: z=3; relation of propeller areas: θ=0,661; diameter at the entrance of the nozzle: D_u=2030 mm; diameter at the exit of the nozzle: D_i=1900 mm; length of the nozzle: l_H=1200 mm;shape coefficient of the nozzle: α_H=1,244; expansion coefficient of the nozzle: β_H=1,089; relative length of the nozzle: $\bar{l}_H = 0{,}66$

General layout of a “K” series pushboat is shown in the figure 1.

4. BASIC CHARACTERISTICS OF THE BARGES

For determination of the pushing (propelling) force of the propellers of the „K“ series pushboats the following barges series have been used: JRB71300, JRB81200 and JRB81500 whose basic characteristics are presented in the table 2.

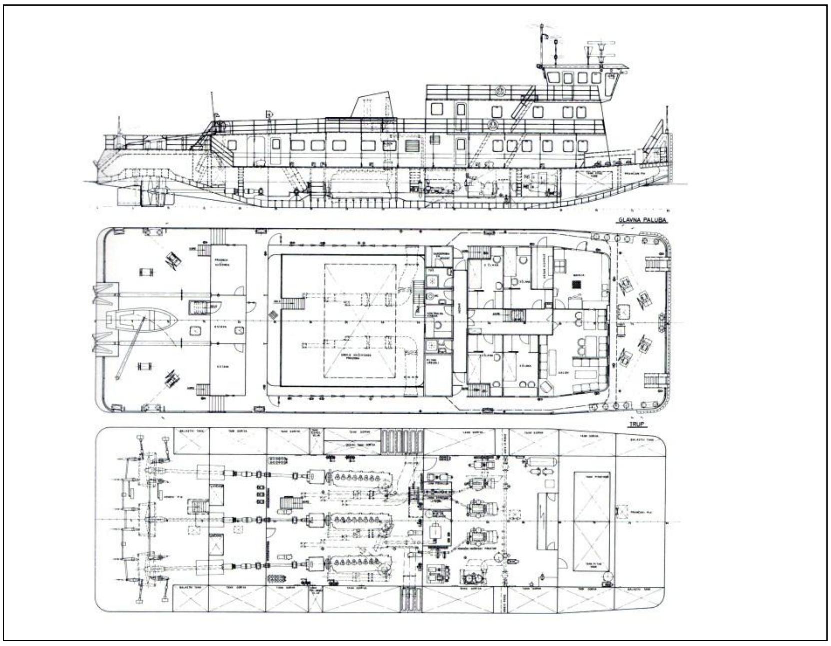

Figure 1. General layout of a "K" series pushboat
Source: [14]

Table 2. Basic characteristics of the series of barges JRB71300, JRB81200 and JRB81500

Basic dimensions	Barge type		
	JRB71300	JRB81200	JRB81500
L_{oa}, (m)	66,95	67,03	77,02
L_{CWL}, (m)	65,65	65,65	75,40
B, (m)	10,20	10,20	11,00
T_{max}, (m)	2,30	2,30	2,56
D, (t)	1497,56	1454,00	1991,22
δ	0,972	0,944	0,9378
Q_r, (t)	1267,56	1224,00	1707,89

Barges used in the experiments with push boats of the „K" series are asymmetrical and they are presented in figures 2 and 3. JRB71300 barges are used for dry bulk cargo without a lid while JRB81200 and JRB81500 barges are for transport of crude oil and its derivates.

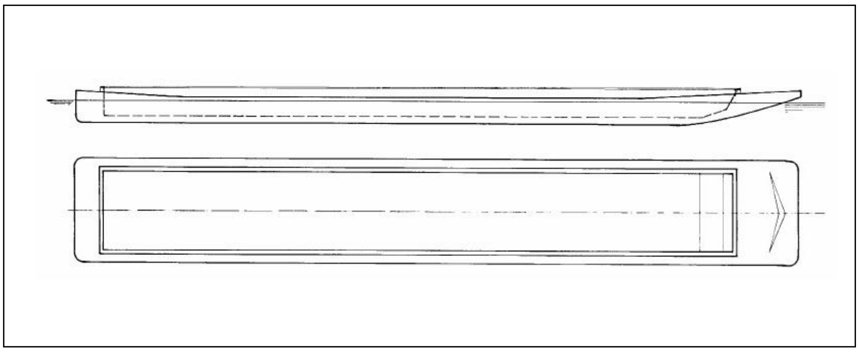

Figure 2. Barge type JRB71300
Source: [16]

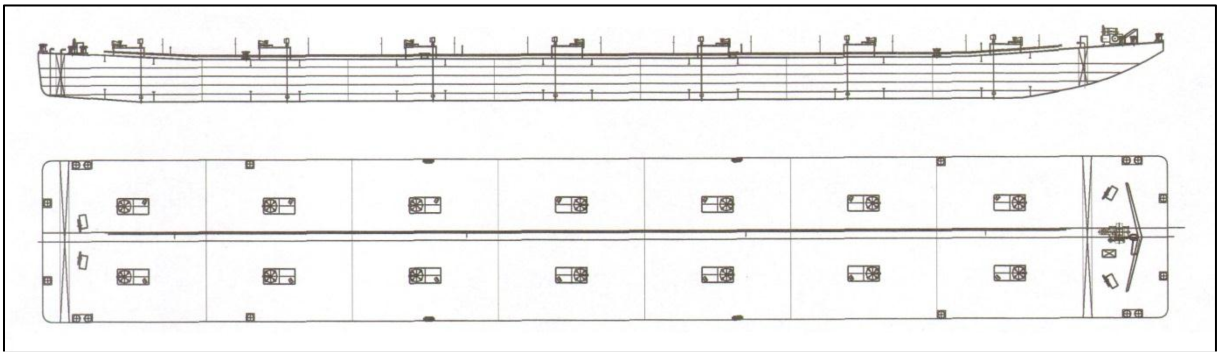

Figure 3. Barges type JRB81200, JRB81500
Source: [16]

To better understand the problem it is necessary to make difference between the terms convoy and pushed convoy. Convoy is made up of barges only, of same or different types, while pushed convoy is made up of convoy of barges together with pushboat. This is shown in the figure 4.

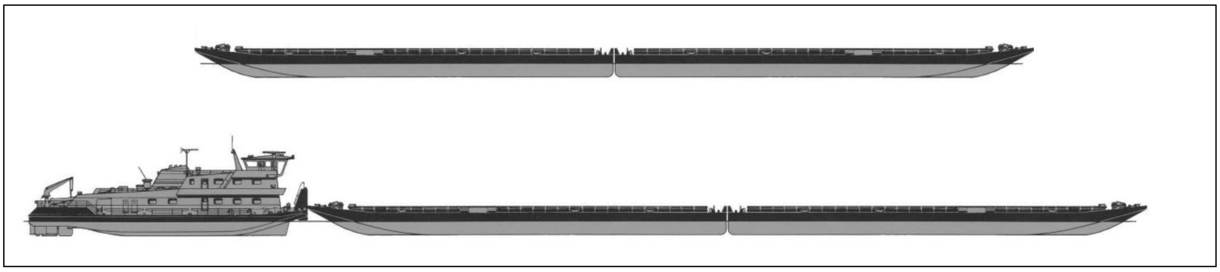

Figure 4. Difference between convoy and pushed convoy
Source: [15]

5. PROCEDURE OF DETERMINATION OF THE PUSHING FORCE OF THE PROPELLER OF THE „K“ SERIES PUSHBOAT

Determination of the pushing (propelling) force of the propeller of the „K“ series push boat is conducted under the condition of the full use of the power of propelling engines and gaining the highest value of the pushing (propelling) force for known characteristics of the propeller-nozzle complex. Torsion meters (devices for measuring the torque Maihak type) and electric contact counters are placed on all three propeller shafts just in front of the propeller shaft post. Determination of propelling characteristics of push boats is based on precise determination of power given to the propeller and number of rotations per minute for each propeller shaft during work with different barge convoys, with simultaneous measurement of speed of navigation of such pushed convoys in still water (in relation to water). Assumption that the torque (calculated power) and number of rotations in front propeller shaft post is equal to the power and number of rotations given to the propeller is made. It is considered that the losses in the propeller shaft post are neglectable.

Measuring procedure consists of measuring characteristics of the working regime of propelling engines for the highest number of rotations of engine shafts which achieves approximately 100% of nominal power.

At the same time with measurements of number of rotations and torques on propeller shafts the speed of navigation in relation to water is being measured as well and it is presented in the table 4.

Table 4. Measured speeds of navigation in relation to water (*v*)

Speed	Shape of pushed convoy							
v	A	B	C	D	E	F	G	H
km/h	14,20	24,078	16,90	12,14	12,02	11,95	18,08	15,75
m/s	3,9444	6,6883	4,6944	3,3722	3,3388	3,3194	5,0222	4,375

Measurement of speed in relation to water is done by hydrometric wing which is positioned at, approximately, 5 meters in front of the front row of barges at a depth of 0,8 to 1,0 meters.

During the testing of the „K“ series push boat in each case the barges that formed the convoy were loaded to the maximal draught so their coefficient of the use of carrying capacity was $\varepsilon = \frac{Q_e}{Q_r} \approx 1{,}0$, where Q_e is really loaded amount of cargo into a barge and Q_r is the registered (maximal) carrying capacity of the barge. The shapes of pushed convoys for which the measurements of propelling characteristics have been done are marked with letters A, B, C, D, E, F, G and H and they are shown in the figure 5.

Experiments with all barge convoys have been done in the Djerdap reservoir where depth on measuring-test track during testing was 15 to 16 meters and it can be considered that there is no negative effect on obtained results of measurements.

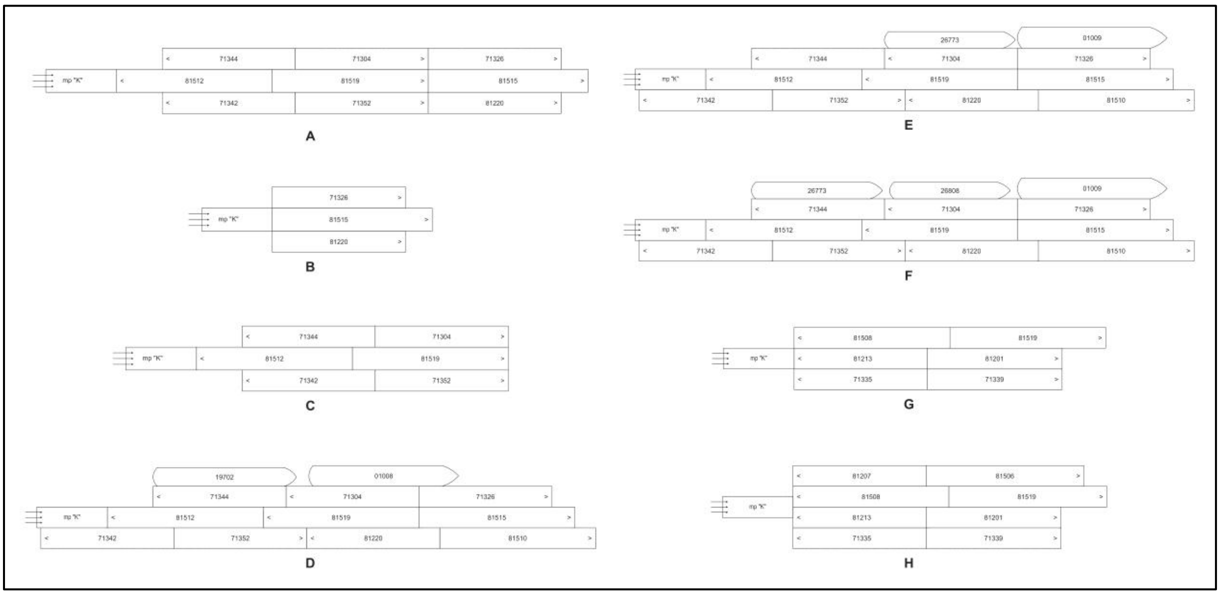

Figure 5. Shapes of pushed convoys while testing the „K“ series push-boat
Source: Authors

Technical parameters referring to pushed convoys A,B, C, D, E and F have been determined by the Laboratory for testing of ships and waterways of the Faculty of transport and transport engineering from Belgrade, while parameters referring to pushed convoys G and H came from results of the research conducted by Brodarski Institute from Zagreb.

In the procedure of measuring the parameters of pushboat convoys whose total carrying capacity ΣQ_e is presented in the table 5 have been used.

Table 5. Total carrying capacities (ΣQ_e) of convoys of barges

ΣQ_e	Shape of pushed convoy							
	A	B	C	D	E	F	G	H
tons	12.685	4.198	8.482	16.251	15.990	16.654	8.396	11.327

The change of carrying capacity of barge convoys as a function of speed *$\Sigma Q_e=f(v)$* is shown in the figure 6 which is best described by polynoms of second and third degree as:

$$\sum Q_{e(1)} = f(v) = 160{,}7 \cdot v^2 - 6.460 \cdot v + 36.051, \ (r^2=0{,}987)$$

$$\sum Q_{e(2)} = -531{,}7 \cdot v^3 + 7.357 \cdot v^2 - 38.252 \cdot v + 81.281, \ (r^2=0{,}989)$$

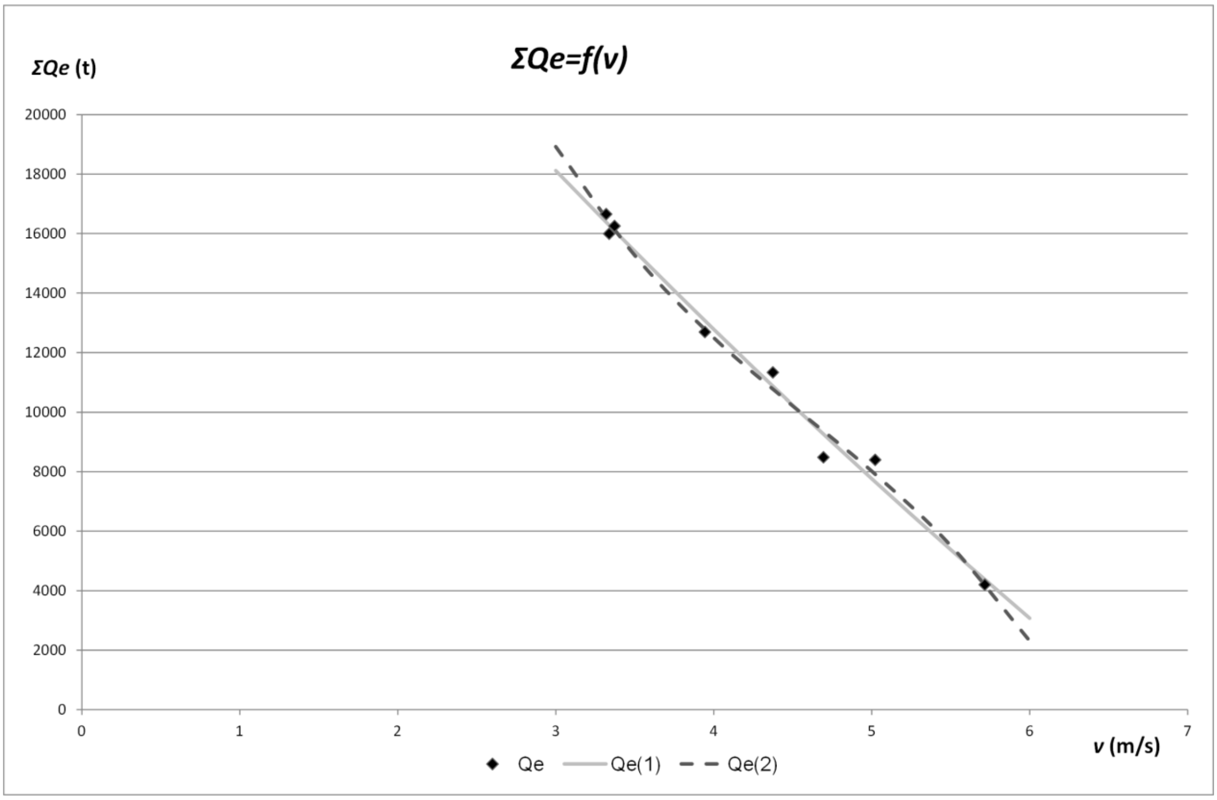

Figure 6. Function of change of carrying capacity of barge convoys *$\Sigma Q_e=f(v)$*
Source: Authors

In the graph points Q_e are original data of the convoys' carrying capacities while $Q_{e(1)}$ and $Q_{e(2)}$ are trend lines that describe the change in carrying capacity as a function of speed.

6. PRESENTATION OF THE RESULTS OF MEASUREMENTS OF THE „K“ SERIES PUSH-BOAT

It can be seen (expression 1) that when calculating the tonnage quality two values occur, total carrying capacity of all the barges in one pushed convoy and reduced resistance of pushed convoy. It is also known that pushing (propulsion) force that is realized by ships propellers (P_p) during stable movement of pushed convoys can be equalized to total resistance of pushed convoy R_S, or in other words $\sum P_p = R_S$ which is why it is necessary to determine the total pushing (propulsion(force of propellers.

It is known that determination of pushing (propulsion) force (P_p) in real navigating conditions realized by ship's propellers presents a special problem. This is the reason why in this paper pushing force of the propeller installed on the „K“ series pushboats is calculated according to methods stated in the literature [3], [7], [8], [9], [11] based on parameters (v), (n_p) and (N_p) measured in real navigating conditions taking into account characteristics that are conditioned by different shapes of pushed convoys.

Based on introduced assumption of equality of propulsion force of propellers and total resistance of pushed convoy, the curve of change of resistance of tested pushed convoys (R_S, kN) shown in the figure 5, for range of measured speeds has the following shape:

$$R_S = f(v) = -0{,}185 \cdot v^3 + 3{,}237 \cdot v^2 - 19{,}02 \cdot v + 397{,}9, \ (r^2=0{,}999).$$

Also, as it has been stated earlier, while solving tasks that refer to the choice of pushboat and pushed convoy it is often suitable to use the method of reduced resistance $\overline{R}_S$ (kN·s²/m²) as a function of speed of navigation (v, m/s) which, in this case, is described with a curve shaped as:

$$\overline{R} = f(v) = 3{,}499 \cdot v^2 - 41{,}06 \cdot v + 131{,}6, \ (r^2=0{,}994).$$

In the figure 7 graphs of change of total resistance $R_S = f(v)$ and reduced resistance $\overline{R}_S = f(v)$ of same pushed convoys are presented.

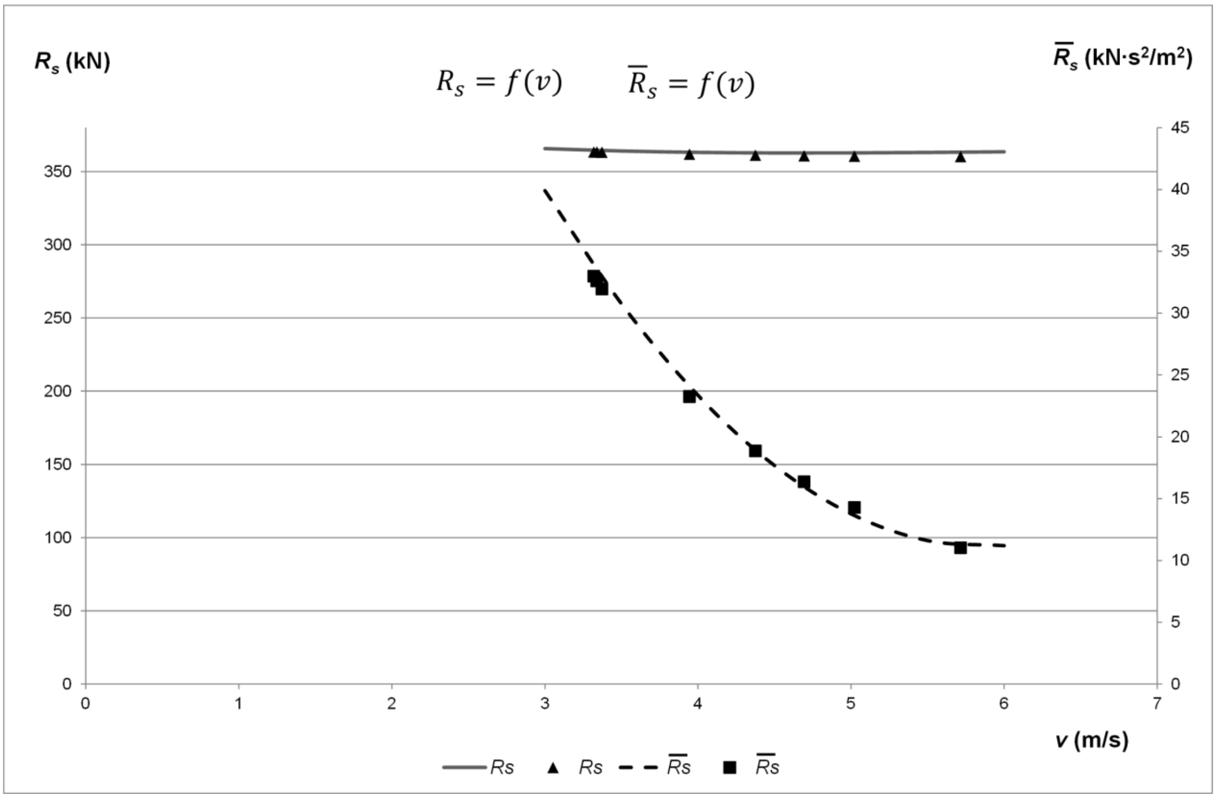

Figure 7. Graphs of changes $R_S = f(v)$ and $\overline{R}_S = f(v)$

Source: Authors

In the graph points R_S and $\overline{R}_S$ are original data of the convoys total resistance and its reduced resistance while their trend lines describe the change of resistance and reduced resistance as a function of speed.

Based on known carrying capacities of pushed convoys (table 5) and values of their reduced resistances the values of the tonnage quality have been calculated $k_T = f(v)$, which was used to obtain a function of change of this parameter in the following shape:

$$k_T = f(v) = -120{,}4 \cdot v^2 + 1049{,}0 \cdot v - 1683, \ (r^2=0{,}996).$$

The graph of change of tonnage quality $k_T = f(v)$ for tested pushed convoys based on results obtained by experiments in real navigating conditions is shown in the figure 8.

By solving the function $\frac{dk_T}{dv} = 0$ maximal value of tonnage quality parameter is determined for speed v=4,356 m/s (15,682 km/h), which for calculated speed equals to k_T=601,885 t·m^2/N·s^2. For optimal speed it follows that the optimal values of carrying capacity of pushed convoys are ΣQ_e=10.960,480 t and ΣQ_e=10.845,315 t.

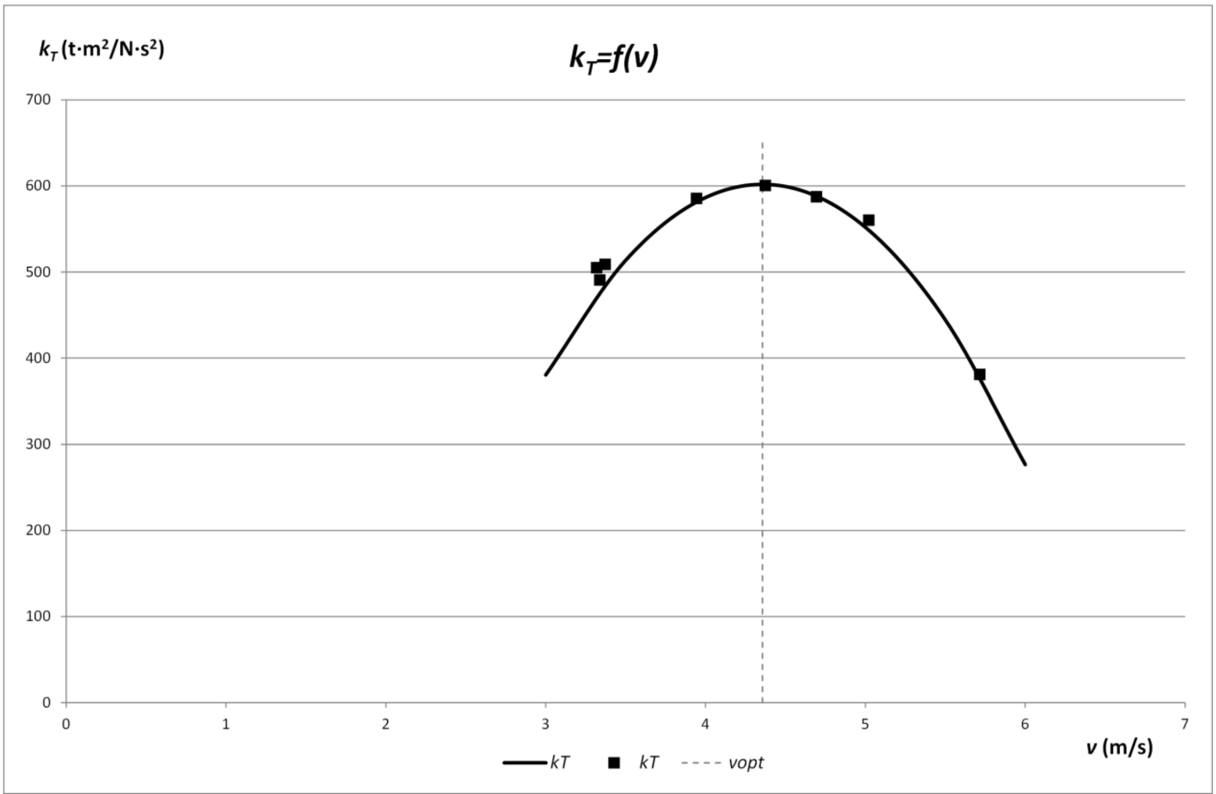

Figure 8. Graph of change of tonnage quality $k_T = f(v)$

Source: Authors

In the graph points k_T are original data of the convoys tonnage quality while the trend line describesits change as a function of speed.

7. CONCLUSION

The meaning of experiments in real navigating conditions of pushboats which are done with different types of barges and different pushed convoys is indisputable. Based on such research the real technical condition of propelling engines and propulsion complex propeller-nozzle is determined, especially if it is determined that the propelling engines are not capable of obtaining the nominal power in the stable working regime of the engines. The experiments have shown significant differences between measured power of propelling engines and installed power, which makes it unreasonable to load the „K“ series pushboat with its designed number of barges, but instead with highest possible number of barges for determined technical condition.

Based on conducted research, by using the optimal solution for tonnage quality, from all tested pushed convoys the closest solution to optimal has the convoy marked with letter H ($k_{T(H)}$=600,328 t·m^2/N·s^2). Tonnage quality parameter that refers to the convoy H, besides the fact that there are two barge types in the convoy and its irregular shape, differs from optimal solution by mere 0,259%. Real carrying capacity of pushed convoy H ($\Sigma Q_{e(H)}$=11.327 t) is higher than optimal carrying capacity by 4,441%, or 3,344%.

This is the reason why, and since barge types JRB71300 and JRB81200 have identical geometric characteristics (*L*, *B*, *T*), they should be combined together in pushed convoys. Geometric characteristics for barge type JRB81500 significantly differ from characteristics of the first two barge types and it is not recommended that they are used together with this type.

From tested pushed convoys it can be seen that convoys marked with letters D, E and F are significantly far from optimal solution. This is because these convoys have irregular shapes formed with two different barge types together with towing barges which when combined with barges for pushing can't form regular shapes of convoys.

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COMMUNAL DOCK CONSTRUCTION – PREREQUISITE FOR NAUTICAL TOURISM DEVELOPMENT

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ABSTRACT
Defining the role of water potential in Sisak implies recognition of the current state in its area, determination of degree of correlation to the population with water potential, needs and habits of the population associated with the water component as one of the key economic segments within the definition of sustainable development and exploitation of water potential supported on a redefinition of the river orientation. Throughout interdisciplinary approach, river orientation and water potential is discussed in the regional and global environment of the city. In accordance with the development plans of the Croatian Government to promote integrated tourism growth, this paper is focused on exploring the potential for sustainable development of nautical tourism on the inland waterways of the Republic of Croatia. Expected results will contribute to proposals and guidelines for development of nautical tourism on inland waterways in Croatia.

KEYWORDS
development guidelines, nautical tourism, sustainable development

IZGRADNJA KOMUNALNOG PRISTANIŠTA – PREDUVJET ZA RAZVOJ NAUTIČKOG TURIZMA

SAŽETAK
Definiranje uloge vodnog potencijala Siska pretpostavlja identificiranje stanja na ovom području, određivanje stupnja povezanosti stanovništva s vodnim potencijalom, potrebe i navike populacije vezane uz vodnu komponentu kao jednu od ključnih unutar gospodarskog segmenta te definiranje održivog razvitka i eksploatacije vodnog potencijala oslonjenog na redefiniranje riječne orijentacije. Interdisciplinarnim pristupom u radu razmatra se uloga riječne orijentacije i vodnog potencijala Siska u kontekstu grada te regionalnog i globalnog okruženja. U skladu sa razvojnim planovima Vlade Republike Hrvatske koji potiču integrirani turistički rast destinacija, ovaj rad je također usmjeren na istraživanje potencijala održivog razvoja nautičkog turizma na unutarnjim vodama u Republici Hrvatskoj. Očekivani rezultati rada utvrditi će prijedloge i smjernice razvoja nautičkog turizma na unutarnjim vodama Republike Hrvatske.

KLJUČNE RIJEČI
smjernice razvoja, nautički turizam, održivi razvoj

1. INTRODUCTION

Republic of Croatia because of its extremely favorable transportation and geographical position, has characteristics and possibilities for road, rail, maritime, air, and for inland waterways. Inland waterways are not enough investigated, given that there are greater potentials and opportunities to use these types of transportation. However, the transport strategy began to give higher importance to inland navigation, primarily because they allow transportation of large amounts of cargo with a relatively low energy consumption, in order to determine European transport policy from 2001, which has a clear goal to promote the development of inland navigation and intermodal transport.

Since the waterway network in Croatia is an integral part of the European network of inland waterways and the Pan-European Corridor VII (Danube corridor), Croatia has adopted this European initiative. Strategically two most important documents for the development of inland navigation in Croatia: "River Transport Development Strategy in the Republic of Croatia (2008-2018) and „Medium-term plan for development of inland waterways and inland ports of the Republic of Croatia (2009-2016).

In accordance with the development plans of the Croatian Government to encourage the growth of integrated tourist destination, this research is aimed at exploring the potential for sustainable development of nautical tourism on inland waters in Croatia.

2. FUNCTIONAL CRITERIA FOR COMMUNAL DOCK CONSTRUCTION

Communal dock Sisak is provided as a facility that would serve the citizens of Sisak for mooring of recreational boats as well as other vessels related to tourism activities. The idea is that the cost of construction works on infrastructure renovation (regulation of banks) shall be supported by the state, and other costs (for electricity, drainage of the parking lot) and suprastructure supported by the concessionaire. Communal dock Sisak will have the rank of dock utility which include mooring of boats and other vessels for sport and recreation, in accordance with Article 159 of the Act of Inland Navigation and Inland Ports (NN 109/07). According to the Regulation on the conditions for inland ports and the criteria for their classification (NN 102/00), ports must have:

- land and water area for vessel mooring;
- objects of navigational safety;
- properly maintained water depth;
- approach paths;
- fire fighting equipment.

Service functions for inland waterwy fleet are not provided for planned communal dock.

Table 1 : Dimensions of berths by vessel category

Vessel category	Vessel length	Berth width	Berth length	Basin width	Draught	Basin depth
	L	B_v	U	3,3 * L_v	Motorna brodica	
	[m]	[m]	[m]	[m]	[m]	[m]
I	do 5	2,1	6,5	21,5	0,4	0,8
II	5-6	2,3	8,0	26,4	0,5	0,9
III	6-8	2,8	10,0	33,0	0,7	1,3
IV	8-10	3,4	12,5	41,3	0,9	1,5

Source: Internal data of the Port of Sisak, Sisak Port Authority

According to the available area between the building and existing waterfront, it is possible to provide one floating jetty for approximately 60 berths, or 2 floating jetties for approximately 120 berths. Mooring structure is defined by vessel length (5-6 m) and width. (2.5 m) In both situations piers are anticipated by length of about 160 meters parallel to the waterway.

3. VARIANT SOLUTIONS FOR PIERS AND VESSEL ORGANISATION

Communal dock territory is formed by longitudinal building on the south side of the existing riverside to the north. It is situated on the left bank of the Kupa river, upstream from the railway bridge in Sisak. Admission to communal dock territory is provided on the downstream side. Territory length amounts to about 170 m. Two alternative solutions were analyzed according to bottom width. First observed variation is the width at the bottom of approx. 20 and 30 m. Each variant represent elongated and narrow territory, which pose a problem in the evaluation area for the purpose of vessel mooring.

The reason for evaluating this form of territory is to maintain the flow profile of the Kupa river bed. It is estimated that construction of communal dock will not affect the flow capacity upon the occurrence of high waters. It is clear that higher importance of project documentation must provide hydraulic budget estimations. Aforementioned longitudinal structures, drawn parallel to the Kupa river are conceived with the crown at elevation + 97.00 m altitude level. It is the higher elevation terrain height of floodplain upstream of the site followed by the communal dock. This means that structure will be periodically flooded by high waters. Likewise, territory scheduled on the same height elevation (seasonal parking) will be flooded by same waters. Such a solution does not protect communal dock territory, but its justification can be seen in two ways. First, longitudinal building is the lower object of the left embankment on the opposite shore, so it will not create a visual barrier and stop flow profile on riverbed Kupa. It is necessary to reposition the piers for mooring boats within the area, taking into account all the functional, technical and economic elements. Pier arrangements are possible in two directions: in direction transverse to the orientation of the territory and in direction along the territory. The solution with the deployment of piers transverse to the territory is unacceptable because of low area utilization and the need for construction a number of access bridges, which price is very high considering the need of overcoming high altitudes (water level fluctuations). Solution to pier deployment along the territory so that pier accommodates centrally and vessels moore on both sides is not feasible due to insufficient territory width. Both sides along the pier area must be provided for the length of 8.0 m and width of 10 m area for maneuvering and passage of vessels. Therefore, total required territory width for proposed solution (pier width is 2 m) is 38m, which is only achievable at higher water levels. The only technically and economically acceptable solution remains setting one or two floating piers along the territory. Piers would be placed along the edges of the territory to the north, or north and south.

Vessels were connected unilaterally to the pier and along the territory leaving space for maneuvering and vessel passing. In this respect, project considered two options:

- First Variant (unilaterally set of floating piers with a length of 230 m - north side of communal dock river basin)
- Second Variant (duplex setting of floating piers - north, south and south-east potential of communal dock basin)

Phase 1 (duplex installation of floating piers at a length of 160 m, north and south side of the communal dock basin) Phase 2 (duplex setting of floating piers – north side (268 m long), south side (268 m long) and south-east (60 m in length) side of communal dock river basin)). Variant projected bottom width is 18.8 meters, which allows only one-sided set of floating piers providing 80 berths. Variant II anticipated bottom width of 27.8 meters which provide setting of mutually floating piers and berthing for 118 vessels in planned construction phase I. It is possible to perform phase II variant that would include landscaping works on southeastern part of territory, and provide an additional 76, ie 194 berths.

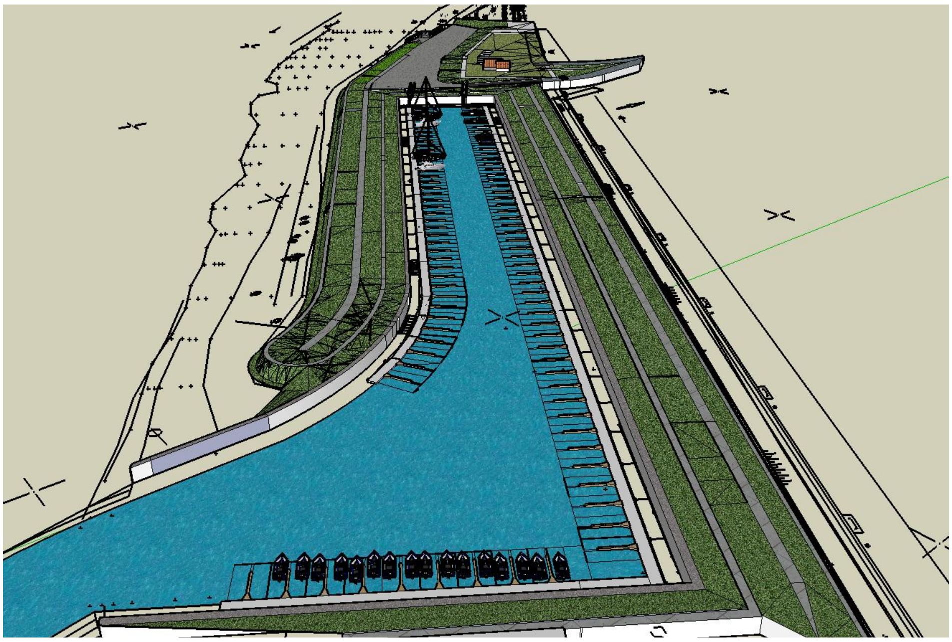

Figure 1 Variant II - Phase II schedule of piers
Source: Internal data of the Port of Sisak, Sisak Port Authority

According to preliminary cost analysis of individual variants, conducted in order to select the proper solution, total cost for construction of variant I is 7.379,786 kn and Variant II – Phase I is 8.844,246 kn, from an economic point of view variant I is the preferred solution. However unit costs variant provide different figures. Unit price of variant I is approx. 92,000 kn/berth, while phase I variant II is appx 75,000 kn/berth. By extending variants II on the second phase, more favorable unit cost is got per connection of appx. 60,000 kn/berth. According to price performance relations variant is 15% cheaper than variant II, however, compared to the unit cost variant II is cheaper by 20% than variant I. As the difference in the total cost of 15% is not a significant size advantage of the selection criteria more favorable alternative gives the comparison of unit prices. From this economic point of view investor selected version II, Phase II as more cost effective.

4. SUMMARY OF RESULTS ON OPINIONS OF SISAK RESIDENTS ABOUT THE RIVER ORIENTATION AND WATER RESOURCES

459 randomly selected citizens were surveyed for the study of attitudes and opinions of citizens of Sisak on the river orientation and development of water activities. Included subjects were employed in water other activities. Results show that 93% of respondents indicated a different frequency of residence on rivers (from rare to everyday), which indicate a need for adequate design of contacts between citizens and rivers. Citizens are at the moment most attached and focused on sports activities on the rivers, because other activities at this time are not offered to them. Therefore, they should offer other programs that are developed in cities that are located on rivers. Respondents mostly accepted river orientation as an integral part of life. It is only necessary to align their aspirations with adequate facilities. Respondents of citizens were extremely focused on river city orientation in economic and other segments and held that activities in this field must be intensified. The weary Sisak economy would thus be opened up to prospects for the affirmation of new activities (from manufacturing to services) and employment opportunities. Even 432 or 94.11% of the respondents considered building a sports harbor is necessary, 208 respondents indicated one or more proposals for the site (Kupa river, left bank of the old bridge to the confluence with the tendency near stadium; Kupa, right bank - Pogorelac; Kupa, left bank in range of promenade to the old bridge; Kupa, right bank - Zibel; Kupa, left bank – near location of Pristanište i Skladišta LtD). Harbour Master`s Office in Sisak proposed two locations:

1. First location: along the right bank of the r. Kupa river rkm 4 + 000 - 4 + 100;
2. Second location: along the left bank of the r. Kupa, rkm 3 + 340 (downstream of Old town bridge).

Interest in the excursion boat in Čigoć expressed 74.94% of respondents, while 15.25% are undecided and only 9.59% disinterested. For many years there was no option for an organized visit to interesting destinations in its vicinity via inland waterways combined with sport and recreational approach to learn about the beauty of the environment, which also has a number of other important characteristics (geographical, biological, cultural, environmental).

Passenger, and therefore tourist river traffic is not represented in Croatia. With an efficient organization, association with healthy food programs, rural tourism, wine routes may increase employment, changes in the social structure, the standard of living and their ecological awareness. For the construction of ancillary facilities which help users to realize activities on rivers, as well as various facilities there is great interest by the interviewed citizens.

The walkway by the Kupa river is one of the most valuable urban areas in Sisak. Recently, the tender for the project of the catering facility with a lookout point at the beginning of the promenade along the shopping center Srce, as well as project protective fencing along the Kupa, which should have a decorative function. So, the action in this direction is already taking place, and the proposed activities and facilities if they take into account the completed project. Respondents confirmed its river orientation and expressed the need to introduce educational programs - sailing and rowing, swimming, diving and skipper school. Educational activities could open up possibility of new jobs - from those who will educate people and take care for the equipment. Results indicate that respondents expressed a willingness to secure the property along rivers and equipment for water activities. Strategy for economic development of Sisak County proposed to citizens credit and other positioning options interested in the river orientation. This means that along with the construction of key facilities on the rivers (port bindings) individuals should be allowed to purchase property and equipment for either permanent or temporary residence along the river with the ultimate goal of self-employment. Dissatisfaction with the ecological state of rivers is evident. Approximately every third respondent estimated that the rivers are heavily polluted. Slightly more respondents, 34.20% stated that rivers are polluted at an allowed level, while 16.12% of respondents consider that river are slightly polluted. For such estimates survey reflected the fact that industrial activitieshave reduced in the last decadeon the Sava river significantly reduced industrial production in the last ten years. Between 1990 and 1996 in Sava river registered reduction of the amount of waste water by one third, suspended solids, total salts and organic matter by more than half, and fats and oils almost completely. The result is a decrease in the production volume of major pollutants, rather than improving the quality of wastewater treatment, or the construction of new purification device. In the study, "The goals and strategies of economic development" / Institute for International Relations / expressed the general opinion that regardless of existing industries, air pollutants, water and soil and tie disposal technology and waste Sisak-Moslavina County falls in well-preserved areas. Future development plans should be based on the principles of sustainable development with respect to environmental parameters.

Results indicate that respondents were extremely focused on river city orientation in economic and other segments and to hold that the activities in this field must be intensified. The weary Sisak economy would thus be opened up prospects for the affirmation of new activities (from manufacturing to services) and employment opportunities.

Table 2: Do you consider necessary the construction of communal dock (it does not require large investments) with a certain number of berths and facilities?

Answer	f	%
Yes	432	94,11
No	27	5,88

Source: The views and opinions of citizens of Sisak on the river orientation and the importance of water activities, Port Authority of Sisak, Sisak, 2002;

Even 432 or 94.11% of the respondents considered necessary the construction of communal dock, while 208 respondents indicated one or more proposals for the site. Systematization of their suggestions we received the following results:

Table 3: Proposals for communal dock construction sites

Suggestions for the location of communal dock	f	%
Kupa, the left bank of the old bridge to the mouth / near the stadium	78	16,99
Kupa – right bank, Pogorelac	50	10,89
Kupa, right bank, Zibel	36	7,84
Kupa, left bank – near location of Pristanište i Skladišta LtD	20	4,36
Other	13	2,83

Source: The views and opinions of citizens of Sisak on the river orientation and the importance of water activities, Port Authority of Sisak, Sisak, 2002;

5. PROPOSED GUIDELINES FOR SUSTAINABLE DEVELOPMENT OF NAUTICAL TOURISM ON INLAND WATERWAYS

Authors proposed guidelines for the development of nautical tourism on inland waters in the following three phases:

1. Research of existing reference models in Europe;
2. SWOT analysis for development of nautical tourism on Croatian inland waters;
3. Integration of framework for sustainable development on Croatian inland waters.

With the aim registering existing trends and collection of best practices study on reference model nautical tourism on the waterways and lakes in Europe will be made with special emphasis on neighboring countries, such as Hungary. Structured analysis of reference models in Europe will generate a detailed review of nautical tourism on European inland waterways, described on the basis of indicators of infrastructure, supply and demand. Methodology for the development of a reference model consist of a detailed list of tourist attractions on waterways and lakes in Europe. It is necessary to focus on tourist facilities which may be relevant to the existing situation in Croatia. Reference models should investigate real and perceived barriers for the development of nautical tourism, as well as mitigation measures which might reduce or remove respective barriers. Generally, the analysis of the reference model can be regarded as an effective mean for encouraging change and increasing competitive appearances for the growing sector of nautical tourism on inland waterways and lakes. Expected results of the research will provide an overview of relevant tourist attractions related to nautical tourism on inland waterways and lakes in Europe and a detailed analysis of selected tourist attractions based on their characteristics, size and activity. Analysis of reference models will provide an overview of modern, current as well as projection of future trends in the field of nautical tourism on inland waterways and lakes. SWOT analysis will identify strengths, weaknesses, opportunities and threats related to nautical tourism on inland waterways and lakes in Croatia. Figure 2 represent a visual summary of the framework that should be accomplished. Systematic analysis of development will focus on:

- National vision and strategy for the development of tourism in Croatia, and how it contributes to the wider economic development in Croatia;
- Level of targeted development of nautical tourism on inland waters;
- Basic features of development of nautical tourism in inland waters or the types of activities that need to be developed;
- Areas that could potentially be problematic for the development of nautical tourism;
- Ecological consequences of nautical tourism on inland waters and how they need to be specifically associated with the reallocation of land for tourism, preservation of natural parks and key environmental values of waterways.

	External: Opportunities (O-opportunities)	**External: Threats (T-threats)**
Internal: Strengths (S-strengths)	**SO** *"Maxi-Maxi" strategy* Strategies used by internal strengths to maximize aggravated achievement of identified opportunities	**ST** *"Maxi-Mini" strategy* Strategies used by internal strengths to minimize external threats which prevent realization of opportunities
Internal: Weaknesses (W-weaknesses)	**WO** *"Mini-Maxi" strategy* Strategies that minimize internal weaknesses so as to exploit provided opportunities	**WT** *"Mini-Mini" strategy* Strategies that minimize internal weaknesses while avoiding threats

Figure 2 SWOT analysis and strategic options for sustainable development

Source: Bukljaš Skočibušić, Mihaela; Brnardić, Mato; Brnardić, Ema. Identification of Framework for Sustainable Development of Nautical Tourism on Inland Waterways in Croatia. // Springer-Verlag. 395 (2013), 224-233, Katowice-Ustron, 2013;

Recreational use of inland waters is becoming an increasingly important issue in Europe. Inland Waterway Member States of the European Union consist over a million motorized recreational vessels. The rate of growth in the sector of water sports is estimated at 2-3 percent per year, while recreation and life along the banks of rivers and lakes are all valuable resources, and also the opportunity to encourage economic performance of regions and places that situated along inland waterways.

At the same time, the Sava River as part of a European network of waterways offer outstanding potential in terms of cultural and social heritage and protected areas, including nature parks, as well as significant and relevant cities. Full accessibility of waterways in the context of nautical tourism to the present day remained limited due to a lack of infrastructure (including full buoyancy and the port of embarkation), and integrated management of nautical tourism.

Taking into account the fact that the development of nautical tourism initiate further employment of the population, as well as further development of support activities (such as food production and catering), it is obvious that the integration of framework for sustainable development of nautical tourism can contribute significantly to the overall economic development and serve as a basis for full use of tourism potential on inland waters in Croatia.

The actions to be undertaken include:

- preparation of the Master Plan for the development of nautical tourism;
- regular updates of Nautical guide for Sava river;
- preparation of legal framework for the development of nautical tourism on a regional and national level;
- establishment of a network of marine, terminal points for tourists and other infrastructure for nautical tourism along the Sava River;
- promotion of opportunities for nautical tourism on the Sava river in international tourist organizations.

6. CONCLUSION

Despite its great tourism potential, rivers and lakes in Croatia have not received so far enough support at the national level as coastal tourism and nature parks. Possible modes of travel for each attraction are eco-tourism, recreation on inland waters, camping, yahting, rafting, kayaking, fishing, etc. It is possible to state that Sisak, once fourth industrial center in Croatia, conceived and executed action to become a recognizable Croatian inland nautical center where the river will be the basis for future economic and tourism development. Water component as the new opportunity of the city and county in transport, tourism and other aspects should be taken into consideration. Research results show that internationalization of the water orientation and economic evaluation of the river, through the protection of ecosystems, coastal development, communal dock construction and other facilities offer new contents. Based on the research results it is possible to make a program of activities for the reaffirmation of the river facing the city and region. In this sense, the program orientation of Sisak Port Authority focus on development activities following strategic objectives of the Croatian transport strategy and the needs of the local community to determine the port area, construction of slipways for boats on the river Sava in Sisak, communal dock construction, commercialization of port and related activities and integration of rivers in the everyday life of citizens.

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VALUE CHAIN OF DELIVERING INFORMATION AND COMMUNICATION SERVICES IN DYNAMIC CARPOOLING SYSTEM

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ABSTRACT
The world trends of implementing various models of shared rides by passenger cars (e.g. carpooling, carsharing, ridesharing, etc.) are oriented to the need of using innovative systems and solutions from the domain of Intelligent Transportation Systems (ITS), Innovative Transport Systems (INTS) and Information and Communication Technologies (ICT) in order to increase the use of alternative and sustainable modes of travelling. The intensity of traffic system development in general, as well as the intensity of the development of shared ride models require increased application of information and communication technologies and services. In order to achieve efficiency in performing shared ride by passenger cars the real-time transfer of relevant and necessary information is significant. The main segments of ICT that are usually observed are: type of information, information technologies, and usage of information in traffic. Using different specialized internet carpooling portals and applications for mobile devices enables more efficient and optimal usage of the existing capacities (passenger cars, carpooling stands and parking lots, HOV lanes and similar). The paper gives an overview of studying the application of technologies in shared rides by passenger cars and proposes a value chain of providing the information and communication services in the system of shared rides by passenger cars (dynamic carpooling).

KEYWORDS
Dynamic Carpooling, ICT, Value Chain, Information and Communication Services.

VRIJEDNOSNI LANAC ISPORUKE INFORMACIJSKO-KOMUNIKACIJSKIH USLUGA KOD SUSTAVA DINAMIČKOG CARPOOLINGA

SAŽETAK
Svjetski trendovi primjene različitih modela zajedničkih vožnji osobnim vozilima (npr. *carpooling*, *carsharing*, *ridesharing* i dr.) usmjereni su k potrebi korištenja inovativnih sustava i rješenja iz domene inteligentnih transportnih sustava (ITS), inovativnih transportnih sustava (INTS) i informacijsko-komunikacijskih tehnologija (ICT) kako bi se povećala upotreba alternativnih i održivih načina putovanja. Intenzitet razvoja prometnog sustava u cjelini, kao i intenzitet razvoja modela zajedničkih vožnji zahtijeva povećanu primjenu informacijsko-komunikacijskih tehnologija i usluga. Za postizanje učinkovitosti u obavljanju zajedničke vožnje osobnim vozilima značajan je prijenos relevantnih i potrebnih informacija u stvarnom vremenu (engl. *real-time*). Glavni segmenti ICT-a koji se obično promatraju jesu: vrsta informacije, informacijske tehnologije i korištenje informacija u prometu. Korištenjem različitih specijaliziranih internetskih *carpooling* portala i aplikacija za mobilne uređaje omogućava se učinkovitija i optimalna upotreba postojećih kapaciteta (osobnih vozila, *carpooling* stajališta i parkirališta, HOV voznih traka i slično). U radu je dan pregled istraživanja primjene tehnologija u zajedničkim vožnjama osobnim vozilima te je predložen vrijednosni lanac isporuke informacijsko-komunikacijskih usluga kod sustava zajedničkih vožnji osobnim vozilima (*dynamic carpooling*).

KLJUČNE RIJEČI
Dinamički carpooling, ICT, Vrijednosni lanac, Informacijsko-komunikacijske usluge.

1. INTRODUCTION

The dynamic or real-time carpooling/ridesharing (also known as instant ridesharing, dynamic ridesharing and ad-hoc ridesharing) is a service which enables connecting and scheduling of passengers in the function of shared rides in a very short period of time using advanced technologies. Traditionally, carpooling arrangements between two or several unrelated individuals to travel to work or study were relatively inflexible. Dynamic carpooling/ridesharing allows additional flexibility of shared rides allowing the drivers and passengers to agree on occasional shared rides in advance or within a shorter period of time, and it is based on the application and integration of various technologies. The basic characteristics of dynamic user connection are simplicity, flexibility and practicality. Applications for real-time booking of places in the passenger cars have high potential to provide the user having the basic IT literacy with the possibility of using this concept, thus indicating the personal benefit for the user in visible savings during passenger car rides. The user-friendliness is insured by a simple interface, and the applications are run on mobile terminal devices that have access to the internet. The paper describes the application of technologies and proposes a value chain of delivering the information and communication services for the requirements of the dynamic carpooling system.

2. APPLICATION OF TECHNOLOGY IN DYNAMIC CARPOOLING SYSTEM

In the last decade there has been a substantial number of various types and categories of papers that analyse the application of information and communication technologies in the function of carpooling. For carpooling to function adequately, the passengers should have the possibility of accessing timely information about the vehicles and rides, realizing communication and interconnections. The application of the information and communication technologies affects especially positively the connecting of the users in order to realize joint mobility. One part of the papers analyses the application of location and navigation systems for the needs of connecting the users of the system of shared rides by passenger cars [1], [2], and the others deal with the application of wireless technologies and the usage of mobile terminal devices and the development and application of web-services as user support [2], [3], [4], [5]. Location Based Services (LBS) by means of mobile telecommunication infrastructure deliver to the carpooling system users relevant information depending on the current location of the users of shared rides and thus provide Value Added Services (VAS). LBS services are linked to applications that integrate the geographical location with other information. An important fact in introducing LBS services lies in the characteristics of mobile terminal devices whose hardware and software features can satisfy a certain level of the quality of using LBS services. Apart from hardware and software features, the supported information and communication technologies are of the same significance. With rapid development and widespread information and communication technologies integrated into mobile terminal devices, determining the position on the move has become everyday practice. The technologies include Geographic Information System (GIS), Global Navigation Satellite System (GNSS), Radio Frequency Identification (RfID) and various other technologies to determine the location with more or less precision, coverage, and higher or lower costs of installation and maintenance.

There are frequently papers that use the possibilities of geographic information systems to plan the locations and positions of traffic system and sub-system infrastructure, e.g. Park&Ride terminals, railway terminals, bus stations, carsharing stands and similar [6], [7]. An increasing role in using and studying carpooling belongs to GNSS systems that together with GIS information technologies and Augmented Reality (AR) enable locating of the users and accessing a new segment of information [8]. Determining the location of carpooling users can be realized also by applying other technologies, such as locating by means of base stations (GSM[1], UMTS[2], LTE[3]) and WLAN[4].

Apart from obtaining precise information on the location of the carpooling users in space, the RfID technology is introduced also to solve the drawbacks in sharing the transport costs among the carpooling users [9]. For the needs of shared rides by passenger cars various multi-agent systems have been developed, that are accessible by means of mobile terminal devices [10], [11], [12].

The preparation for the shared ride system by passenger cars can encompass different methods of connections, including:

- public internet pages, that act as points at which transport supply and demand meet, i.e. shared ride by passenger cars;
- internet pages of closed access (e.g. for employees of certain companies, students at student homes and other groups);
- applications for mobile terminal devices because of shared rides by passenger cars (carpooling smartphone applications);
- filling of vehicles by means of carpooling of specialized services and/or usage of automated ride matching software), and
- the defined meeting places – pick-up points for carpooling purposes [2].

Carpooling internet pages can be of closed and open type. The open carpooling portal is, namely, available to all internet users thus referring to a greater number of potential users. The closed-type portals are different; they serve only the defined groups of users, such as e.g. employees of certain companies to agree the term of departure from work and arrival to work. Since the late 1990s numerous carpooling projects have proposed the usage of internet portals and services of mobile communication systems to establish connections among users, and since 2004 also networking of the users via social networks. The application of internet carpooling portal encompasses a series of new strategies for the creation of the critical mass of users, such as: partnerships at the level of the city, region or big companies, plans of financial incentives for the users, networking via social networks and real-time carpooling services with the use of automated ride-matching programs.

With the development of new generations of information and communication networks the users require services that are personalized, adapted to the current context, intelligent, mobile and always accessible. Connecting of new concepts is infrastructurally based on the existing internet network and 3rd/4th Generation (3G/4G) and supported by Artificial Intelligence (AI) mechanisms which allow automation of the process and their personalization and high level of competitiveness (parallel performance). One of the advanced integrative approaches from the information and communication domain is the application of the Cloud Computing (CC) concept which provides flexibility regarding location of accessing computer resources [13].

3. PROPOSAL OF ICT VALUE CHAIN IN DYNAMIC CARPOOLING SYSTEM

Based on the presentation of the application of technologies in the function of shared rides by passenger vehicles, the ICT value chain in the system of dynamic carpooling is proposed (Figure 1). The value chain makes it possible to coordinate the relationships among entities. In classical ICT value chain the highest value was contained in the network itself, i.e. its infrastructure and the technologies that enabled communication. Unlike this, the ICT value chain in the carpooling system has on the one hand emphasis on complete

[1] Global System for Mobile Communications
[2] Universal Mobile Telecommunications System
[3] Long Term Evolution
[4] Wireless LAN/ Wireless Local Area Network

satisfaction of the user's needs providing personalized services, and on the other hand, on efficient downloading of contents and innovative modelling of services. The contents that may be of interest for the user can be schedule of vehicles and rides, user profile, analytics of users and traffic entities, video contents important for the user, GPS data, etc. In the domain of network operators there is the network, servers, and services and applications. Figure 1 shows the ICT value chain in the dynamic carpooling system.

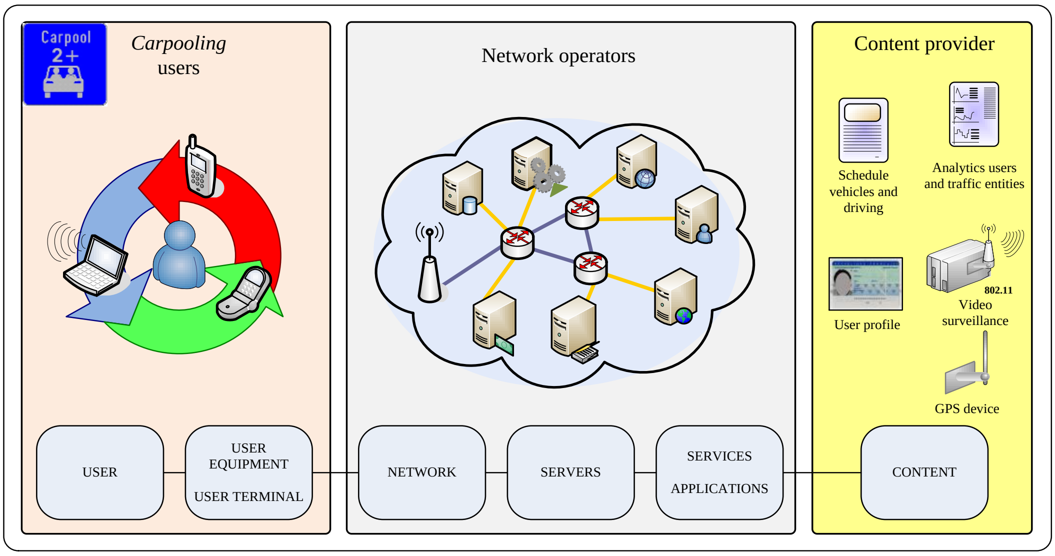

Figure 1 Value Chain of ICT in the Dynamic Carpooling Systems
Source: Created by authors

Observing different entities within the ICT value chain the following types of convergences need to be recognized: network convergence, devices convergence and content convergence. The basic requirements of dynamic carpooling include these elements of the value chain (presented in Figure 1):

- **Smartphones** – many mobile telephony service providers rely on the spreading of smartphones on the market (user equipment). Carpooling services are developing software for real-time carpooling and their efforts are focused on platforms that are user-friendly and that have attractive user interfaces, such as e.g.: Apple iPhone software and Google Android platform (applications).

- **Constant Network Connectivity** – the users should be constantly linked to the internet network in order to exchange data and receive ride requests as well as accept offers within a short period of time (network). Smartphones are precisely the ones that allow unlimited connectivity and access to data.

- **GPS Functionality** – GPS functionality is installed in many mobile terminal devices (services, applications). In other words, the users who request carpooling ride do not have to input their current location since GPS is integrated in their smartphones and the information about their position is automatically available.

- **Ride Matching Algorithms** – storing of data on the server. Certain algorithms are based only on the origin and destination of the users, whereas some of the newer algorithms connect drivers and passengers based on the frequency of their travelling relations, interstations, and preferences (applications).

- **Data Repository** – all real-time systems, as well as the internet-connected carpooling systems in general have a data repository where the data are stored. The types of stored data may include the current list of requests and offers for rides, individual user profiles, and the overall statistics about the activity and participation of the users (contents).

4. CONCLUSION

By studying the application of technologies in the function of shared rides by passenger vehicles and recognizing the users' requests (commuters) a value chain for the delivery of information and communication services has been proposed for the requirements of the dynamic carpooling system. Future research regarding the application of information and communication technologies and services in the carpooling system is oriented to testing and determining the added value of the Service Oriented Architecture (SOA) and the possibility of Cloud Computing. The carried out research is the basis for further analysis of the possibility of applying various models of Cloud Computing and on the Cloud-based architecture which would enable real-time carpooling services (at any time and at any location) and the development of new value chains in delivering information and communication services for the needs of dynamic carpooling.

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DETERMINATION AND ASSESSMENT OF TRAFFIC CORRIDORS FOR THE TRANSPORT OF DANGEROUS GOODS

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ABSTRACT
This paper discusses the issues of defining the technological model of corridors for the transport of dangerous goods in the Republic of Croatia, with the goal of putting it into operation. To that end, we explore the benefits of introducing and using defined model of corridors with respect to the Croatia geographic position, its maritime orientation and condition of existing infrastructure capacities. The purpose of implementing such a model also arises from the need for the development of optimal, adaptive and agile system which is based on the compatibility of all stakeholders in the transport chain, their interconnectivity and synergism.
Implementation of this model requires research and thorough analysis of existing capacities, definition of development guidelines, harmonization with international guidelines, identification of various strengths and weaknesses and the study of stimulative development measures. The development of different strategies for the future transport system poses a demanding and difficult task for traffic experts. Different variants arise as a result of various predictions and assumptions for variables that determine the characteristics of the transport system. Each of the measures applied to the transport system has a different qualitative and quantitative impact on the target function and the observed criteria.

KEYWORDS
Dangerous goods, tracing corridors, development strategy

TRASIRANJE KORIDORA ZA PRIJEVOZ OPASNIH TVARI

SAŽETAK
U ovom je radu dan osvrt na prometno tehnološko definiranje modela koridora za prijevoz opasnih tvari u Republici Hrvatskoj s ciljem stavljanja istog u funkciju, što je značilo istražiti prednosti uvođenja i korištenja modela koridora s obzirom na geografski položaj Hrvatske, pomorsku orijentaciju, te stanje postojećih infrastrukturalnih kapaciteta. Svrha također proizlazi iz potrebe razvitka optimalnog, prilagodljivog i agilnog sustava čija je osnova kompatibilnost svih učesnika u prijevoznom lancu, njihova međusobna povezanost i sinergizam.
Trasiranje modela koridora zahtijeva istraživanje i temeljitu analizu i istraživanje postojećih kapaciteta, definiranje smjernica razvoja, usklađivanje sa svjetskim smjernicama, uočavanje prednosti i nedostataka te proučavanje stimulativnih mjera za razvoj. Razvoj različitih strategija za budućnost prometnog sustava predstavlja zahtjevan i težak posao prometnim stručnjacima. Različite varijante proizlaze kao rezultat različitih predviđanja i pretpostavki za varijable koje determiniraju obilježja prometnog sustava. Svaka od mjera kojom se djeluje na prometni sustav ima različiti kvalitativni i kvantitativni utjecaj, odnosno težinsku vrijednost na funkciju cilja i kriterije koji vode tom istom cilju.

KLJUČNE RIJEČI
Opasne tvari, trasiranje koridora, strategija razvoja

1. INTRODUCTION

Regardless of the fact that transport plays a central role in modern society, it also has numerous negative impact on the environment in local and global context, which produces different kinds of problems that can be reduced by introducing a number of different strategies.

Many governments direct their strategies towards sustainable transport mobility. In this context, it is evident that during recent years, attention to environmental protection in the transport of dangerous goods has been significantly increased. In the transport of dangerous gods, knowledge about the risks associated with these types of transportation have taken particular importance. In some cases, transport accidents related to these products have caused environmental damage on a wide level.

The international transport of dangerous goods is regulated by international agreements for road (ADR, 2007), rail (RID, 2007), maritime (IMO, 2005) and air transport (IATA ICAO, 2003).These agreements contain regulations that are primarily related to dangerous goods labeling, the characteristics of the containers and transport equipment, loading and unloading procedures, driver training, driver behavior and approval of documents. However, a frame for the general assessment of risk level in the dangerous goods transportation process is missing.

In this context, it is necessary to provide a global assessment of transport activity with a systematic approach. In order to prevent major damage in the transportation of dangerous goods it is necessary to know the quantity, type and nature of dangerous goods. For this aim, the European Union has already imposed on its Member States to record information about the types of dangerous goods transported in order to ensure monitoring of dangerous goods on its territory.

2. ANALYSIS OF TRANSPORTATION OF DANGEROUS GOODS IN REPUBLIC OF CROATIA

Analysis of the available data indicate that in the Republic of Croatia, the majority of dangerous goods is transported by road. This imbalance produces a relatively high external costs in terms of negative impact on the environment and the community.

Dangerous goods can be defined as substances which release or create an infectious, irritating, flammable, explosive, corrosive, suffocating, toxic or other hazardous particles, fumes, gases, mists, vapors or fibers and harmful radiation during their production, transportation, processing, storage or usage in the technological process in quantities that can endanger human life and health or have a negative impact on the environment within a certain distance from objects in which they are located.

In Croatia, several thousands tons of dangerous goods is transported each year by road and rail transport.

In broader context, the basis for a full analysis of dangerous goods transport and the projection of the necessary guidelines for improvement of transport for these categories of goods lays in consideration of the trade flows dynamics and the share of individual transport sectors in total traffic structure.

In 2011, in Republic of Croatia a total of 129.746 millions of tons of all kinds of goods was transported, of which a total of 20.7 million tonnes were dangerous goods. In rail transport a total of 1.569 million tons of dangerous goods was transported, of which 847 thousand tonnes were transported in domestic transport and 722 thousand tonnes in international transport. In road transport a total of 3.131 million tonnes of dangerous goods was transported, of which 2.691 million tonnes were transported in domestic transport and 440 thousand tonnes in international transport. A total of 7.729 million tons of dangerous goods was transported by pipelines. In inland waterways transport of dangerous goods amounted to 95 thousand tonnes. In the same year transport of dangerous goods in seaports was 7,321 million tonnes.

In the last 10 years, the total transport of goods in Rijeka seaport has been increased by more than 69%, with an increase of 50% in liquid cargo transport, while the amount of dry cargo transhipped was increased by more than 109%. Main type of goods transhipped in Rijeka seaport include liquid cargo of oil and petroleum products (59% to 68% of total goods transhipped). Amount of transhipped oil in Omisalj oil terminal has grown from 4.6 million tonnes in the 1996 to 5.6 million tonnes in the 1998, and from 4.3 million tonnes in the 2000 to 7 million tonnes in the 2005, when it reached the level of transhipped oil recorded in the 1980s. The fact that the total amount of oil and petroleum products transhipped is approaching levels recorded in the pre-war period (until 1991), suggests that Rijeka seaport once again becomes the main supply port for oil which is transported via the Adriatic pipeline to Croatia and other countries in the hinterland, primarily Hungary.

In the future, it is expected that Rijeka seaport will develop further and become the Adriatic gate of the Pan-European Transport Corridor Vb. In 2010, total container traffic in Rijeka seaport has already amounted to 137,048 TEU units. The development of Rijeka seaport will generate additional input of dangerous goods which are delivered by ships and than transported by road or rail.

However, such transport structure clearly indicates that there is no systemic directing of cargo flows on non-road transport modes at the national level. On the other hand, there is the significant potential of using existing alternative infrastructure capacities on the Pan European corridor routes.

Due to the growing threat of terrorism, protection of dangerous goods during transportation process is set as a top priority. In order to ensure effective protection of cargo, it is necessary to continuously monitor its location, regardless whether the cargo is transported in tank, wagon or intermodal container. Continuous monitoring of cargo can be achieved by application of Intelligent Transport Systems (ITS).

The main goal of research in this paper is to consider the issues of defining the technological model of corridors for the transport of dangerous goods in the Republic of Croatia, with the goal of putting it into operation. To that end, we explore the benefits of introducing and using defined model of corridors with respect to the Croatia geographic position, its maritime orientation and condition of existing infrastructure capacities. The purpose of implementing such a model also arises from the need for the development of optimal, adaptive and agile system which is based on the compatibility of all stakeholders in the transport chain, their interconnectivity and synergism.

Development of technological model of corridors (Figure 1) requires research and thorough analysis of existing capacities, definition of development guidelines, harmonization with international guidelines, identification of various strengths and weaknesses and the study of stimulative development measures.

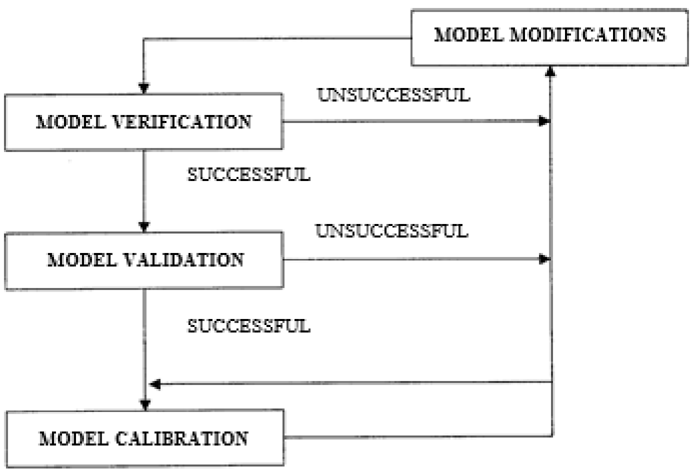

Figure 1 Model verification algorithm.
Source: Made by authors

The main objective of the transportation costs analysis is to find the means for their reduction, since high transport costs prevent the further development of dangerous goods transport. Reduction of transportation costs is based on decrease of external and rationalization of internal costs. Thereby, rationalization depends on technical and organizational measures which may be taken.

Accidents which include dangerous goods can be defined as those accidents that occur because of uncontrolled release of dangerous substances from stationary and mobile objects in such quantities that adversely affect people, property and the environment. The most common causes of accidents with dangerous goods are human error or negligence in operation, improper handling of dangerous goods, disregard for static electricity in technological process, malfunction of facility equipment, improper transport of dangerous goods, traffic accidents and terrorist attacks on facilities.

3. SAFETY REQUIREMENTS IN TRANSPORT SYSTEM

3.1. Traffic Safety

Traffic safety can be defined as a state without exposure to the risk of accident with fatal or serious consequences, and it is estimated by monitoring and analyzing the number and severity of accidents, that is dangers to which traffic participants are exposed during accident occurrence. Developed countries with strong economies have a strong desire and obligation to thoroughly assess and manage risks related to people, property and the environment, which may occur as a direct consequences of noncompliance with the regulations for the transport of dangerous goods. Incidence and risk analysis of undertaking activities related to the transport of dangerous goods should ideally include certain additional elements, but the safety of the transport system and traffic density are undoubtedly the two most important elements to consider.

The aim of this analysis is to indicate the need to determine transport corridors (channeling of transport flows) for the safe transport of dangerous goods. These corridors should then be used for transport of all types of dangerous goods since the risk of accident occurence during transportation process would be minimized [2].

According to the Law on the Transport of Dangerous Goods by Road or Rail (ADR, RID), there are limitations on choice of transport route for certain substances, for example, the law defines the default limits for the tunnels, so that only a small number of existing tunnels (with the exception of newly built) satisfies the categorization for transport of dangerous goods. According to this classification, tunnels are categorized into four groups: B, C, D and E type which indicate certain structural and organizational requirements depending on the type of dangerous goods transported.

3.2. Transport security

Transport security has become particularly important after the terrorist attack in New York, which has shown and proved that the previous protection was insufficient and that the system itself is vulnerable. After that, a whole range of new measures were introduced with the aim to gain complete control of shipments in the dangerous goods transportation process. Security of transport can be considerably increased by application of various ITS solutions, such as satellite tracking of intermodal containers during transport of dangerous goods [3].

The level of safety in the transport process is influenced by three main groups of factors:

- technical and technological factors
- organizational and utility factors
- subjective factors

Man appears in all three groups in the form of a subjective factor because he controls transport entities, produces and maintains them, organizes the transport process and manages entire traffic system.

Traffic accident can be defined as any unanticipated and undesirable event on transport entities or in the traffic environment, which can result in serious injury or death of traffic participants and cause material damage. Most accidents occurs as a result of human error. Accident then causes disorder in a system with three basic elements which include human, transport entity and traffic environment. Human errors occur due to actions of traffic participants who do not know, cannot or will not behave according to the traffic rules and regulations [4].

Based on previous experiences and monitoring of traffic and other types of accidents, it can be concluded that the relation between the two security factors, a man and environment shows the ratio of 80:20%. There is only a small number of accidents that have been caused by higher force, since 98% of accidents can be prevented by human action, and only 2% of accidents cannot be prevented due to unanticipated events (earthquake, flood, lightning, etc.).

Therefore, traffic accident can also be defined as unexpected conflict of man and his environment, which has resulted in injury or death of participants in the traffic process and caused material damage.

The three fundamental factors of traffic safety are:

- man
- transport entity
- traffic infrastructure

3.3. Traits of a man as a factor of traffic safety

The behavior of man as a factor of traffic safety is influenced by:

- human psychophysical characteristics
- personal characteristics of driver (pedestrian)
- level of education and culture

People who use the transport entities and other traffic participants have different abilities, knowledge and skills acquired so they make different judgments and estimates that can cause traffic accidents in situations when they make wrong decisions.

Human abilities can be generally divided into the following three groups:

- abilities of sensory organs
- mental abilities
- psychomotoric skills

Human capabilities are expressed through ability to identify the danger, its reaction time and ability to overcome the perceived danger. The analytical data on the vulnerability of traffic participants clearly indicate that these capabilities are related to age and sex. Based on the analysis of data collected it can be concluded that human error is the main cause for the occurrence of accident in 85% of cases.

Based on further analysis of these data, it becomes clear that these factors can be divided into the following categories:

- abilities
- acquired knowledge
- acquired skills
- wrong decisions and judgments.

Taking into consideration the fact that the percentage of injured persons does not necessarily increase with distance (Figure 2), and that the number of injured persons in accidents with dangerous goods show different trends compared to the other types of traffic accidents, it is therefore necessary to pay special attention when selecting personnel for the transport of dangerous goods.

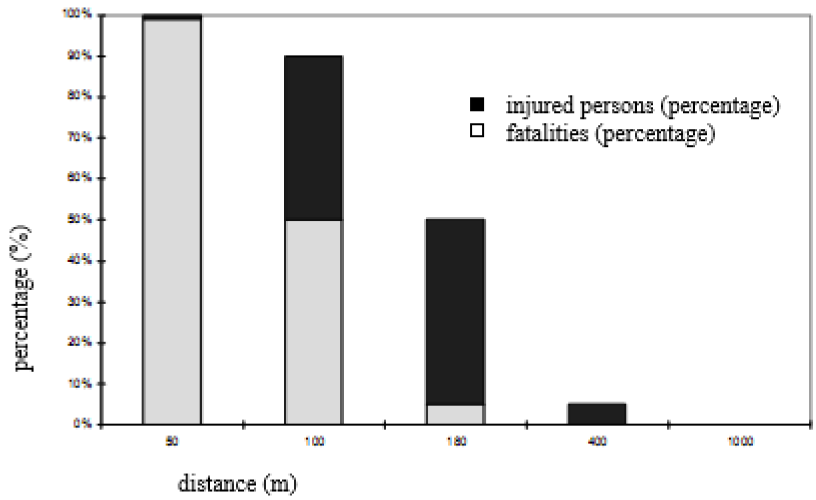

Figure 2 An example of the ratio of injured/killed persons in traffic accidents depending on the distance of travel.

Source: Asociation mondiale de la route, OECD 2007, Safety in tunnels

4. DISCUSSION

During the transport of dangerous goods on the transport route with one or more tunnels, 500 meters or more in length, transport operator is required to obtain approval for passage through the tunnel from the maintenance organization which manages the tunnel. The driver must turn on flashing or rotating lights 50 meters before entrance to the tunnel.

Dangers of transporting dangerous goods by road generally arise due to the poor conditions of the roads. Statistics show that the outcomes of accidents with dangerous goods largely depend on the quality of the tunnel protection systems (Table 1).

Table 1 Data on accidents in tunnels.

Type of fire	Country	Length of tunnel (m)	Date of fire	The cause of the accident	Accident duration (h)	Dangerous goods (class)	Number of fatalities	Number of injured
A	USA	2564	13.5.1949	Dangerous good	4	3	0	0
A	USA	1083	3.4.1974	Defective tires	4	3	0	1
A	Italy	148	1993	Collision	3	3	5	20
B	Austria	6400	29.5.1999	Collision	15	5.2	12	0
B	France	12670	5.5.1993	Engine failure	2	4.1	0	0
B	France	425	11.8.1976	Engine failure	0,45	3	0	5
B	Germany	243	31.8.1969	Defective tires	2	2	0	0
B	Netherlands	1283	13.6.1993	Collision	2	2	0	0
B	Spain	2670	14.8.1975	Defective transmission	3	4.2	0	0
B	USA	1302	1955	Engine failure	6	9	0	0
C	Austria	6719	10.9.1995	Collision	1	4.1	3	0
C	France	11600	24.3.1999	Engine failure	53	3	39	0
C	France	1100	9.9.1986	Collision	5	3	3	5

C	Italy	662	1983	Collision	3	3	9	20
C	Italy	442	1993	Collision	3	5.2	4	4
C	Japan	740	17.4.1980	Collision	2	3	1	0
C	Japan	2046	11.7.1979	Collision	96	9	7	3
C	Japan	459	15.7.1980	Collision	3	4.1	5	5
C	Netherlands	753	11.8.1978	Collision	2	4.1	6	6
C	Africa	4000	27.2.1994	Defective transmission	1	5.2	1	28
C	Switzerland	343	1987	Collision	2	9	2	3

Source: Asociation mondiale de la route, OECD 2001, Safety in tunnels

If we add the fact that road transport is the most expensive form of transportation (eg, compared with rail freight transport, energy consumption in road transport is 9 times higher, and that the share of harmful substances emissions is almost 100% higher), transport of dangerous goods by rail imposes itself as the best, cheapest, and safest solution according to the International Union of Railways (UIC)"[5].

Some of the measures that should certainly be implemented in designing and organization of dangerous goods transport are shown in Table 2.

Table 2 Measures for reducing the risk classified by main purpose.

Measures for reducing the probability of accidents with dangerous goods		
Tunnel with merging/diverging areas for vehicle exclusion	Lighting	Tunnel and paving maintenance
Related to traffic and vehicles		
Speed limit, overtaking prohibition	Vehicle escort, distance between vehicles	Vehicle roadworthiness
Measures for reducing accident consequences		
Alarm, informing, coordination of operators and emergency services		
Automatic detection of accidents, video surveillance	Fire alert, radio communication	Automatic Vehicle Identification, sos phone
Communication with traffic participants		
The phone in case of an accident, radio link between the users	Signs of of danger	Loudspeaker system
Evacuation or user protection		
Emergency exits, smoke detectors	Emergency Lights, fire equipment	Evacuation and rescue protocol
Safety precautions		
Fire equipment, rescue teams	Drainage, impermeable pavement surfacing	Action plan in case of an accident, Vehicle escort
Safety Precautions in tunnel construction		
Fireproof structure	Explosion-resistant and collapse-resistant structures	

Source: Asociation mondiale de la route, OECD 2001, Safety in tunnels

The concentration of traffic, is a term that encompasses the density of traffic flow that is occupancy of road lanes and it is defined as the number of traffic entities that are currently located on the observed length of the road, or network element. The changes in concentration of traffic are determined by the intensity and variation of traffic flows, transportation speed and traffic management systems.

Estimation of traffic density can be difficult and time consuming task. Since the current method only allows conduction of superficial and rapid assessments of available data which is often limited, it is proposed to conduct detailed traffic analysis only on corridor sections which affect the level of public risk.

5. CONCLUSION

Each modification of the transport system (such as the building of new infrastructure, the introduction of a control system, etc.) needs to achieve a specific goal in a particular area. These modifications can be achieved in different ways.

Transport security gained particular importance after the terrorist attack in New York, which has shown and proved that the previous protection was insufficient and that the system itself is vulnerable. After that, a whole range of new measures were introduced with the aim to gain complete control of shipments in the dangerous goods transportation process. Security of transport can be considerably increased by application of various ITS solutions, such as satellite tracking of intermodal containers during transport of dangerous goods.

Measures for reducing the risk (Table 2.) are only part of the guidelines for increasing traffic safety in the transportation of dangerous goods. Since the transport of dangerous goods is a complex task it also requires simultaneous coordination of the legal basis with the tests results and current situation analysis.

The development of different strategies for the future transport system poses a demanding and difficult task for traffic experts. Different variants arise as a result of various predictions and assumptions for variables that determine the characteristics of the transport system. Each of the measures applied to the transport system has a different qualitative and quantitative impact on the target function and the observed criteria [6].

Some of the measures are already elaborated through the research of other authors and offer concrete real-time solutions. "In the search for possible software solutions for the exact determination of the required parameters with specific data in real time and space, in order to ensure the effective functioning of transport system in emergency conditions, the analysis of the possibility of the unmanned aircraft usage was conducted together with a comparative analysis of the road, rail and maritime transport"[7].

This paper analyzes the initial hypotheses of setting up the model of corridors in operational level. Model of corridors is a simplified representation of the real world that contains all the relevant characteristics of the analyzed problem. Models must represent the characteristics of the analyzed system in a way that is understandable and easy to handle. On the other hand, model must also have sufficient level of detail to give satisfactory results. Model needs to include all the features that are relevant for problem solving. Depending on the structure of the model it is possible to perform different classifications (analog, symbolic, mathematical). The most accurate description of the process in the observed traffic system can be obtained by detailed specification of his relevant characteristics. However, in real conditions this level of detail is almost or nearly impossible to achieve, so it is necessary to introduce certain simplifications and limitations. From the data analysed, it can be concluded that the greatest attention should be given to the harmonization of technical and organizational aspects which will then result in increased safety and efficient functioning of the transport system.

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ORGANISATION OF DEMAND-RESPONSIVE TRANSIT

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ABSTRACT
Over the last decade Demand-Responsive Transport (DRT) services have grown in popularity for several reasons including: the shortcomings of conventional regular bus and taxi services; shortcomings of special transport services; and new developments in community transport. Traditional dial-a-ride services have often been criticised because of their relatively high cost of provision, their lack of flexibility in route planning and their inability to manage high demand. The potential for overcoming these limitations may be realised through the introduction of telematics-based DRT and this has been widely demonstrated, for example, in recent research funded by the European Commission (SAMPO and SAMPLUS projects). Telematics based DRT systems are organised via Travel Dispatch Centers (TDCs) using booking and reservation systems which assign passengers to vehicles and optimise the routes. The aim this paper is to explain the concept and organization of the DRT system, and to analyze best practices of the implementation in European cities.

KEYWORDS
Demand-Responsive Transit, DRT concept, Implemented schemes, Telematics based systems

ORGANIZACIJA PRIJEVOZA PO POZIVU

SAŽETAK
Tijekom posljednjeg desetljeća usluge prijevoza po pozivu (DRT) razvile su se iz više razloga, uključujući: nedostatke konvencionalnih autobusnih i taksi usluga, nedostatke posebnih usluga prijevoza i zbog novih kretanja u razvoju prijevoza. Tradicionalne usluge prijevoza po pozivu često su bile kritizirane zbog relativno visokih cijena prijevoza, nedostatka fleksibilnosti u planiranju ruta i njihove nemogućnosti upravljanja velikom prijevoznom potražnjom. Potencijal za prevladavanje tih ograničenja može se realizirati kroz uvođenje telematički orijentiranih DRT sustava, što je pokazalo nedavno istraživanje financirano od strane Europske komisije (SAMPO i SAMPLUS projekti). Telematički orijentirani DRT sustavi su organizirani putem dispečerskih centara (TDCs) koji koristeći rezervaciju u sustavu dodjeljuju putnike vozilima te na taj način optimiziraju rute. Cilj rada je pojasniti koncepciju i organizaciju DRT sustava, te analizirati najbolje primjere u europskoj praksi.

KLJUČNE RIJEČI
Prijevoz po pozivu, DRT koncept, Primjeri implementacije DRT-a, Telematički sustavi

1. INTRODUCTION

Demand-Responsive Transit (DRT), Demand Responsive Transport, Demand Responsive Service or Dial-a-ride or Flexible Transport Services is "an advanced, user-oriented form of public transport characterised by flexible routing and scheduling of small/medium vehicles operating in shared-ride mode between pick-up and drop-off locations according to passengers needs" [1].

Demand Response Transit Service is comprised of vehicles operating in response to calls from passengers or their agents to the transit operator, who then dispatches a vehicle to pick up the passengers and transport them to their destinations. A demand response operation is characterized by the following: (a) The vehicles do not operate over a fixed route or on a fixed schedule except, perhaps, on a temporary basis to satisfy a special need; and (b) typically, the vehicle may be dispatched to pick up several passengers at different pick-up points before taking them to their respective destinations and may even be interrupted en route to these destinations to pick up other passengers. In many areas DRT is instead known as DART, or Dial-a-Ride Transit [2].

DRT systems provide a public transport service in rural areas or areas of low passenger demand, where a regular bus service may not be as viable, and/or for disabled passengers. As such, DRT schemes for may be fully or partially funded by the local transit authority, as providers of socially necessary transport. As such, operators of DRT schemes may be selected by public tendering. Other schemes may be partially or fully self-funded as community centered not for profit social enterprises (such as a Community interest company in the UK).

DRT schemes may also be provided by private companies for commercial reasons; some conventional bus operating companies have set up DRT style airport bus services, which compete with larger private hire airport shuttle companies [3].

2. DRT BACKGROUND

Societal factors such as ageing communities, protection of the environment, problems associated with social isolation, increased need for access and mobility and regional economic growth are affecting thinking about public transport worldwide [4]. New challenges for public transport administrators and service providers include maintaining the quality of life and economic sustainability of outer urban and regional areas, making traditional public transport relevant to people’s needs, addressing regulatory restrictions that impede responsiveness to community needs, changing the culture of public transportation organisations to embrace change, improving the quality of customer service on public transportation and more effectively using technology to maximise efficiency and market penetration [5]. DRT system have been identified as being an important element in future public transport systems in low density cities [6].

There is growing pressure for higher levels of service from transport systems in urban areas as congestion levels rise and fuel prices continue to increase. Cars offer flexibility and convenience but are costly, inefficient due to their effect on road congestion and their need for parking space. Cars also create substantial environmental problems due to emissions and fuel consumption and create social problems in terms of road safety. Buses, trams and trainstend to operate to fixed schedules that are often infrequent, and on fixed routes that frequently do not match the traveler's route. Trams and trains require also extensive purpose, specific infrastructure that is expensive to build and maintain and usually not available in low density urban areas. Taxis are expensive for the user and may not be available when required. DRT system have the potential to the address these problems. They reduce the dependency on private cars, can operate without schedules and by flexibly choosing routes, share existing infrastructure, and since they offer shared transport their fares should be cheap.

DRT exist in many cities; however, these often involve fixed origins or destinations, or fixed routes, or some form of pre-booking. In this paper we will process DRT service concepts, their strategy objectives and review several examples implemented in European cities.

3. DRT SERVICE CONCEPTS

As mentioned above, the distinction between DRT and conventional public transport is the distinction between the levels of personalisation in the service provided. Buses tend to operate a fixed route specified in advance while DRT services tend to provide close to door-to-door taxi like services. However this is not the only facet of flexibility as the following diagram in Figure 1 shows.

Figure 1 The Demand Responsiveness of Public Transport
Source: Brake J., Mulley C., Nelson J.D., Wright S.: Key lessons learned from recent experience with Flexible Transport Services, Transport Policy, 2007.

This has therefore led to the usage of the more general term Flexible Transport Services (FTS) [7]. In the spectrum of flexibility, DRT is only one category of FTS. Other FTS include community and special needs transport as well as car sharing and car pooling schemes.

FTS is a subcategory refers to as “purpose driven Public Transport” [8]. To underscore this point and point out that flexible transport is designed to be flexible, integrated and customer centric. The focus is on the customer (i.e. personalised transport).

DRT can also be classified into its variants and service offerings [9]:

- Routing
- Timing
- Vehicle Assignment

3.1. Routing

With regard to the categorisation of the routings of DRT services, the following definitions are in common use [10]:

- Many to One: This routing pattern involves a vehicle picking up individual passengers from locations specified by them (perhaps their home), and taking them to a single destination – with the vehicle arriving either in accordance with a published timetable, or within a time window. This has the focus on bringing people to a fixed point (e.g. a bus or rail interchange or even a park and ride site);
- **One to Many:** This is a routing pattern where passengers are picked up from a fixed boarding point and taken to disparate destinations, on demand;
- **Many to Many:** This is the routing which allows the service to pick up passengers from various locations, on demand, and taking them to disparate destinations (within a defined geographical area of operation), again on demand.

Some authors introduced some definitions regarding DRT operations which can be thought of as an “evolution” or growth model for DRT operations [11]:

- **Interchange DRT:** DRT for the purpose of providing feeder links to conventional public transport;
- **Network DRT:** As part of an overall network of public transport service provision, DRT services are operated only at particular times or in particular routes or both;
- **Destination Specific DRT:** Similar to Interchange DRT but could encompass particular destinations such as airports, employment locations, health, shopping, social and leisure destinations;
- **Substitute DRT:** DRT replaces conventional public transport.

At one end of the spectrum, DRT services can be fully flexible very much like a conventional taxi service. However, in practice, DRT services tend to follow a fixed route with deviations as requested by the passengers.

3.2. Timing

A further level of flexibility can be achieved by adapting the timing of the offered service. The main options include:

- Advancing or delaying the departure time for the service;
- Pick-up or set-down at a time specified by the user;
- Adjusting the timing to meet/wait for another transport service for transfers;
- Choosing whether or not to operate a specific trip;
- Time period for switching between conventional and DRT operating mode.

3.3. Vehicle Assignment

The vehicle assigned to carry out the trip can be altered for cost, operational or facilities reasons. The main options include:

- Upsizing/downsizing vehicles to match the expected number of passengers on the outbound or return trip;
- Assigning a smaller or more robust vehicle when required to operate on smaller roads (e.g. in rural areas) or in traffic-calmed areas;
- Assigning a more appropriate vehicle/driver if the handling of packages/documents is offered as part of the service;
- Where there are very few passengers for the planned trip, pass the work to a taxi firm and do not operate the (mini) bus trip.

4. DRT STRATEGY OBJECTIVES

In developing the objectives it has been kept in mind that transport is generally a means to an end. Better transport is desirable because of the consequential benefits it brings, such as better access to employment, education and health care and more efficient business travel.

Each of this strategy's objectives relate to road based passenger transport, which encompasses commercial and subsidised scheduled DRT services. They reflect and nest within the RTS overarching objectives, as follows [12]:

- **Economy**
  - To ensure that key employment, education, retail and tourism locations are linked to the passenger transport network by a service that meets the needs of the local economy;
  - To achieve improvements in journey times and the reliability of the region's road based passenger transport network.
- **Accessibility**
  - To ensure that everyone across the region has access to a key regional centre, where they can access a range of services, facilities and opportunities;

  - To remove physical, financial and perceptual barriers to accessing road based passenger transport services and infrastructure;
  - To enable patients and visitors to access necessary health facilities by road based passenger transport;
  - To ensure a level of information provision across the whole road based passenger transport network that promotes its use and does not hinder accessibility.
- **The Environment**
  - To enhance the environmental standards of the road based passenger transport fleet and infrastructure;
  - To achieve greater use of road based passenger transport services in place of travel by private car.
- **Health and Well-Being**
  - To increase physical activity and improve access to leisure opportunities across the region by road based passenger transport.
- **Safety & Security**
  - To provide for and improve the safety of passengers when travelling on the road based passenger transport network.
- **Integration**
  - To increase connectivity between road based passenger transport services and between different modes of transport;
  - To strengthen the links between land-use planning and provision of road based passenger transport.

5. ORGANISATION AND TECHNOLOGY OF DRT SERVICES

As Figure 1 shows, the routes of conventional public transport are fixed in advance through standard scheduling methods. The type of vehicle and the number of drivers required to operate the service is well known ahead of time. However, in the case of DRT services, the entire process is different as shown in Figure 2.

The user of the service telephones into a dispatching centre to book a journey (the time limit for bookings varies considerably). Historically, the primary method of booking the DRT service was via the telephone [13]. Using advances in transport telematics, it is possible also to book journeys via the internet and short messaging service (mobile phone sms) [14].

Booked journeys are assigned, via dispatching systems which are very similar to those for private hire vehicle services except that vehicles are usually shared with other passengers. The vehicle type used for the journey may not be decided until the service is operated, although some small schemes may only have access to one or two minibuses, or for a community scheme run by volunteers, drivers own personal cars. Stops are usually determined only at the passenger’s request.

In the simplest DRT systems, scheduling (the process of assigning vehicles to each run and drivers to vehicles) may be done manually by assigning vehicles to collect passengers [11].

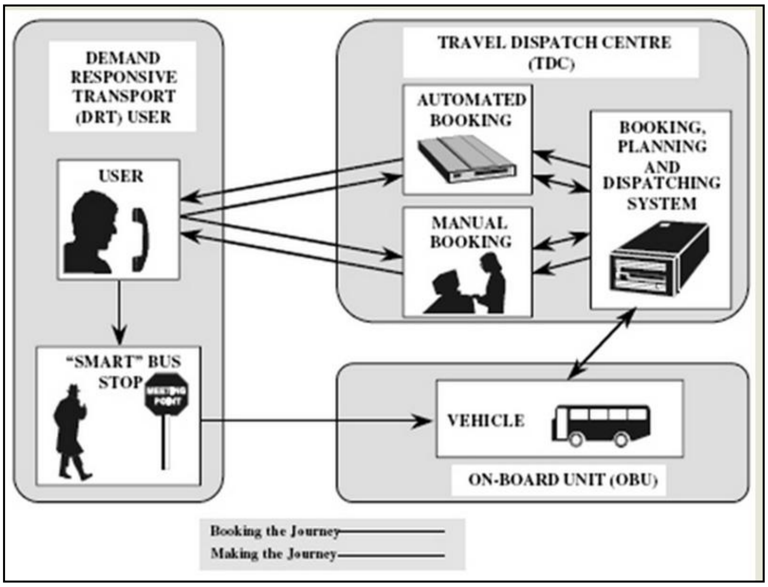

Figure 2 Illustration of DRT Service and Operation
Source: Mageean J., Nelson J.D.: The evaluation of demand responsive transport services in Europe, Journal of Transport Geography, 2003.

In more comprehensive operations computerised scheduling systems are employed. The issue of technology using the concept of transport telematics has been discussed in prior research [15]. Various research program funded by the European Commission SAMPLUS (1999), FAMS INVETE (2002), CIVITAS Caravel Project (2005) marked the transition of DRT to its second phase. In this second phase, it was demonstrated that the application of the field of transport telematics to DRT was possible.

The main components of the Telematics based DRT system are:

1. Travel Dispatch Centers (TDCs)
2. Devices for users to access the DRT system
3. On-board units
4. The communications network

Telematics based DRT systems are organised via TDCs using booking and reservation systems which assign passengers to vehicles and optimise the routes. Automated Vehicle Locationing (AVL) systems provide real-time information on the status and location of the fleet for the route optimising software.

The evidence suggests that technology can make the task of dispatching vehicles and coordination much smoother and increase the reliability of the service. However, the cost of technology may be prohibitive especially for initial operation.

6. EXISTING DRT SCHEMES IN EUROPEAN CITIES

During the last few years Demand Responsive Transport (DRT) services have shown important advantages and benefits in several European countries, cities and regions. These services are complimentary to conventional, scheduled passenger transport serving dispersed mobility needs, low demand hours or areas of low population.

In some cases there may be a default route with variations applied as required. In other cases the service may be determined entirely from the specific demand for that trip. It is important to remember that the characteristics of both DRT and conventional transport services vary dramatically depending on whether the location is urban, per-urban or rural in nature.

In the following subsections we will process two European cities that have developed DRT system. The two criteria for cities selection in this paper are:

- participation in CIVITAS Caravel project
- developed DRT bus system.

DRT has at least one degree of freedom within any specific trip. This allows the dispatch centre or the operator to alter the service offer in response to the actual demand.

6.1. DRT scheme in Genoa

A classic example of demand-responsive transit (DRT), AMT's Drin Bus is a flexible bus service that connects the hilly, low-density areas of Genoa through a "many to many" (pickup/drop-off points) operational model. Riders can reserve the bus up to 30 minutes prior to their desired departure time via telephone, or catch it "on the road" if the bus has room. GPS-GIS integrated bus-monitoring software allows a central call center to manage the bus fleet dynamically according to demand.

Since its implementation in April 2002, the percentage of residents in the Drin Bus served areas who use their cars everyday has dropped 4%, and the number of people who never use a car has increased 13%. Drin Bus ridership has been increasing by 5-13% per year in different neighborhoods [16]. In 2004, Drin Bus expanded to serve the Bolzaneto area, replacing two existing bus lines and extending the service area previously covered by the traditional bus routes.

Data from the first several years of operation show that the operating costs of the Drin Bus service are similar to previous traditional fixed-route bus services, but the Drin Bus has an increased number of passengers and revenue. Additionally, environmental cost/benefit analyses of the Drin Bus program indicate an estimated savings of €34,500 per year due to decreased environmental impact [16].

Genoa's public transport company AMT operates the Drin Bus service with a fleet of Mercedes Sprinter minibuses, which seat 8-13 passengers and run on low-emissions methane. GPS-GIS integration allows the call centers to monitor buses on the road and helps bus drivers keep track of their scheduled routes. The call centers are connected with the buses through GSM digital telecommunication technology.

Bus stops are an average of 200m apart. The call to make a reservation is free, and Drin Bus honors Genoa public transportation passes, with a minimal supplemental charge. Drin Bus service is available Monday through Saturday from 6 AM to 8 PM. Customers requesting the service in advance may choose their time of departure and arrival.

The CIVITAS Caravel Project (2005-2009) is currently working on software upgrades for the Drin Bus system, which will add new booking capabilities and include an interactive voice recognition system.

As a form of public transportation, Drin Bus could easily be incorporated into personal navigation software (such as Trekker and Navitime) that allows users to plan multimodal trips. Drin Bus can be used by navigation software in several ways:

- Navigation devices can incorporate the flexibility of Drin Bus into trip planning made in advance, allowing riders to request pickup at times tailored to a multimodal trip involving other fixed-schedule transport;
- GPS location information sent by the buses (and shared by the Drin Bus control centers) would allow personal navigation devices to alert travelers if a Drin Bus is nearby and can be caught "on the road;"
- Real-time traffic information monitoring capabilities offered by pedestrian navigation devices would allow riders to track Drin Bus efficiency and change or cancel reservations in the case of unexpected traffic or delays;
- Navigational software for mobile phones could allow riders to use the above information from anywhere in the city and immediately schedule or cancel a ride with the Drin Bus call center.

As a public transportation system with on-board GPS and communications technology, Drin Bus could potentially be used as a fleet of mobile traffic monitoring devices. Over the past several years, mobile phone companies such as Nokia and Vodafone have been researching ways to use mobile phones in cars for traffic monitoring in place of more expensive and maintenance-intensive fixed traffic cameras and speed sensors. One major problem such traffic monitoring programs are actively researching is phone owner privacy/anonymity. Since Drin Buses are public vehicles whose locations are monitored routinely in the interest of providing efficient service, they already have the infrastructure to provide traffic information without having to address privacy concerns. Obviously, Drin Buses are limited in number and cannot provide full traffic coverage, but it may be possible to use Drin Bus monitoring technology in coordination with GPS/communications retrofits for fixed-route buses, taxis, and other municipal or commercial vehicles to form a network of mobile traffic monitors without needing to rely heavily on private mobile phones.

6.2. DRT scheme in Krakow

In 2005 with the start of the CIVITAS Caravel Project Krakow decided to implement innovative, flexible public transport based on the experience of Genoa's Drin Bus. The main objective of demand-responsive transit (DRT) in Krakow was to better serve passengers by giving them more personalised service that could be adjusted to their actual needs regarding journey time and destination, and without generating significant costs for the service launch and daily operation. According to assumptions, the DRT service could replace conventional public transport in low density areas where regular service is inefficient.

The DRT service in Krakow, called Tele-Bus, was launched in July 2007 after the transfer of technology and know-how from Genoa to Krakow. The preparation of the service operating design, adaptation of the software for managing flexible service, and staff training were all conducted in collaboration of Polish and Italian CARAVEL project partners.

Tele-Bus is "many to many" public transport service with fixed stop points and flexible routes and timetables. It operates every day in the southeastern part of the city and during defined operating hours. The service is carried out by the local public transport operator Miejskie Przedsierbiorstwo Komunikacyjne SA on the basis of a service contract with the Public Road and Transport Authority (PT&RA). The operator is paid on the basis of vehicle-kilometers delivered. Daily operating costs include: personnel (dispatchers and Tele-bus drivers) and vehicle maintenance.

The service covers three districts: Rybitwy, Podwierzbie and a part of Biezanów. This area consists of residential and industrial zones of low population density. Conventional service here is not efficient and runs infrequently. A main goal of the DRT service is to make it easier for inhabitants to reach communication junctions where changes to other lines are possible.

Since mid-July 2007, the Tele-bus service has been developing and the number of transported passengers has been gradually increasing, starting with about 300 passengers in July and August 2007 and exceeding 2,000 in January 2008 [17]. The pilot phase will allow all the involved actors to evaluate the impact and the functionality of the flexible service with a view to future development of DRT in the city of Krakow.

The launch of the Tele-bus service in Krakow was based on technology and know-how transfer from Genoa. This kind of public transport flexible service with different target groups (e.g. people with reduced mobility, students travelling to schools, etc.) is successful in many European countries. The key factors for the DRT service success are the following:

- Definition of the objectives of the service implementation;
- A good choice of the service availability area;
- Implementation of DRT technology;
- Clear regulations between involved public transport actors and a corporate image of the service, that distinguishes it from regular public transport.

7. CONCLUSION

Flexible public transportation that responds to demand (DRT) can save money and emissions over fixed-route systems. At the same time, DRT services are capable of serving a wider geographic area, thus contributing to the social inclusiveness of a region by making inexpensive public transportation (and therefore urban conveniences and opportunities) available to underprivileged or mobility-challenged social groups in low-density areas.

DRT is any kind of transport whose day-to-day service provision is determined by the demand of its users. The system can work in different ways but most commonly is carried out as follows: the customer rings up the booking service from their location and can be picked up at the same place as soon as availability allows. The bus, taxi etc. then takes them to wherever they want to go - in essence the system has made it possible to respond more directly to the mobility requirements of the individual passenger. In many cases this is not always the quickest or cheapest way to travel but it is often the most convenient for the type of passenger the scheme is aimed, elderly and people with mobility problems.

While DRT services offer cost savings, social inclusion, and environmental benefits, however, they require a sophisticated and adaptive management structure as well as a tight communications system connecting the dispatch centers, buses, and numerous bus stations. Regional transportation authorities interested in starting a DRT program should expect a learning period after implementation, during which data from customer feedback and real-time bus monitoring can be incorporated into the program management structure. The European Union CIVITAS Initiative (which was formed to improve transportation in European cities) suggests that new DRT programs focus their attention on communication and marketing. As an example, they recommend that new DRT programs include a free test period during which the public can be encouraged to get to know the new service while data is being collected to customize the service to the specific region.

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ERGONOMIC ASSESSMENT OF ACCESSIBILITY OF THE PASSENGERS' SPACE IN TRAMS IN ZAGREB

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ABSTRACT: This paper presents the ergonomic assessment of accessibility of passengers' space within the general population of travelers for all series and models of ZET (Zagreb electrical tram), and it analyzed the average age of the individual series of trams. Accessibility to the doors has been analyzed concerning the passengers, when entering and exiting the tram. Special attention was paid to the accessibility of passengers' space for persons with disabilities (persons with hearing impairment, persons with visual impairment, persons with physical impairment), as well as special categories of passengers (mothers with young children, the elderly). Ergonomic evaluation was carried out according to the principle of accessibility of the CRPD on the Rights of Persons with Disabilities, which was ratified by Croatia in 2007. Major unconformity and inaccessibility of all researched series of trams in Zagreb, including a new model of TMK 2200, is an example of a lack of implementation of the UN Convention on the Rights of Persons with Disabilities; in Croatia, but also the aggravating circumstances that Croatian Law of implementation guidelines of the CRPD is transferred to the local and regional governments. The paper has demonstrated the necessity of detailed studies of user needs and the need of implementation of research results into an executive legislation.

KEY WORDS: trams, passengers' space, accessibility, persons with disabilities, universal design

ERGONOMSKA PROSUDBA PRISTUPAČNOSTI PUTNIČKIH PROSTORA U TRAMVAJIMA U GRADU ZAGREBU

SAŽETAK: U radu je prezentirana ergoprosudba prostorne pristupačnosti putničkih prostora što široj populaciji putnika za sve serije i modele tramvaja operatera ZET (Zagrebački električni tramvaj), te je analizirana prosječna starost pojedinih serija tramvaja. Analizirana je i pristupačnost vratima tijekom manipulacije ulaska putnika u tramvaje i izlaska putnika iz tramvaja. Posebna pažnja posvećena je pristupačnosti prostora osobama s invaliditetom (osobe s oštećenjima sluha, osobe s oštećenjima vida, osobe s tjelesnim invaliditetom), ali i posebnim kategorijama putnika (majke s malom djecom, starije osobe). Ergonomska procjena izvršena je prema načelu pristupačnosti iz Konvencije UN-a o pravima osoba s invaliditetom koju je RH ratificirala 2007. Vrlo velika neprilagođenost i nepristupačnost za sve istraživane serije tramvaja u Gradu Zagrebu, uključujući i novi model tramvaja TMK 2200, primjer je neprovođenja Konvencije o pravima osoba s invaliditetom u RH, ali i otegotnih okolnosti da je zakonom RH implementacija smjernica Konvencije prepuštena lokalnoj zajednici. U radu je dokazana nužnost detaljnih istraživanja potreba korisnika i potreba implementacije rezultata istraživanja u izvršnu zakonsku regulativu.

KLJUČNE RIJEČI: tramvaji, putnički prostori, prostorna pristupačnost, ljudi s invaliditetom, univerzalni dizajn

1. INTRODUCTION

On a concrete example of public passengers transport of ZET (Zagreb electrical tram) is examined whether a sufficient extent is implemented globally and accepted guidelines for suitability and accessibility of passenger space for persons with disabilities (hearing impairment, visual impairment, motor impairment) or special categories of passengers (mothers with young children, the elderly).

The rights of persons with disabilities in Croatia were established by the CRPD (Convention on the Rights of Persons with Disabilities) [1] which was signed by Croatia on 30th March 2007. and on the 15th of August accessed. In its provisions, CRPD's taking into account the needs of persons with disabilities, warrants, but also obliges signatory states to implement basic human rights such as: equality, non-discrimination, personal freedom, freedom of movement, the right to education, access to information, access, and many other rights that are provided to all persons regardless of their special needs. Furthermore, the Convention guarantees: special attention to women with disabilities, raising awareness of the society about persons with disabilities and their capabilities, ensuring mobility in public transport, in buildings owned by the state and their adaptation to the conditions of life;of in general. The aim of the Convention is full social inclusion of persons with disabilities, focused on empowering persons with disabilities, and increasing accountability of society concerning persons with disabilities. Also, domestic legal regulation is harmonized with the CRPD and the most important is Constitution of the Republic of Croatia [2], which emphasizes the need of special care for persons with disabilities, and their involvement in community life. Croatian Government adopted the National Strategy of Equalization of Opportunities for Persons with Disabilities from 2007 to 2015. (hereinafter: the National Strategy) [3]. Mobility, accessibility and transportation are indispensable factors for inclusion of persons with disabilities in every day activities. Article nb. 9. of the CRPD [1] provides the obligation of all states (parties) to take measures to ensure accessibility for persons with disabilities and to take easier implementation measures and become more independent and participate in all aspects of life. The CRPD provides equal access to environment [1], and as a basic regulatory framework in Croatia according to [4] the Regulations on Accessibility for persons with disabilities and people with reduced mobility [5]. However, effect is not identified as an implementation deficit, but it is suggested (who) to Regulation [5] included in the analysis of compliance with the legislation adopted by the Convention [1], and where necessary; guide to all the elements of access to physical environment. National Strategy [3] proposes consideration of competitiveness between the Regulations [5] and other laws and regulations governing accessibility within the sector areas such as education, culture, social policy, transport, etc. Furthermore, Article 9 of the Convention [1] focuses on removing barriers to accessibility within the public and private sectors and the creation of the previously mentioned national plans for adaptation to transparent targets. However, in a report on the implementation of the National Strategy [6], the following measures that influence the removal of obstacles and lacking overall review of the effect of the same in a domestic legal regulations. Report on the Implementation of the National Strategy of Equalization of Opportunities for Persons with Disabilities [6] emphasizes the importance of the process of structural adjustments in certain sectors such as education, but repeatedly absent data on the jurisdiction of the ministries. But an even greater obstacle or problem is that the report [6] highlights an overview of the units of local (regional) government (hereinafter JL(R)S).

Due to the research, which is focused on an ergonomic evaluation of factors and conditions of passengers transport in ZET (Zagreb electircal tram), and the Implementation of global guidelines for suitability and accessibility of passengers' space, there will be the results of ergonomic assessement; presented with concrete guidelines for analysis, when it comes to persons with disabilities (hearing impairment, visual impairment, motor impairment).

2. ACCESSIBILITY

According to Španić [7] the result of applying technical solutions in the design and construction of buildings, where persons with disabilities and reduced mobility are provided to the access, movement, residence and work in mentioned buildings on the same level as other persons. Accessibility to the public transport [7] implies an independent movement of persons with disabilities and reduced mobility, and make the following factors: position, platform, parking space, public space, pedestrian crossing, pedestrian etc.

During the public transport; when transporting the passengers; it is necessary to ensure accessibility and space of trams, so these special groups could use them, and one should take into account the following physical barriers according to Haničar and Spanic. [8]: vertical, horizontal, ergonomic, anthropometric and sensory.

Vertical barriers, show differences in altitude, which should not be larger than 2 cm, for example, for unrestricted movement of persons in a wheelchair. [8] Horizontal barriers prevent entry and safe movement in objects. Minimum clear width of the door (90 cm wide) doesn't allow safe passage to all the passengers [8]. Barriers prevent or hinder smooth and free use of equipment and items for daily life, which is not in accordance with the guidelines for ergonomic design of space and objects, taking into account human capabilities and limitations [8].

Anthropometric obstacles appear when the environment isn't designed on a human scale, and for that reason it is important to take account of the anthropometric adaptation to target the entire population of users when it comes to any kind of planning, development or design [8]. According to the instructions provided by Kroemer and Grandjean [9] 5% of the tallest and 5% of the shortest individuals of the entire population of respondents should be excluded (in the physical dimension to which the analysis applies). During the 2013 there have been investigated ranges of anthropomeasures of the 90% of the entire male-female population of tram drivers in Zagreb [10,11], the male population of drivers of trams in Sarajevo [12], and for Anthropomeasures essential for driver's cabs and control panels. There had also been compared driver's cabs in the latest models of trams NT 2200 in Zagreb (Croatia) and SATRA II in Sarajevo (Bosnia and Herzegovina) domestic producers, and has studied anthropometric suitability control panels for the central 90% of the entire population of drivers [13]. However, the authors are not available with the results of measurements of characteristic anthropomeasures at random and sufficient sample from the entire population of passengers in Zagreb, as well as the population of passengers with disabilities. In the absence of results, recent anthropometric measurements of the 90% of the entire population of users of public transport; it is desirable to use globally applicable guidelines of the scientific and technical literature.

Sensory barriers occur when during the planning and construction of facilities it's not taken into account the requirements and needs of persons with visual impairment and persons with hearing impairment, for it is important to plan in such a way that all information should be available through at least two senses, namely: vision, hearing or touch [8], in this case we are talking about equal access to information. Regarding to the work examined barriers; faced by persons with disabilities, but in other groups, such as mothers with young children and the elderly, and taking into consideration guidelines for ensuring accessibility. This study aims to examine the implementation of the conditions of accessibility to the public transport for the transport of the ZET (Zagreb electrical tram).

3. SURVEY OBJECTIVE

The aim of this ergonomic assessment on a concrete example of public passengers transport of the ZET (Zagreb electrical tram) is to verify guidelines for suitability and accessibility of passenger space for persons with disabilities (hearing impairment, visual impairment, motor impairment) or special categories of passengers (mothers with young children, the elderly), and the following provisions of the passenger compartment:

A) Entrance/Exit in the passengers compartments on trams (vertical barriers, horizontal barriers, access to information)
B) Tram interior (access to information, horizontal barriers, ergonomic barriers, anthropometric barriers)

The average tram age by the tram type, has been presented and explored; the most important factor of the thermal comfort of work and passenger space that can become a factor of a workload (air-conditioned space), and points out the barriers that exist in the passenger areas of trams, not only in the older models of trams, but in significant volume in the new low-floor tram models NT 2200 and NT 2300 (manufacturer: Crotram). Applicable contribution to this research is contained in the proposals of possible solutions to the identified barriers in the form of guidelines for human environment.

4. THE AVERAGE AGE OF THE TRAM AND BASIC PARAMETERS OF THERMAL COMFORTABLE SENSATION

Table 1 The average age of the trams and basic parameters of comfort of working and passenger space in trams in ZET (Zagreb electrical tram)

Tram model: manufacturer:	nb.	The average age (year)	Air conditioned		Passengers		
			Passengers space	Cabin	Sitting	Standin g	Σ
TMK 2100: TŽV Gredelj	16	14,71	NO**	YES	46	197	243
NT 2200: Crotram	140	6,05	YES	YES	48	154	202
NT 2300: Crotram	2	3,85	YES	YES			
TMK 201* + trailer TP 591: Đuro Đaković	12 + 13	39,56 + 41,09	NO	NO	20	97	117
Articulated TMK 301 i 354 (KT4): ČKD Praha	51	27,96	NO	YES	25	136	161
60 kom TMK 401* (T4) + trailer TP 801 (B4): ČKD Praha	54 + 50	34,45 + 35,67	NO	NO	20	100	120

*Note: * for trams that are not MPVs; trailers are not analyzed (TP)*
*Note: ** ventilation only*
Source: Internal data operator ZET, 7th of July, Zagreb

The striking fact is that in the year 2014 in Zagreb certain types of ZET (Zagreb electrical tram) trams operate without air-conditioned cabines and without air-conditioned passengers space, which will contribute to the feeling of thermal discomfort of passengers, but also increase the subjective feeling of working over-load of drivers; with possible consequences on security and reliability of traffic. According Kroemer and Grandjean [9] subjective feeling of thermal comfort is defined by the following climate factors that determine the heat exchanger (which can in a larger scope, of course; accept the temperature of surfaces and objects in space; can be controlled by a quality air -conditioning):

- air temperature in the environment (in winter ranging from 20 to 21 °C, in summer, the optimum range from 20 to 24 °C),
- temperature of objects and surfaces in space (ideal would be: the same temperature as in the space, the largest endorsing difference must not exceed from 2 to 3 ° C, and none of the area; such as: outer glass in passengers areas, should not be colder than the air in the space (of 3 °C), mentioned above.
- relative humidity (must fluctuate between 30 and 70%, should not be lower than 30% in winter, and pleasant for passengers is from 40 to 60%),
- air velocity (for those sitting passengers air that is greater than 0.2 m / s is annoying at the level of the knee or head and sighs flow rate from 0.1 m / s can be uncomfortable with the back, or neck and feet),

- volume flow rate of air (depending on the available volume per person - indoors, but generally the amount of fresh air indoors with more than one person is 30 m^3/h per person)

Future anthropometric measurements of the entire population of potential passengers in trams in Zagreb are important because the share of overweight and obese passengers, taking into consideration the amount of the BMI (Body Mass Index); (normal body weight is a BMI <25). According to Kroemer and Grandjean [9], the risk of heat stroke is higher for obese persons than for skinny persons and increases by as much as six times (600%) if a person has a 25 kg body weight more than they should, according to the amount contemplated by BMI. Therefore, the Laboratory for Applied Ergonomics in Traffic and Transportation is equipped by calibrated digital scales with moderate altimeter Tanita WB-3000.

5. ERGONOMIC ASSESSMENTS FACTORS OF ACCESSIBILITY AND ADAPTIBILITY OF PASSENGERS' SPACE

Table 2 shows the results of the analysis of the input space around doors and interior space for passengers in trams, compared with the recommendations of spatial accessibility according to Haničar and Španić [8], for persons with disabilities, such as: persons in a wheelchair, as well as persons with hearing impairment and vision impairment.

Table 2 shows that only low-floor trams; models NT 2200 and NT 2300 (manufacturer; Crotram) meet the accessibility of the foyer, in the sense that there are no vertical obsticles, for other trams have entrance stairs. The same circumstance is necessary for further exploration of tram stops in Zagreb, because if the distance and height of the stops are not adapted to the floor in low-floor trams, the spatial difference in dimensions passenger sees as an obstacle in the form of stairs or opening in which could fall wheel stroller for baby, caster wheelchair or cane of persons with visual impairment. According to Haničar and Španić [9] reccomendation is that the increase of the input space should not be larger than 2 cm, so that it could be used by persons who are moving by wheelchair, and also mothers with young children in a stroller.

As far as access to information in a way that there are no sensory obstacles [8]; Table 2 shows that all types of trams have a microphone and a sound notification of the line number, both on the external and the internal speaker. However, no single type of tram, despite the fact that internal space uses more than 100 persons, it has no built-in inductive loop, which is recommendation for access to information, for persons with hearing impairment and hearing aids [8]. Induction loop is an electronic device that is installed in spaces larger than 500m², or in premises which are also used by more than 100 persons; where speech is reproduced by speakers [8]. This electrical device enables wireless transmission of sound from space directly to the hearing aid (hearing aid or cochlear implant); the persons with hearing impairment, and thus allows these individuals to receive full and timely information in the public transport (eg. danger information, announcements about route ie . direction of vehicle movement, change of direction, etc.) [8].

According to the List of determination of spatial accessibility from Haničar and Pavlović [14], the floors of the Internal space in trams should be slip-resistant processed; flat and without any technological projections (covers). These determinants of accessibility are important for the movement of persons with visual impairment, persons who are moving with the help of wheelchairs, mothers with small children in stroller and elderly persons who are moving with aids. The analyzes shows that only the older model TMK 201 (manufacturer; Đuro Đaković) doesn't have slip-resistant floor while only two of the new low-floor trams NT 2200 and NT 2300 (manufacturer; Crotram) have slip-resistant flat floors without technology protrusions (covers).

Table 2 Ergonomic assessment factors of adaptability and accessibility of passenger space in trams in ZET (Zagreb electrical tram)

Tram model: manufacturer	A) The low-floor tram	B) Microphone in the cab, PA indoor and outdoor	B) Sound announcement of the time-table and nb. of the line	B) Inductive loop for persons with visual impairment	B) Non-slip flat floor	B) Flat floor without technological projections (covers)	B) Tactile line from the entrance to the seat (blind)	B) Font size on the internal display (cm)	B) Font size on the external display (cm)	B) opening height/display (cm) device for tickets	B) The light warning of danger (Flash)
TMK 2100: TŽV Gredelj	No	Yes	Yes	No	Yes	No	No	3,5	> 7 cm	107/ 124	No
NT 2200: Crotram	Yes	Yes	Yes	No	Yes	Yes	No	3÷5	> 7 cm	107/ 124	No
NT 2300: Crotram	Yes	Yes	Yes	No	Yes	Yes	No	3÷5	> 7 cm	107/ 124	No
TMK 201* + trailer TP 591: Đuro Đaković	No	Yes	Yes	No	No	No	No	3,5	No	107/ 124	No
Articulated TMK 301 i 354 (KT4): ČKD Praha	No	Yes	Yes	No	Yes	No	No	3,5	> 7 cm	107/ 124	No
TMK 401* (T4) + trailer TP 801 (B4): ČKD Praha	No	Yes	Yes	No	Yes	No	No	3,5	No	100/ 117	No

*Note: * for trams that are not MPVs; trailers are not analyzed*

When it comes to the movement of persons with visual impairment, it is important to emphasize that these persons orient themselves by touch and/or sound [8], for that reason it is important to provide a tactile warning line to positions from where it will be a door in the passenger compartments, but also in the inner space of the tram doors to the chairs for persons with disabilities. Tactile warning lines, according to Haničar [15] are tactile running surfaces for the purpose of warning of the danger for persons with visual impairment, while tactile running lines represent tactile walking surfaces for directing the movement of persons with visual impairment, with grooves in the direction of running. After examining the internal spaces of trams; it was observed that none of the models has no secured accessibility for persons with visual impairment who are using tactile warning lines.

For persons with visual impairment, there is also an order to ensure equal access to information in the passengers space that should a visual display of information according to Haničar and Pavlović provide [14], so that the written information that are beeing displayed in public places should have a font size of 7 cm and how to take care of contrasting colours and lightning. Also, for persons with hearing impairment; it is important to ensure the availability of information by using the visual-light announcements [8], such as for example a warning light in the case of opening/closing doors or light warning for danger.

After examining the situation; it has been observed that the new models of trams have too small font size on the internal displays 3-5 cm, which does not correspond to the recommendations, and the font size on external displays larger than 7 cm, which satisfies recommendations. Two older model of trams have no external display with written information, models TMK 201 (manufacturer: Đuro Đaković) and Model 401 TMK (manufacturer: ČKD Praha). Also, it was observed that none of the models of ZET (Zagreb electrical tram); does not have a flashing light warning of danger.

According to the List of spatial accessibility by Haničar and Pavlović [14] it is necessary to ensure that controls on devices intended for public use should be located at a maximum height of 121 cm and should reach the front of the device, the minimum height should be 38 cm. The height of the opening for tickets was measured and according to the standard in all models minimum height is 107, and at 124 cm height is where the two dimensions are a bit lesser, except for the older model TMK 401 (manufacturer; ČKD Praha), where the two dimensions are lesser which is better. It can be said that the value of the height of the screen display, ticket device does not significantly exceed the recommendations of the maximum height of 121 cm (3 cm), while only the older model 401 TMK maximum height corresponds fully recommendation on accessibility.

Table 3 Ergonomic assessment factors of adaptability and accessibility of seats for persons with disabilities in trams in ZET (Zagreb electrical tram)

Tram model: manufacturer:	A) The narrowest central interpass between the seats (cm)	B) Additional space for guide dog near the seats	B) Seats dimensions			B) Maximum seat height from the ground to the top of the seat (cm)	B) Elevation on the floor under the seat (cm)	B) Visual mark for elevation under the seat	B) Maneuvering space for wheelchairs 1.5 x 1.5 m near the doors	B) Maneuvering space for the visually impaired 1.2 x 1.2 m near the doors
			Back rest height (cm)	Seat weidth (cm)	Seat length (cm)					
TMK 2100: TŽV Gredelj	110	No	60	44	41	46	No	/	No	Yes
NT 2200: Crotram	59	Yes	60	43	43	66	Yes	No	Yes	Yes
NT 2300: Crotram	59	Yes	60	43	43	66	18,5	No	Yes	Yes
TMK 201* + trailer TP 591: Đuro Đaković	107	No	50	45	50	43	No		No	No
Articulated TMK 301 i 354 (KT4): ČKD Praha	110	No	60	44	41	48	No	/	No	Yes
60 kom TMK 401* (T4) trailer + TP 801 (B4): ČKD Praha	110	Ne	39	44	41	45	No		No	No

*Note: * for trams that are not MPVs; trailers are not analized*

Table 3 shows the factors adaptability and accessibility for passengers seats, according Haničar [15] should have the following dimensions: seat height of up to 45 cm, minimum dimensions for non-seater 40 cm x 40 cm, and the height of the backrest ≥ 50 cm.

Based on measurements and analysis in the field; it was observed that the highest seat height for persons with disabilities is (up to 45 cm);and satisfied only in the two older models of trams, model TMK 201 (manufacturer; Đuro Đaković;) and Model 401 TMK (manufacturer; ČKD Praha). Layout dimensions of seats for persons with disabilities in all the observed models of trams are beyond recommended minimum dimensions of 40 cm x 40 cm. The recommended height of the back rest seats for disabled persons (≥ 50 cm) is satisfied or higher in all models ZET (Zagreb electrical tram), except for the older model TMK 401 (manufacturer; ČKD Praha), which is too small, and it is 39 cm. It is also important; the accessibility of the space around the seats for persons with disabilities to accommodate a guide dog, which can be used for their movement and for persons with visual impairment, but in a way that guide dog does not disturb other passengers movement. It has been observed that there is sufficient space available to accommodate a guide dog by the seats for persons with disabilities; in only two newest trams NT 2200 and NT 2300 (manufacturer; Crotram), though that space is not clearly marked for the mentioned purpose.

Width of the corridor, and the central interpass by the layout-axis symmetry between opposite seats should meet the required minimum of 70 cm of width, in order to be used by persons with visual impairment, and seniors who are moving with the help of aids. It measured a serious flaw in the two newest trams NT 2200 and NT 2300 (the manufacturer; Crotram), measured clear width of only 59 cm width doesn't have recommended central interpass.

Any increase in the internal space, or in the entrance space, if there is; it is more than 2 cm [8], and should have a tactile warning field (other colors flags in the stairs or elevations), which serves to inform persons with vision impairment on changing levels of movement [9]. By measurements and analysis it was observed a serious disadvantage in the latest models of low-floor trams NT 2200 and NT 2300, with increases in front of the seats for persons with disabilities, if there is no tactile warning field.

In the interior space for passengers; it is necessary to provide maneuvering space for persons who are moving with the aid of a wheelchair, persons with visual impairment, as well as mothers with young children in a stroller. Recommendation for maneuvering space [15] for turning of the persons who are using wheelchair is: 150 cm x 150 cm, while for persons with visual impairment recommendation is: 120cm x 120cm. It was observed that only two models of low-floor trams NT 2200 i NT 2300 have recommended maneuvering space of 150cm x 150cm, while models TMK 2100 (manufacturer; Gredelj) and articulated TMK 301 and 354 (manufacturer; ČKD Praha) have: 120 x120 cm.

Table 4 shows the factors of ergonomic adaptability and accessibility of doors in passenger space, who's specifications to accessibility [15] must contain the following guidelines: clear width of at least 90 cm (width of one stick is 70 cm, width of the walker is 70 cm, width for a blind person and a guide dog is 77 cm, the minimum width for wheelchairs should be at least 90 cm, as well as the minimum joint width for two sticks is 90 cm), all with thresholds that are not higher than 2 cm, and the compulsory labeling of glass surfaces larger than 1.5 m² ranging from 90 to 160 cm.

Table 4 Ergonomic assessment factors of adaptability and accessibility of the doors for disabled in trams in ZET (Zagreb electrical tram)

Tram model: manufacturer:	A) Clear width of the door (cm), B) DD = double door, HD = harmonica door, SD = single door	A) No central handles in the space of the doors for disabled	A) Additional and lighted internal and external buttons for the doors	A) Height (cm) of the internal door/s buttons, from the tram floor	A) Minimum height (cm) of the external door/s buttons to the ground	A) Sound door signal	A) Labeling of large glass surfaces of doors, ranging from 90 to 160 cm from the tram floor	A) Stairs height (first / second) + height to the ground
TMK 2100: TŽV Gredelj	DV / 110	Yes	No	154	145	Yes	No	26/26 + 33
NT 2200: Crotram	DV / 130	Yes	Yes	82/122 /141	110 /120	Yes	No	No + 30
NT 2300: Crotram	DV / 130	Yes	Yes			Yes	No	No + 30
TMK 201* + trailer TP 591: Đuro Đaković	HV / 64	Yes	No	None	None	Yes	Not necessary, yellow handles over the glass	26/27 + 34
Articulated TMK 301 i 354 (KT4): ČKD Praha	HV/115	Yes	No	None	None	Yes		28/27 + 31
60 kom TMK 401* (T4) trailer + TP 801 (B4): ČKD Praha	HV/100	Yes	No	None	None	Yes		30/27 + 36

*Note: * for trams that are not analyzed MPVs trailers*

Analyzes and measurements of accessibility of doors found that all the models of trams have sufficient clear width of the door, except for the clear width of the door within the model TMK 201 (manufacturer; Đuro Đaković). It was also noted that all models of trams, accept two new models of low-floor NT 2200 and NT 2300, have an obstacle in the form of a central handle in the front door area (except the first door of the vehicle), which prevents the output passengers with visual impairment, and older persons who move with the help of aids. Persons who are using a wheelchair, and mothers with small children in stroller, independent entry is neither possible nor through the first door because of the vertical obstacles (stairs).

Guidelines for marking glass surfaces which are greater than 1.5 m² ranging from 90 to 160 cm does not apply to the glass door surface of all studied types of trams, because they all have glass surfaces smaller than 1.5 m^2. However, measurements established that models TMK 2100 (manufacturer; Gredelj), NT 2200 and NT 2300 (manufacturer; Crotram) have no marks on the glass surfaces on the recommended height, while other older models of trams have visually distinct yellow handles at the doors, which indicate the existence of the glass barriers, and when in a situation of open doors; physically protect passengers from direct access to glass surfaces. Deficiency of the handles on the doors is to reduce the light spot when opening the doors, therefore the visual markings on glass surfaces at the proper height are better solution. Only the door in the latest models of low-floor trams NT 2200 and NT 2300 have internal and external self-luminous buttons to open doors provided for the entry and exit of persons with disabilities, noting that there are special exterior buttons for persons with disabilities.

In accordance with the List of finding spatial accessibility from Haničar and Pavlović [14] it is recommended; the range of heights for locating controls on the front of the unit ranging from 38 cm up to 121 cm. New models of low-floor trams NT 2200 and NT 2300 have a height of internal and external buttons for the doors on the recommended height, while the model TMK 2100 (manufacturer; Gredelj) has a button above the recommended maximum level. Other models have no exterior and interior push button for opening.

6. RECOMMENDATIONS FOR ACCESSIBILITY OF PASSENGERS SPACES OF TRAMS

On the basis of the analysis and measurement, and in accordance with recent guidelines, the authors recommend necessary factors to ensure physical accessibility and adaptability of the cabin space, for it is necessary to take into account, already during the preparation of specifications for ordering new trams, while directing the process of design:

- Tram design without vertical barriers at the front door (stairs).
- Installation of inductive loops in all models of the trams because of equal access to information for persons with hearing impairment.
- Provide a non-slippery floor surfaces on all models of trams.
- Remove technological projection (edges of covers) on floors in all tram models and provide a flat floor surface.
- Provide tactile warning lines for persons with visual impairment in all of the models.
- Ensure equal access to information for persons with visual impairment in the written form on the internal displays (font size should be at least 7 cm).
- Provide external displays with written information on the direction of movement on all models of trams.
- Provide a flash-light warning of danger in the interiors of all models, because of equal access to information for persons with hearing impairment.
- Set up seats on recommended maximum height (≤ 45 cm) in all models of trams.
- Provide sufficient seatback height (≥ 50 cm) in all models of trams.
- Ensure all models of trams in the space around the seats for persons with disabilities; marked space to accommodate a guide dog for persons with visual impairment that should not interfere with movement of other passengers.

- The narrowest central interpass between the seats in accordance with recommended width (≥ 70 cm) for the movement of persons with visual impairment and the elderly who are moving with the help of aids (inadequacy of the width of the central clearance is perceived between the seats of the new models of low-floor trams, where the width clearance is only 59 cm and in the parts of trams which are designated seats for disabled persons).
- Provide tactile warning fields (yellow line) at an elevation below the seats for persons with disabilities in the new low-floor models NT 2200 and NT 2300.
- Provide maneuvering space for persons who are moving with the aid of a wheelchair (150cm x 150cm), persons with visual impairment (120cm x 120cm), and mothers with small children in strollers, in all models of trams and in areas that are marked for disabled persons.
- Provide the required minimum of clear width of the door (≥ 90 cm) on new models
- Provide internal and external light push button to open the door to all models of trams.
- Set buttons for doors opening at the recommended height (ranging from a minimum height of 38 cm to a maximum of 121) in all models of trams.
- Required air-conditioning of passenger space (subjective feeling of thermal comfort) but also cab's (safety and reliability of traffic).

In conclusion, the future ergonomic solutions in passenger space should respect the principle of a universal design recommended by Haničar [15] respecting human diversity and promoting inclusion of all persons in all of the life's activities, according to Kish Glavaš et al. [16] it is necessary to provide planning and designing of entire environment to make it to the greatest extent possible for all users.

7. CONCLUSION

Inaccessibility of passenger space in ZET (Zagreb electrical tram) is an example of non-compliance with the CRPD in practice, in Croatia, during the flow of traffic for the sake of public transport and the lack of adaptation to the whole population, including persons with disabilities, as well as specific groups of passengers, such as mothers with children and the elderly. Ergonomic assessment identified serious gaps in the design of passenger space in the two newest low-floor trams NT 2200 and NT 2200 (manufacturer; Crotram).

In Croatia is, both at local and regional level, evident the absence of the establishment of committees and working groups to deal with issues accessibility, but also the lack of operational and technical plans for its implementation. It is necessary to develop standards and guidelines for the implementation of the CRPD provisions relating to accessibility. Also, Article 9 of the CRPD, in the elaboration of the obligation to provide accessibility, highlights and other measures for the persons with disabilities equal access to transportation. Furthermore, the law of Croatia does not know other measures in transport services which established standards of equal access. The issue of public transport is largely under the jurisdiction of local and regional government (JL(R)S), the use of low-floor buses, trams and assistive technologies, and specialized transportation differs in some of them. For example, it hasn't been noted existance of Braille in passenger spaces on trams in Zagreb, including the latest low floor models NT 2200 and NT -2300.

The results of these studies suggest the need for a detailed analysis of the needs of passengers, including the targeted categories of passengers studied in this paper, with the aim to p design customized passenger space and affordable for the general population of passengers, as well as the necessary additional corrections of the executive legal regulative in accordance with the results of these and future studies. Also, due to circumstance of unconditioned cabin and passenger space in some models in ZET (Zagreb electrical tram), probable in extreme circumstances, of summer and winter period, the possibility of subjective feelings of intense thermal discomfort and the subjective feeling of workload of tram drivers when uncontrolled factors of thermal comfort which could become very dangerous factors for safety of traffic. It is, therefore necessary to carry out measurements of thermal comfort factors (temperature, relative humidity, air velocity, volume flow rate) parallel with the measurement of light intensity. Measurements will be conducted in all models of trams in passenger spaces, but also in workspaces of cabs while using a measuring device Metrel Poly MI 6401 EU; for passengers in time interval of length of time for each line, and for drivers duration of the longest shift .

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ABOUT ORGANISER

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.

CAREER PROSPECTS

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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