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UNIVERSITY OF MONTENEGRO | FACULTY OF MARITIME STUDIES KOTOR

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Kotor, 9.06.2022.
Broj: 01-1502/1

UNIVERZITET CRNE GORE
CENTAR ZA DOKTORSKE STUDIJE
SENAT UNIVERZITETA
PODGORICA

Poštovani,

U prilogu dostavljamo materijale koji se tiču predaje doktorske disertacije na ocjenu i predlaganja komisije za ocjenu doktorske disertacije na Pomorskom fakultetu Kotor, i to:

»Analiza isplativosti i model primjene jedinstvenog nacionalnog pomorskog prozora u malim obalnim zemljama« doktoranda mr Nexhata Kapidanija.

Prednje dostavljamo na dalji postupak.

S poštovanjem,

DEKAN
Prof.dr Špiro Ivošević

Na osnovu čl. 64. Statuta Univerziteta Crne Gore i čl. 38, 41. i 55 Pravila doktorskih studija i čl. 12. Poslovnika o radu Vijeća, Vijeće Pomorskog fakulteta Kotor na sjednici održanoj dana 6. 06. 2022. godine, donijelo je

ODLUKU

1. Utvrđuje se da su ispunjeni uslovi iz Pravila doktorskih studija za dalji rad na doktorskoj disretaciji „Analiza isplativosti i model primjene jedinstvenog nacionalnog pomorskog prozora u malim obalnim zemljama" doktoranda mr Nexhata Kapidanija.
2. Predlaže se Centru za doktorske studije i Senatu Univerziteta Crne Gore da formira komisiju za ocjenu doktorkse disertacije „Analiza isplativosti i model primjene jedinstvenog nacionalnog pomorskog prozora u malim obalnim zemljama" doktoranda mr Nexhata Kapidanija u sastavu:
   - Dr Enis Kočan, van. prof. Elektrotehničkog fakulteta Univerziteta Crne Gore, oblast Telekomunikacije, mentor
   - Dr Edvard Tijan, van. prof. Pomorskog fakulteta Sveučilišta u Rijeci, oblast tehničke nauke, tehnologija prometa i transporta, grana inteligentni transportni sistemi i logistika, komentor,
   - Dr Tatijana Dlabač, van.prof. Pomorskog fakulteta Kotor Univerziteta Crne Gore, oblast Brodska elektrotehnika i elektronika, član.
3. Odluka se sa pratećim materijalima dostavlja Centru za doktorske studije i Senatu Univerziteta Crne Gore.

O b r a z l o ž e n j e

Doktorand mr Nexhat Kapidani je uradio svoju doktorsku disertaciju „Analiza isplativosti i model primjene jedinstvenog nacionalnog pomorskog prozora u malim obalnim zemljama", istu predao i uputio molbu Komisiji za doktorske studije i Vijeću Pomorskog fakulteta Kotor da predloži sastav Komisije za ocjenu disertacije.
Na osnovu podnijete dokumetacije i saglasnosti Komisije za doktorske studije, Vijeće je donijelo odluku kao u dispozitivu.
Odluka se sa pratećim materijalima dostavlja Centru za doktorske studije i Senatu Univerziteta Crne Gore.

VIJEĆE POMORSKOG FAKULTETA KOTOR

Broj 01- 1461
Kotor, 6.06. 2022.

DEKAN
Prof.dr Špiro Ivošević

ISPUNJENOST USLOVA DOKTORANDA

OPŠTI PODACI O DOKTORANDU			
Titula, ime, ime roditelja, prezime	mr Nexhat Kapidani		
Fakultet	Pomorski fakultet		
Studijski program	Pomorske nauke – doktorske studije		
Broj indeksa	2/14		
NAZIV DOKTORSKE DISERTACIJE			
Na službenom jeziku	Analiza isplativosti i model primjene jedinstvenog nacionalnog pomorskog prozora u malim obalnim zemljama		
Na engleskom jeziku	Cost-benefit analysis and implementation model of the National Maritime Single Window in small coastal states.		
Naučna oblast	Pomorske nauke, Informaciono-komunikacioni sistemi		
MENTOR/MENTORI			
Prvi mentor	Prof. dr Enis Kočan, vanredni profesor	Elektrotehnički fakultet Univerziteta Crne Gore	Telekomunikacije, Informaciono-komunikacioni sistemi
Drugi mentor	Prof. dr Edvard Tijan, vanredni profesor	Pomorski fakultet Sveučilišta u Rijeci, Hrvatska	Pomorski saobraćaj, ICT, Ekonomija
KOMISIJA ZA PREGLED I OCJENU DOKTORSKE DISERTACIJE			
Prof. dr Tatjana Dlabač, vanredni profesor		Pomorski fakultet, Univerzitet Crne Gore	Brodska elektrotehnika i elektronika
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Datum značajni za ocjenu doktorske disertacije			
Sjednica Senata na kojoj je data saglasnost na ocjenu teme i kandidata	15.10.2020.		
Dostavljanja doktorske disertacije organizacionoj jedinici i saglasanost mentora	31.05.2022.		
Sjednica Vijeća organizacione jedinice na kojoj je dat prijedlog za imenovanje komisija za pregled i ocjenu doktorske disertacije	6.06. 2022.		
ISPUNJENOST USLOVA DOKTORANDA			

U skladu sa članom 38 pravila doktorskih studija kandidat **je** cjelokupna ili dio sopstvenih istraživanja vezanih za doktorsku disertaciju publikovao u časopisu sa **(SCI/SCIE)/(SSCI/A&HCI)** liste kao prvi autor.

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1. **Kapidani, N.**, Tijan E., Jović M., Kočan E., „National Maritime Single Window: Cost-Benefit Analysis of Montenegro Case Study", "Promet – Traffic & Transportation", Zagreb – Hrvatska, vol. 32, no. 4, pp. 543-557, Jul. 2020.

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Pored rada u časopisu sa SCIE liste, doktorand je rezultate istraživanja vezane za temu doktorske disertacije objavio i u radovima publikovanim u zbornicima 3 međunarodne konferencije:

1. **Kapidani N.**, Aksentijević S., Tijan E., Kočan E., "Establishing a National Maritime Single Window in Small Coastal Countries," 2021 44th International Convention on Information, Communication and Electronic Technology (MIPRO), 2021, pp. 1448-1453, DOI: 10.23919/MIPRO52101.2021.9596744
2. Rødseth O.J., **Kapidani N.** 2017 „A Taxonomy for Single Window Environments in Seaports" proc. of the MTEC2017, 26-28 April 2017, Singapore; DOI https://doi.org/10.3850/978-981-11-2722-9_MTEC020114 https://www.sintef.no/en/publications/publication/?pubid=1468477
3. **Kapidani N.**, Kočan E., „Implementation of National Maritime Single Window in Montenegro", 23rd Telecommunications Forum TELFOR 2015 - IEEE Conference, Belgrade, Serbia, 24-26.11.2015; DOI: 10.1109/TELFOR.2015.7377385

Obrazloženje mentora o korišćenju doktorske disertacije u publikovanim radovima

Doktorand Nexhat Kapidani, kao prvi autor, dio rezultata sopstvenih istraživanja vezanih za doktorsku disertaciju objavio je u radu koji je publikovan u časopisu indeksiranom na SCI/SCIE listi.

U pomenutoj publikaciji se najprije objašnjava pojam Jedinstvenog nacionalnog pomorskog prozora (NMSW), daje pregled relevantne literature i regulative vezane za NMSW, a zatim se opisuju troškovi i koristi primjene NMSW-a u obalnim državama koje imaju ograničene ljudske resurse i infrastrukturu vezane za pomorski saobraćaj. U radu je predložen analitički model, koji predstavlja opštu metodu sprovođenja analize troškova i koristi prilikom uvođenja NMSW-a, sa

akcentom na male obalne države koje imaju ograničene resurse. Koristeći predloženi model i ulazne podatke za Crnu Goru, kao primjer male obalne države, autor procjenjuje da li ulaganje u primjenu NMSW-a može biti isplativo za obalne države koje raspolažu ograničenim resursima. Dobijeni rezultati pokazuju da nivo ulaganja pri implementaciji NMSW-a prevazilazi nivo direktne koristi, predstavljene kroz uštedu u vremenu za pripremu i obradu podataka koji se šalju pri uplovljenju i isplovljenju broda iz luke. Međutim, ako se u razmatranje uključe i indirektne koristi, kao što su smanjenje ilegalnih aktivnosti na moru, povećanje bezbjednosti luka,zaštita životne sredine, ali i mogućnost uključenja plovila koja nisu u skladu sa SOLAS konvencijom, onda se može reći da koristi primjene NMSW-a prevazilaze troškove implementacije ovog sistema.
Pored opisanog istraživačkog doprinosa predstavljenog u radu sa SCIE liste, u radovima objavljenim na međunarodnim konferencijama, autor je razmatrao moguća tehnička rješenja i predložio modele implementacije NMSW-a, a sve u zavisnosti od stanja postojećih informaciono-komunikacionih sistema u pomorstvu.
S obzirom da je kandidat ispunio sve uslove propisane Statutom Univerziteta Crne Gore i Pravilima dokorskih studija, mentor i komentor su saglasni da se imenuje Komisija za pregled i ocjenu doktorske disertacije.

Datum i ovjera (pečat i potpis odgovorne osobe)

U Kotoru,
09.06.2022. god.

UNIVERZITET CRNE GORE
MP
Pomorski fakultet Kotor

DEKAN

Prilog dokumenta sadrži:

1. Potvrdu o predaji doktorske disertacije organizacionoj jedinici
2. Odluku o imenovanju komisije za pregled i ocjenu doktorske disertacije
3. Kopiju rada publikovanog u časopisu sa odgovarajuće liste
4. Biografiju i bibliografiju kandidata
5. Biografiju i bibliografiju članova komisije za pregled i ocjenu doktorske disertacije sa potvrdom o izboru u odgovarajuće akademsko zvanje i potvrdom da barem jedan član komisije nije u radnom odnosu na Univerzitetu Crne Gore

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Kotor, 31. 05. 2022.

Broj 03-1404

Pomorski fakultet Kotor Univerziteta Crne Gore, izdaje sljedeću

POTVRDU

Potvrđuje se da je mr Nexhat Kapidani, doktorand na Pomorskom fakultetu Kotor Univerziteta Crne Gore, studijski program Pomorske nauke, predao na ocjenu svoju doktorsku disertaciju »Analiza isplativosti i model primjene jedinstvenog nacionalnog pomorskog prozora u malim obalnim zemljama«.

SEKRETAR

Vera Popović

UNIVERZITET CRNE GORE
UCG
Pomorski fakultet Kotor

UNIVERZITET CRNE GORE

POMORSKI FAKULTET - KOTOR

KOMISIJI ZA DOKTORSKE STUDIJE

VIJEĆU POMORSKOG FAKULTETA

Predmet: Predaja doktorske teze

Poštovani,

Dostavljam 5 (pet) primjeraka doktorske teze pod nazivom „Analiza isplativosti i model primjene jedinstvenog nacionalnog pomorskog prozora u malim obalnim zemljama“ na dalju proceduru.

U prilogu dostavljam:

- Saglasnost mentora i komentora za predaju doktorske teze,
- Spisak radova sa rezultatima iz doktorske teze,
- Štampane primjerke radova sa rezultatima teze, kao dokaz da ispunjavam uslove definisane Pravilnikom doktorskih studija. Elektronske forme radova se nalaze na dostavljenom CD-u.
- Kompletnu bibliografiju;
- Biografiju;
- CD sa navedenom dokumentacijom.

MSc Nexhat Kapidani

Kotor, 31. maj 2022. godine

IZJAVA O AUTORSTVU

Potpisani Nexhat Kapidani

Broj Indeksa: 02/2014

IZJAVLJUJEM

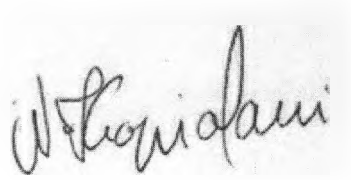
Da je doktorska disertacija pod nazivom:

Analiza isplativosti i model primjene jedinstvenog nacionalnog pomorskog prozora u malim obalnim zemljama

- Rezultat sopstvenog istraživačkog rada,
- Da predložena disertacija nu u cijelini ni u dijelovima nije bila predložena za dobijanje bilo koje diplome prema studijskim programima drugih ustanova visokog obrazovanja,
- Da su rezultati korektno navedeni, i
- Da nisam povrijedio autorska I druga prava intelektualne svojine koja pripadaju trecim licima.

U Kotoru, 08.06.2022.

Poptis doktoranta:



UNIVERZITET CRNE GORE

POMORSKI FAKULTET

Komisiji za doktorske studije

Vijeću

Poštovani,

Dajemo saglasnost da se doktorska teza kandidata mr Nexhata Kapidanija, pod nazivom "Analiza isplativosti i model primjene jedinstvenog nacionalnog pomorskog prozora u malim obalnim zemljama" preda Vijeću Pomorskog fakulteta, radi pokretanja procedure ocjene teze.

U Podgorici i Rijeci,

31.05.2022. godine

Mentor,

Prof. dr Enis Kočan

Komentor,

Prof. dr Edvard Tijan

Vijeću Pomorskog fakulteta Kotor
Centru za doktorske studije Univerziteta Crne Gore

PREDMET: Izvještaj Komisije za doktorske studije Pomorskog fakulteta Kotor

Komisija za doktorske studije Pomorskog fakulteta Kotor održala je dana 6.06. 2022. godine sjednicu na kojoj je razmatrala dvije predaje doktorskih disertacija na ocjenu i to:

1. Doktorsku disertaciju „Humanocentričan model jedinstvenog prozora u pomorstvu za potrebe luke u razvoju" doktoranda mr Ane Radulović.
2. Doktorsku disertaciju „Analiza isplativosti i model primjene jedinstvenog nacionalnog pomorskog prozora u malim obalnim zemljama" doktoranda mr Nexhata Kapidanija.

Komisija je nakon razmatranja dostavljenih materijala ustanovila da su se stekli svi uslovi za dalju proceduru, pa predlaže komisije za ocjenu i to:

1. Za ocjenu doktorske disertacije „Humanocentričan model jedinstvenog prozora u pomorstvu za potrebe luke u razvoju" doktoranda mr Ane Radulović, komisiju u sastavu:
   - Dr Nikša Grgurević, vanredni profesor Univerziteta za poslovni inžinjering i menadžment Banja Luka, oblast Međunarodna ekonomija, predsjednik,
   - Doc.dr Ranka Krivokapić, Pomorski fakultet kotor Univerziteta Crne Gore, oblast Menadžment u pomorstvu, član,
   - Dr Mimo Drašković, vanredni profesor Pomorskog fakuulteta Univerziteta Crne Gore, oblast Menadžment u pomorstvu, mentor.
2. Za ocjenu doktorske disertacije „Analiza isplativosti i model primjene jedinstvenog nacionalnog pomorskog prozora u malim obalnim zemljama" doktoranda mr Nexhata Kapidanija, komisiju u sastavu:
   - Dr Enis Kočan, van. prof. Elektrotehničkog fakulteta Univerziteta Crne Gore, oblast Telekomunikacija, mentor,
   - Dr Edvard Tijan, van. prof. Pomorskog fakulteta Sveučilišta u Rijeci, Oblast tehnologija prometa i transporta, inteligentni transportni sastavi i logistika, komentor,
   - Dr Tatijana Dlabač, van.prof. Pomorskog fakulteta Kotor Univerziteta Crne Gore, oblast Brodska elektrotehnika i elektronika, član.

KOMISIJA:

Prof.dr Romeo Meštrović, predsjednik,

Prof.dr Tatijana Dlabač, član,

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NATIONAL MARITIME SINGLE WINDOW – COST-BENEFIT ANALYSIS OF MONTENEGRO CASE STUDY

ABSTRACT

In this paper, the costs and benefits of the National Maritime Single Window (NMSW) for coastal countries that have limited human resources and infrastructure related to maritime traffic are researched. A general method for conducting a cost-benefit analysis of NMSW implementation is proposed. Using this method and the input data for Montenegro, as an example of a small-sized coastal country, the authors assess whether such an investment in NMSW implementation can be beneficial to coastal countries with limited resources.

KEY WORDS

National Maritime Single Window (NMSW); cost-benefit analysis; Montenegro case study;

1. INTRODUCTION

Numerous continuous and often very radical changes occur today in the maritime port service market [1]. The Single Window concept, which enables all stakeholders involved in the business process to input the data and information used by other stakeholders only once (by using a single point of data entry), has significantly changed the methods of information exchange between transport stakeholders, particularly in maritime transport and maritime port business [2]. The Single Window is a national or regional facility mainly built around an ICT platform, initiated by a government or ad hoc authority to facilitate import, export and transit formalities, by offering a single point for the submission of standardized information and documents, in order to meet all the official demands and facilitate logistics [3].

Maritime transport is composed of organizations and activities such as shippers, maritime port stakeholders, and a wide range of professional services around the maritime activities etc. [4, 5]. In 2018, eleven billion tons of cargo were transported by sea [6]. In this respect, maritime transport also involves a lot of procedures and data that need to be exchanged [7]. The International Maritime Organization Convention on Facilitation of International Maritime Traffic (FAL Convention) plays an essential role in facilitating data exchange in maritime transport, as its main objectives are to prevent unnecessary delays in maritime traffic, to aid co-operation between governments and to secure the highest practicable degree of uniformity in formalities and other procedures [8, 9]. In this respect, IMO has developed standardized forms, i.e. IMO FAL Forms to simplify the formalities, procedures regarding the arrival and departure of ships and to unify the documents that are requested to be presented to the authorities.

A mandatory requirement for contracting states to IMO FAL Convention (currently 123 states, including Montenegro [10]) to introduce electronic

information exchange between ships and ports is effective from 8 April 2019. The provision, necessary under IMO (FAL Convention), is part of a package of amendments under the revised Annex to the FAL Convention, adopted in 2016 [11]. The Convention encourages the use of a "single window" for data, to enable all the information required by the public authorities in connection with the arrival, stay and departure of ships, persons and cargo, to be submitted via a single portal, without duplication [11].

National Maritime Single Window (NMSW), also known as the Maritime Single Window, is a place where all information is entered only once and becomes available to various stakeholders [12]. NMSW is an important instrument for facilitating and expediting maritime transport. NMSW is considered primarily to be a business to administration (B2A) system. Seaborne trade could be increasingly affected by the IMO decision to make NMSW mandatory. It could be a potential opportunity for the developing countries, but also a threat if it is not implemented appropriately. Actually, there is a risk that the costs of implementation may be higher than the benefits.

Many endeavors are being undertaken globally to delineate the concept for NMSW and to define the standards and issue recommendations on its implementation [13]. In the early 1980s, the systems based on Electronic Data Interchange (EDI) have been implemented in more significant maritime ports. The aforementioned systems are called Port Community Systems (PCS), and they are still in use in Hamburg - Germany, Felixstowe - UK, Port - MIS in Korea, FCPS in the UK, Portbase in the Netherlands, and others [14, 15]. The levels of electronic reporting, remote monitoring, and control have rapidly increased in recent years in all industrial fields. Furthermore, new trends and concepts are being developed such as maritime clouds, e-navigation, e-maritime, "maritime Big Data" and the Internet of Things (IoT) that entail both challenges and opportunities for the maritime transport [16-20]. All these trends, even if they are partly overlapping, could lead to digitalization, real-time information [21], and improved connectivity in the maritime transport sector that could not only facilitate shipping, but also improve the energy efficiency, reduce emissions, and develop traffic management and routing.

Undoubtedly, the implementation of the NMSW is a challenging task in terms of costs, complexity, re-engineering of the existing business processes and system maintenance. Dozens of regulations, recommendations and other related documents have to be studied before taking the first steps in the demanding process of the NMSW implementation. This motivated the authors of this paper to provide a comprehensive research of the regulations, recommendations, implementation options, experiences, and expected benefits of deploying the NMSW. More importantly, in this paper the authors provide a method for conducting a cost-benefit analysis of the NMSW implementation, which is general and applicable to any country intending to implement the NMSW. Using the known input data for Montenegro, a cost-benefit analysis of the NMSW implementation and the appropriate concluding remarks are provided. The presented case study could be used as a reference point for different small-size developing countries, which are aware of their limited resources, but are required (or willing) to implement the NMSW.

2. FRAMEWORK OF SINGLE WINDOWS

This section aims to analyze and describe the framework of Single Window and the NMSW. The most commonly accepted definition of a Single Window is the one provided by the United Nations Economic Commission for Europe (UNECE) Recommendation No. 33: "a facility that allows parties involved in trade and transport to lodge standardized information and documents with a single-entry point to fulfil all import, export, and transit-related regulatory requirements" [22]. The Single Window concept permits the trader or transporter to submit all the data needed for determining the admissibility of the goods in a standardized format only once. The data should be forwarded to the authorities involved in border controls and at a single portal. It places the onus on the authorities to manage the Single Window and to ensure that the other participating authorities or agencies are either given access to the information or are actually given the data by the managing authority [2]. Furthermore, it eliminates the need for the trader or transporter to submit the same data to several different border authorities or agencies [23].

Single Window may be also considered as a trade facilitator. For UNECE and its UN Centre for Trade Facilitation and Electronic Business (UN/CEFACT), the trade facilitation is "the simplification, standardization and harmonization of

procedures and associated information flow required to move goods from seller to buyer and to make payment" [24]. Such a definition implies that not only the physical movement of goods is essential in a supply chain, but also the associated information flows. It also encompasses all governmental agencies that intervene in the transit of goods and the various commercial entities that conduct business and move the goods. This is in line with the discussions on trade facilitation currently ongoing at the World Trade Organization [24]. The trade facilitation involves a broad and diverse range of public and private stakeholders seeking to establish a transparent, consistent and predictable environment for border transactions based on standardized and straightforward procedures and practices [25]. In this respect, many countries and international organizations have recognized the numerous benefits of electronic trade facilitation, promoting the development and implementation of trade portals that allow business operators and governments to process the trade information submitted in electronic formats, typically in one place, to all the concerned parties [26].

A National Single Window (NSW) system enables a single submission of electronic documents by the trader such as single data preparation and submission of customs declaration and duty payment for customs release and clearance [27]. The NSW is also a facility that allows parties involved in trade and transport to lodge standardized information and documents with a single-entry point to fulfill all import, export, and transit-related regulatory requirements [28]. The NSW refers to the implementation of a national system that will act as a single point of contact for the electronic submission and exchange of information between public and private stakeholders from different transport modes [29]. It is important to note that the Single Window has evolved from the customs automation era to trade information exchanges, from limited Single Windows connecting traders with a single regulation (e.g. customs, port, etc.) to nationwide NSWs that allow all parties to submit standardized information only once to fulfill all regulatory requirements [30].

As mentioned before, the National Maritime Single Window is similarly defined as a National Single Window: a place where all information is entered only once and becomes available to various stakeholders [12], but related to the maritime environment. Its focus lies on the data associated with vessels, and not the data about cargo and trading.

The NMSW, as an authority operated SW for clearance of ships, should at a minimum cover the handling of IMO FAL data related to the vessel, where general safety and security information regarding the transported cargo is included. Furthermore, the NMSW should be developed to deal with reporting formalities that are the result of international laws that the individual country has acceded at the regional and international levels. Additionally, the NMSW should also cover the information related to the ship clearance which is required by national legislation.

For the past several years, the EU has been working on the development of the European Maritime Single Window – EMSW, with the aim to fully harmonize the interfaces available to operators of ships in order to provide the required information all across the EU [12]. The purpose of EMSW is to standardize the information needed for port management so that the submitted data can be publicly available to all relevant stakeholders [31]. The harmonized EMSW environment for ships will build on the already existing framework (National Single Windows structure) [32]. The National Single Windows will continue to be mainly a coordination mechanism, serving primarily as a router (with technical converter between data formats where needed) to pass the two-way information between the maritime transport operators and the data recipients (e.g. port authorities, customs interfaces and reporting systems, border control authorities, the SafeSeaNet, statistics authorities) with the aim to facilitate reporting for the maritime industry [32].

Due to the strategic importance of creating common regulations for all modes of transport across the Member States, the EMSW has been regarded as a matter of high priority. In 2017, the EU Transport Ministers underlined in the 'Valetta Declaration' the shortcomings of the Reporting Formalities Directive (RFD) and invited the Commission to propose a follow-up to the evaluation of the RFD, which would include a harmonized EMSW environment [33].

At the beginning of 2019, the European Commission signed the agreement with the European Parliament and Council on the implementation of the EMSW, which is expected to enter into force in 2025. Although the deal was well accepted by the

maritime sector, including the European maritime ports, the ports of Hamburg, Antwerp and Rotterdam have urged the European Transport Committee to vote against the EMSW when an amendment proposal sought to introduce an EU level access point interface, in addition to the new harmonized interface that would be developed at the European level for the NSW [34].

Apart from administrative stakeholders and procedures which fall under the scope of the NMSW, the commercial procedures also need to be handled in an efficient manner. In order to simplify the commercial procedures, a concept of a Port Community System (PCS) was introduced. A PCS is a neutral and open electronic platform enabling an intelligent and secure exchange of information between the public and private stakeholders to improve the competitive position of the sea and airport communities (*Figure 1*).

The PCS optimizes, manages and automates the port and logistics processes through a single submission of data and connecting transport and logistics chains [36]. The PCS helps stakeholders of the port processes to reduce logistics costs through faster information flow, to deliver the cargo faster, to enable the flow of goods, and finally, to boost the economic growth. As a secondary result, it helps to reduce the externalities such as pollution and harmful emissions [12].

3. COSTS AND BENEFITS OF NMSW IMPLEMENTATION

The NMSW is usually developed by the national maritime authorities. For its successful implementation, a selection of the business model is of utmost importance. NMSW business model could be fully developed and funded by the public authorities or by the commercial port companies. For example, the users could finance the NMSW as a fee-per-transaction, as is usually the case with privately operated PCSs [13]. Imposing the fees for the NMSW could be seen as a business barrier and could reduce the competitiveness of ports and countries, as charges will lead to higher transportation costs. Obviously, the no-fee business model requires a commitment to long-term government funding for the implementation and operation of the system [13]. In this section, an overview and quantification of costs of the

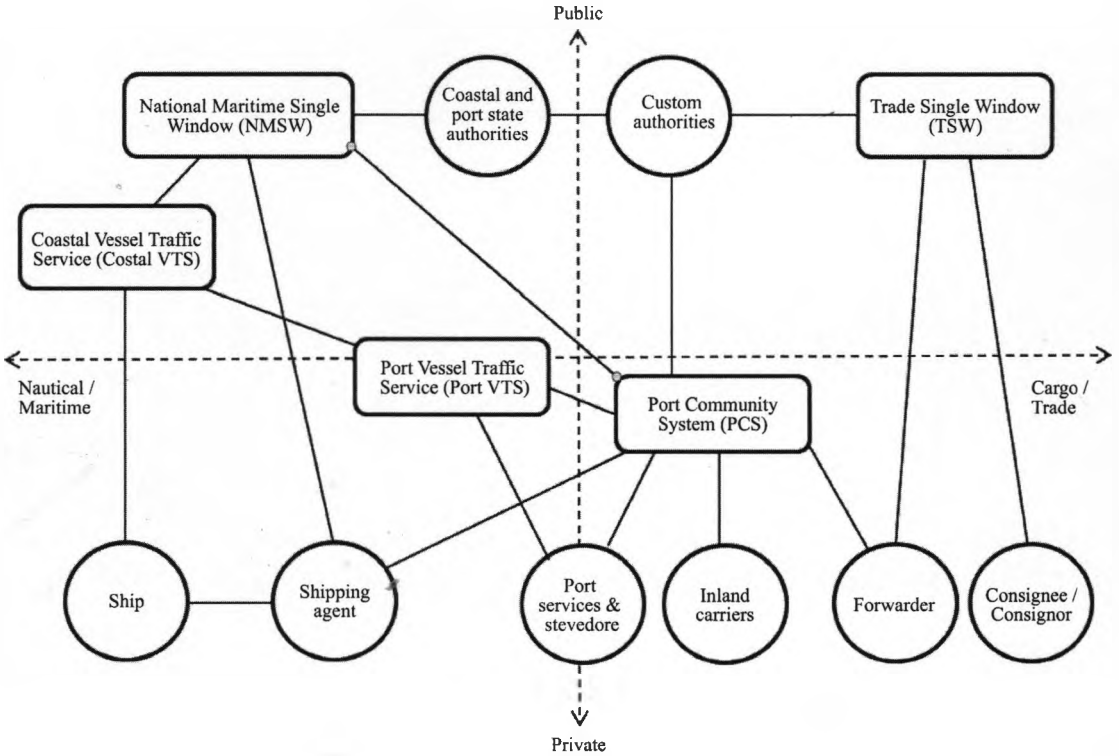

Figure 1 – Model of NMSW environment
Source: adapted from [14] and [35]

NMSW deployment have been provided, as well as the overview and quantification of the NMSW implementation benefits.

3.1 Costs of NMSW deployment

The costs of the NMSW deployment could be divided into two principal categories: implementation costs and running costs. Implementation costs could be further divided into preparation costs, technical costs and human resources costs [13].

Preparation costs encompass all costs at the initial phase of NMSW implementation, which is critical for the success. The initial phase should start with establishing a Project Management Group (PMG), which will initiate the first steps and have a lead role during the implementation phase. If the country has previously established a National Facilitation Committee according to the FAL Convention [37], it could also take the role of the PMG. PMG should define the scope of the feasibility study at the very beginning. The study should provide answers to numerous questions such as: what are the project needs, what are the potential benefits of the NMSW services, what is the scope of the NMSW, what are the possible scenarios for implementation, what are the costs, resources and time frame of deployment under the different scenarios, etc. Besides, the feasibility study should identify possible risks and potential benefits of the NMSW application. In addition to the feasibility study, other studies could be used, focusing on particular aspects such as the legal framework, business model, technical issues, business processes, human resources, training, and others. During the preparation phase, a business model should be proposed, which should include the efforts to update the existing regulations to achieve the highest possible harmonization and simplification of procedures. This phase should detect any obsolete or unnecessary regulations and propose their abolishment. The maritime port regulations affect the maritime port efficiency in a non-linear way, and an excess of the rules could have a negative impact on the maritime port efficiency [38].

The overall technical costs of a new NMSW system will be determined by the expenses of the necessary software and hardware investments, as well as by the costs of changes of the existing legacy systems like PCS, etc. Thus, to keep costs down, careful consideration should be given to which legacy systems, processes and information flows should be changed [13]. However, the emphasis should be on the harmonization of processes and data models. The legacy systems are more present in the developed countries than in transition economies such as Montenegro.

Human resources costs are related to the training of end users for using the system and for the preparation of personnel who will be the first level of support and who will deal with the management and basic maintenance of the system. The service level agreement for the maintenance and the extent of "outsourcing" depends on the capabilities of the technical staff of the organization in charge of operating the system. Human resources costs are also related to consultants who are in charge of monitoring the system design and implementation.

Running costs incorporate all the costs after the roll-out and handing over the system to the competent authority, including the maintenance of software and hardware, user support services, communication links, and other operation costs.

According to previous experiences, the total implementation costs could be from less than 1 million US dollars (Guatemala) up to 4 million dollars (Finland, Senegal, Malaysia) or sometimes even more, for example in the US [39].

3.2 Quantification of costs

For the purpose of costs quantification, the NMSW is presumed to be an information system with a lifecycle of N years. It is assumed that during the first N years only the running costs will occur, with no additional hardware/software implementation costs. Therefore, overall costs C for N years will be:

$$C = P + T + M + \sum_{i=1}^{N} R_i \quad (1)$$

where P are preparation costs, T are technical costs, M are human resources costs and R_i are running costs for each year.

Preparation costs should cover all the expenses related to conducting fundamental/feasibility studies and the preparation of tender documentation that will precede the NMSW implementation. The preparation phase is a paramount step, and the decisions made in this phase will determine the future costs of the NMSW implementation.

Technical costs could be further elaborated depending on how many legacy systems have to be updated (existing PCSs, customs, etc.). Assuming M legacy systems exist, the technical costs can be calculated as follows:

$$T = H_0 + S_0 + \sum_{j-1}^{M} L_j \quad (2)$$

where H_0 are hardware costs, S_0 are software costs and L_j are the costs of updating each legacy system for $1 \leq j \leq M$.

Running costs R_i present the annual expenses of the NMSW after its implementation. These costs should cover the costs for "in-house" first level support (if there is any) and for outsourcing one or more companies for hardware and software maintenance. These companies will perform second level support.

"In-house" support considers that the National Competent Authority (NCA) for the NMSW employs technically skilled personnel that could provide basic support such as password reset, client configuration and basic hardware and software maintenance. The first level support should gather and analyze information about different end users' issues, and determine the best way to resolve their problems. The advantage of having an "in-house" support team is that the response time is quicker, while the costs of outsourcing contracts will be lower. Costs related to the "in-house" support team are their wages and expenses of their continuous training. Assuming that the NCA is also the authority in charge of other systems like VTMIS (Vessel Traffic Monitoring Information System), AIS (Automatic Identification System), etc, the costs for "in-house" support could be shared, as the same personnel could provide support for various systems. This scenario should be recommended for Montenegro. Otherwise, establishing the new "in-house" support team only for the NMSW is not cost-efficient, and outsourcing should be considered as a more appropriate solution.

Hardware maintenance (according to Gartner IT glossary [40]) includes preventive and corrective services that physically repair or optimize the hardware. It also provides hardware warranty upgrades and technical troubleshooting.

Software maintenance is an integral part of a software lifecycle. It consumes most of the budget during the software lifecycle but is needed for many reasons. It ensures that the software satisfies the end-user requirements, corrects faults, implements enhancements and policy changes, interfaces with other software, etc. Software maintenance should also improve the existing functions, and identify security threats and installation of necessary security patches for vulnerabilities. Besides preventive and corrective software maintenance, it is also required to include adaptive and preventive software maintenance. Adaptive support deals with inevitable future changes if the working environment of software changes. Preventive support will take care of future variations in the software that occurs while adding new modules or functionalities in the software.

Therefore, running costs for year i, where $1 \leq i \leq N$ can be formulated as:

$$R_i = P_i + H_i + S_i \quad (3)$$

where P_i are costs of "in-house" first level support team, H_i costs of second level hardware maintenance support and S_i costs of second level software maintenance.

Thus, for the overall costs, the following is provided:

$$C = P + T + M + \sum_{i=1}^{N} R_i = P + H_0 + S_0 + \sum_{j=1}^{M} L_j + M + \\ + \sum_{i=1}^{N} (P_i + H_i + S_i) \quad (4)$$

Regarding factors j and i, it is possible to observe the difference between the developed and undeveloped countries.

The developed countries, assuming that they have still not implemented an NMSW solution, will have a higher number of legacy systems that need to be updated, while developing countries will have a lesser number (or none) of legacy systems to update.

Factor i is also correlated with the development of the country. If the state is developing, N should be higher ($15 \leq N \leq 20$) than for the developed countries $N \leq 15$.

3.3 Benefits of NMSW implementation

The implementation of an NMSW can be highly beneficial for both the state where it is deployed and the stakeholders that are involved in maritime transport [41]. The benefits of the NMSW implementation could be numerous, such as increased revenues through more effective and efficient utilization of human and financial resources for the authorized inspections, transparent and predictable interpretation and application of rules, and enhanced safety and security due to improved and preemptive risk management [25, 30].

Maritime traders could reduce their costs via NMSW by reducing delays through faster clearance and release of their goods, increased transparency, and predictability of rules. Finally, they could deploy

their resources more effectively and efficiently as a result of the one-time electronic submission of information [42].

It is estimated that the introduction of EMSW will cost 29.4 million euro between 2020 and 2030 and will directly save from 22 to 25 million staff hours in the 10-year time frame from 2020 to 2030, which is equivalent to a value of 625 to 720 million euro for all EU member states, while indirectly it will also positively affect the shift of transport mode from road to waterborne transport [43]. An electronic document-exchange system for maritime port operations in the port of Hamburg (Germany) saves approximately 22.5 million euro yearly, mainly through the reduction of labour costs [44]. In Senegal, the National Single Window implementation has reduced the average document collecting time from four days to one day. Customs clearance procedures in Cameroon have been reduced from six days to three hours. The total cargo turnover/dwell time in Benin has decreased from 39 days to six days, and in Malaysia from four days to two days [43].

The NMSW will introduce electronic documents that are better structured and more reliable than paper documents. Such documents may assist in risk management, for example, to determine whether a ship is safe or whether it may be carrying contraband goods or similar. The NMSW enhances automated track and tracing systems of ships and cargo, monitoring of document processing, security, and non-repudiation. In some countries, the introduction of improved clearance led to fewer customs and Port State Control (PSC) inspections [45].

The ability of ports to decrease the transport costs is an essential dimension of their competitiveness. The container freight rates between Shanghai and the Mediterranean are around 739 USD and have dropped by 41% in seven years (2010 – 2016) [46]. In some maritime ports, the paperwork costs still present a significant share of overall transport costs. A World Bank Report states that improving the trade efficiency could be done through port and customs automation. The average export border compliance time for the ports with no electronic data exchange is almost 100 hours, which is more than double compared to the ports with automatic data exchange [47].

3.4 Quantification of benefits

To quantify the benefits of the NMSW implementation, the overall processing time required for each document associated with the port call (arrival and departure) or transit should be determined, before the NMSW implementation (t_1) and after implementation (t_2). The difference between these two working times (t_d) will quantify the time that will be saved after the NMSW deployment for one port call or transit.

$$t_d = t_1 - t_2 \tag{5}$$

Saved time, represented in hours, could be multiplied by the average cost per working hour so that the benefit of the NMSW could be quantified. For this purpose, it is assumed that K documents exist that should be handled by I governmental agencies or data providers (agent or ship master). Overall time consumed for managing all these documents for one ship call before the NMSW implementation is equal to:

$$t_1 = \sum_{i=1}^{I} \sum_{j=1}^{K} t_1^{ij} \tag{6}$$

Likewise, time spent on processing the paperwork during the ship call after the NMSW implementation will be:

$$t_2 = \sum_{i=1}^{I} \sum_{j=1}^{K} t_2^{ij} \tag{7}$$

Furthermore, assuming that an average cost of working hour is p, and that the NMSW will serve V number of vessels yearly, overall benefit B for N years could be calculated through:

$$B = NVpt_d = NVp\left(\sum_{i=1}^{I} \sum_{j=1}^{K} t_1^{ij} - \sum_{i=1}^{I} \sum_{j=1}^{K} t_2^{ij}\right) \tag{8}$$

It is assumed that the NMSW will serve only SOLAS ships. If the NMSW also serves non-SOLAS vessels, that will be an added value feature.

It is also assumed that the NMSW serves V ship calls on an annual basis, out of which C are calls to national ports, while T is the number of transits served by the NMSW annually. Hence:

$$V = C + T \tag{9}$$

4. RESEARCH RESULTS AND DISCUSSION

Montenegro has four ports of national importance, which are open for international traffic: Port of Bar, Marina Bar, Port of Kotor, and Shipyard Bijela [48]. There are other official ports of entry of local importance open for international traffic: Porto Montenegro, Porto Novi, Dukley Marina Budva and Port of Zelenika.

The Port of Bar is the largest and the crucial port in Montenegro. It can handle dry cargo, liquid cargo, general cargo, cruise ships, and ro-ro ships. The Port of Bar also has a Passenger terminal but is mostly oriented to transport of goods. Almost 95% of products coming from the sea to Montenegro are transported through this port. Although the Port of Bar alone is designed to handle 5 million tons of cargo, in the last years, the total cargo load in the whole of Montenegro did not exceed 2 million tons on a yearly basis (*Table 1*). According to data from the Harbour Master Office (HMO) Bar [49], 596 ships called to Port of Bar during 2018, carrying 21,887 passengers and 2,028,172 tons of cargo.

The Port of Kotor has lately become a top-rated cruising destination. The number of cruise ships had almost tripled, while the number of cruise passengers has increased more than tenfold since Montenegro gained independence in the year 2006 [51-53], owing to the fact that the size of the cruisers has also increased. According to the data from the Harbour Master Office Kotor [49], 445 ships called to the port of Kotor and other ports in the Boka Bay during 2018, with 493,444 passengers and 1,276 tons of cargo.

The Marina Bar is dominantly oriented to pleasure crafts, as other points of entry of local importance, while the Shipyard Bijela is in the process of transformation. The HMO Bar issued 1,494 vignettes, while the HMO Kotor issued 3,582 vignettes to foreign pleasure yachts that arrived in the Montenegro ports [49].

More comprehensive and accurate data with a total throughput of maritime traffic in the last twelve years in Montenegro is shown in *Table 1*, as it will be a valuable input for the NMSW concept planning.

It should be emphasized that the MontStat and HMO data on maritime traffic are incoherent. Implementing the NMSW could remove the inconsistencies in data collected by different institutions using different methods and criteria.

As maritime administration and arrival/departure procedures are carried out similarly in Croatia, the steps in the implementation process are explained through the case of the Croatian NSW. Two studies were produced in Croatia in order to enable successful NSW implementation (in 2011 and 2017). Several issues slowed down the implementation of the Croatian NSW: less cooperative stakeholders (who mostly own and operate separate ICT systems), insufficient government support, and financial issues. In the meantime, the Croatian Ministry of the Sea, Transport and Infrastructure has developed a unique Maritime Single Window system (CIMIS) that implements all national-level processes related to the administrative aspect and aspect of navigation safety. In order for CIMIS to be able to exchange data with external systems, a new service CIMISNet has been established, which aims to improve data exchange, reduce administrative procedures among all Port authorities, various Ministries, the Customs administration, Coastal Shipping Agency, Croatian Bureau of Statistics, etc. [2].

Table 1 – Montenegro maritime traffic data for the period 2007-2018 [50-52]

Year	Maritime traffic					
	Passengers in ports	Turnover in ports in tons	Foreign yachts	Passengers on foreign yachts	Cruisers	Cruise passengers
2007	-	-	-	-	174	45,653
2008	-	-	-	-	245	50,554
2009	-	-	-	-	268	70,749
2010	-	1,758,692	2,807	12,877	313	142,259
2011	-	1,749,982	2,964	13,977	319	187,171
2012	-	1,227,877	2,987	14,494	348	244,084
2013	-	1,295,366	3,786	15,778	409	314,961
2014	107,814	1,241,431	3,961	18,129	350	306,397
2015	98,974	1,488,399	4,018	20,859	411	441,513
2016	110,127	1,645,797	4,384	21,544	480	532,337
2017	118,535	2,096,122	4,598	23,001	430	540,445
2018	98,455	1,963,204	4,710	27,685	424	506,198

In this section, the authors have elaborated the current situation of ship reporting formalities in Montenegro and have shown the desired state of the art for eMaritime services in Montenegro. Ultimately, the costs and benefits estimation of the NMSW implementation in Montenegro has been provided.

4.1 Current situation of ship reporting formalities

The process of reporting and clearance of ships calling at Montenegro ports is time-consuming for the shipmasters and ship agents. The shipmaster or ship agent should, for each port call, deliver in a paper form, via fax or e-mail, various documents to different authorities responsible for the ship clearance process. The pre-arrival documents are mainly sent electronically, while port documents are handed in paper form upon arrival. Also, ship masters with dangerous cargo on board transiting ADRIREP [53] Montenegro zone of responsibility are supposed to send information regarding dangerous cargo on board to the MRCC Bar via VHF.

The Law on Maritime Safety [54] requires the agent to electronically report the pre-arrival information 24 hours in advance to the Maritime Safety Department (MSD). The agent mostly reports safety-related information to the MSD, such as the NOA (Notice of Arrival), DGM (Dangerous Goods Manifest - FAL 7), ISPS (Ship pre-arrival security information form for all ships prior to entry into the port of Montenegro), Notification of ship-generated waste, BWR (Ballast water reporting form) and NOD (Notice of Departure). The requested forms should be delivered via e-mail as an XLS file in a specific template. Upon reception, the MSD forwards some of the data to other authorities. Information which is received from the MSD or directly from ship agents, are entered by port operators into their improvized systems (spreadsheet tables and/or stand-alone applications) for their internal use and reporting; therefore, these systems could not be considered as legacy systems. The regulation of this Law [55] appoints the Harbour Master (HM) for issuing "Free Pratique" and "Permit of Vessel's Departure". The agent must electronically send to HM, 24 hours in advance for the arrival and 2 hours before for the departure, all FAL forms and MDH (Maritime Declaration of Health). Other authorities (Police, Health, Customs, etc.) also require reporting via e-mail in advance.

Before the ship arrives in one of the ports in Montenegro, the paper copies of various documents should be prepared by the ship crew, and delivered upon arrival to the authorities responsible for the ship clearance.

4.2 Desired state of the art for eMaritime services

Future NMSW in Montenegro should facilitate maritime traffic by simplifying and minimizing the formalities on arrival, stay and departure of ships in international voyages. It should also introduce electronic reporting, making paper reporting obsolete. The NMSW should be the foundation for the future eMaritime services, as presented in *Figure 2*.

A proposal of the system architecture for the NMSW implementation in Montenegro, as well as the initial steps and tools necessary for the NMSW implementation, are given in [56].

4.3 Costs and Benefits estimation of NMSW implementation

Estimation of costs

As a starting point for cost estimation for setting up and running an NMSW, *Equation 1* will be used and its elements will be discussed.

For estimating the preparation costs (P), MSD experience in the VTMIS project [57] will be used. The overall preparation expenditure for this project was 150,000 euro. The preparation funds covered all relevant studies, including a draft of the national VTMIS regulation and tender preparation. The same amount is proposed for the NMSW preparation. Also, it is recommended to plan the funds for two study visits to two EU countries. The visits are beneficial for people who will be leading the NMSW project implementation. It is also proposed that, along with the preparation expenses, the expenses of the Technical Assistance team should be included during the tendering process.

For the implementation of the NMSW, a turnkey solution for hardware, software and training is suggested. The estimation for equipment (H_0), software (S_0) and human resources costs (M) is 500,000 euro [58]. Bearing in mind that, at the moment, there are no legacy systems in Montenegro that should be updated, the overall implementation costs are estimated at 500,000 euro.

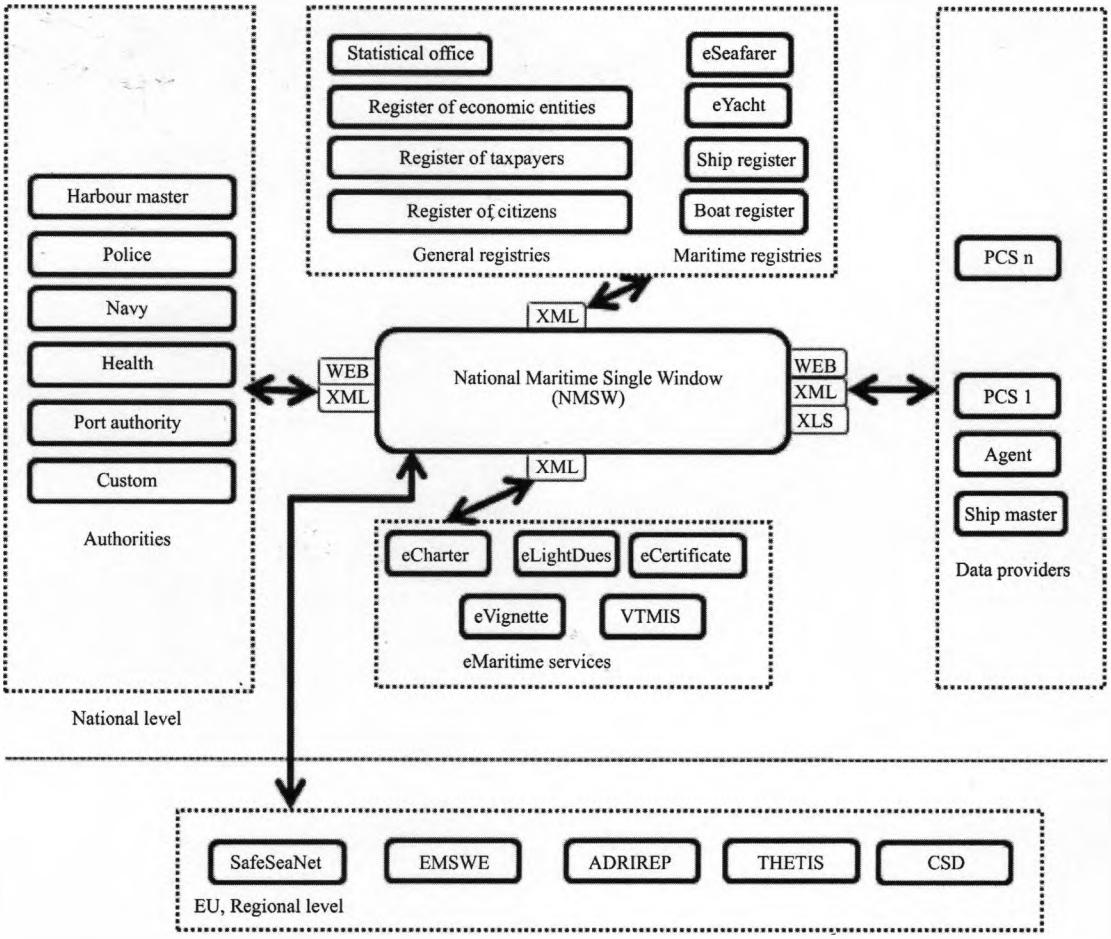

Figure 2 – TO-BE model of communication among stakeholders for ship clearance in Montenegro (authors)

The MSD (as future NCA for NMSW) already employs skilled staff for technical maintenance of VTMIS and ICT equipment. Following the scenario of VTMIS maintenance, it is suggested that the existing technical staff should be trained to carry out the first level support services. Costs of their additional training should be covered by the implementation budget. Same as for the implementation phase, a turnkey solution for the needed outsourced maintenance is suggested. If possible, one company should be a single point of contact for both hardware and software maintenance issues. The implementation of the VTMIS system was worth 1,800,000 euro, while the yearly maintenance contracts, including spare parts, were 67,938.89 euro for the year 2018 [59] and 64,995.00 euro for the year 2019 [60]. For the year 2020, the deal of a total worth of 89,382.00 euro will be signed [61]. It is possible to calculate that the mean value of the yearly maintenance contract with spare parts for the VTMIS system is 4.1% of the implementation costs.

The maintenance of VTMIS is more complex, bearing in mind different types of state-of-the-art telecommunication equipment, such as solid-state radars, direction finders, radio links, VHF and AIS transponders, etc., all positioned at locations with severe weather conditions (thunderstorms and lightning). The majority of corrective and preventive maintenance operations on the VTMIS system are performed by the MSD technical staff. The NMSW maintenance contract will most likely require fewer hardware interventions and will mostly be focused on software improvements and changes. The highly skilled team (such as developers) is needed, and for the time being, the MSD does not employ such staff [62]. It can be concluded that the maintenance contract shall not exceed 4.1% of the total value of implementation, which

is 20,500.00 euro yearly. This figure is based upon the experience of MSD with VTMIS maintenance contracts in the last three years.

Finally, to determine the overall costs, NMSW life expectancy of 15 years is assumed. According to *Equation 4*:

$$C = P + T + \sum_{i=1}^{N} R_i = 150,000 + 500,000 + 15 \cdot 20,500 = \\ = 957,500 €$$

Estimation of benefits

To quantify the benefits of the NMSW implementation in Montenegro based on *Equation 8*, several things will be assumed:

1) The number of SOLAS ships calling at Montenegro ports is expected to be 1,000 on a yearly basis;
2) The lifecycle of the NMSW is 15 years;
3) To estimate the overall time that can be saved per ship call by using an electronic NMSW, the research results from [63] and [64] are used. Research in Croatia has shown 3.7 person-hours working time savings after reengineering the process "Vessel arrival to the port". Bearing in mind that the procedures for ship calls in Montenegro are similar to the ones used in Croatia, the research results from [63] and [64] can be used to quantify the benefits for Montenegro.

The average monthly gross salary in Montenegro in the "Transport and Storage" sector, according to the latest data from the Statistical Office of Montenegro is 812 euro [65]. The average price of the working hour (p) can be obtained by dividing the gross average wage with 174 (the number of working hours in one month). Therefore, the average price of the working hour in the "Transport and Storage" sector in Montenegro is 4.67 euro per hour.

Bearing in mind the above assumptions, the overall quantitative benefit of the NMSW will be:

$$B = NVpt_d = 15 \cdot 1,000 \cdot \frac{3.7x}{174h} \cdot 812 = 15 \cdot 17,266.67 = \\ = 259,000.00 €$$

Apparently, the overall quantitative benefits are lower than the costs. Moreover, the quantitative benefits on a yearly basis are lower than the running costs of the system. It has to be noted that many topics in quantitative benefit estimation were not included. Only the benefits for SOLAS ships have been quantified. According to *Table 1*, there is a growing tendency of foreign yachts calling at Montenegro ports and marinas. Undoubtedly, if pleasure crafts are included in the NMSW, more savings in the working hours will be achieved, while revenues from Vignettes will be higher and more control on yacht rental will lead to more income for the country. Likewise, Montenegro will become more attractive as a yachting destination, owing to simplified and timely clearance procedures.

Advanced reporting, in combination with the VTMIS system, will help organize maritime traffic in congested areas like the Boka Bay. It will increase safety at sea and have an impact on reducing emissions. Police and customs will have the possibility to improve risk assessment and influence in mitigation of criminal activities that will decrease transport costs [38].

Light dues paid by commercial ships entering ports in Montenegro are a primary source of income for the MSD. Vessels can receive discounts depending on the number of entries in the Montenegro waters. The process of invoicing will be more transparent and with less workload, if eLightDues are introduced as a part of an NMSW in Montenegro. The pilot and tug service data exchange will be an added value for the system if pilots and tugs are incorporated in the NMSW. Moreover, pilot engagements could be cross-checked in advance with the seafarer database (eSeafarer module) if the appointed pilot has requested certificates for that area. The NMSW will imply shorter port time for the ships and shorter export/import delays in Montenegro. It will definitely position Montenegro economy higher in "Making Business reports" issued by the World Bank.

5. CONCLUSION

The NMSW facilitates communication among stakeholders in maritime trade and enhances maritime transport efficiency, safety, reliability, and security. Many developed countries have already implemented the NMSW, while in some regions, such as the EU, the NMSW has become mandatory. For further promotion of maritime trade facilitation and the use of standardized electronic systems for ship clearance at the global level, IMO has agreed to amend the FAL Convention and the NMSW has become mandatory since April 2019. This necessary system should at least cover the reporting documents included in the FAL Convention.

Previous research related to NMSW shows that previous papers and studies are mostly focused on ports or systems located in the developed countries. Little attention has been given to developing coastal

states that have to fulfill the obligations stemming from the signing of the FAL convention. Thus, in this paper a comprehensive overview of the NMSW has been provided, as well as the cost-benefit analysis of the NMSW implementation, with the case study of Montenegro as a representative of a small developing country.

The main concern for the developing (and smaller) countries is the cost of the NMSW implementation, and the running costs afterward. Creating a Regional NMSW that could encompass the needs of several countries is one way of cost reduction. Such initiatives already exist in the Adriatic-Ionian Region, European Union (where direct benefits are estimated to be several times higher than the costs) and in some smaller developing island countries. However, regional and global Single Windows or cloud solutions pose a threat to data privacy. The issue of how to protect the commercial data will have to be addressed during the implementation. Moreover, in some countries such as Montenegro, it is forbidden for public servers of governmental entities to be located outside the country.

Regardless of all obstacles and expenses in the NMSW implementation, the NMSW can definitely be recommended for the smaller developing countries. In this paper, the economic benefits have been quantified such as the value of time and labour saved. Numerous other benefits that could not be quantified are mentioned, which can be subject to further research, such as the prevention of illegal activities and corruption, decrease in tax frauds and smuggling, and in this way, increasing revenues and overall efficiency.

It is important to simplify the national procedures and harmonize the reporting formalities at the national level before the NMSW implementation. The harmonization process is time-consuming, but it will enable the stakeholders (mainly the Ministry of Transport and Maritime Affairs of Montenegro and Maritime Safety Department) to fully benefit from the NMSW system. Not being a member of the EU, Montenegro has expressed interest to participate as observer in the Expert group on Maritime administrative simplification and electronic information services (eMS group), SafeSeaNet Group (managed by EMSA) and the High-Level Steering Group on SafeSeaNet (managed by the European Commission), by sending official request to the European Commission in 2014.

A large challenge is to introduce the NMSW in conjunction with the existing legacy ICT infrastructure. Transition economies and smaller countries, such as Montenegro, should have fewer issues with the legacy systems, because fewer legacy systems are implemented.

Finally, for tourism-dependent destinations such as Montenegro and numerous small developing countries, adding non-SOLAS vessels and pleasure crafts in the NMSW will provide added value, creating more income for the country. All this will lead to a higher ranking in the "Doing business" list, which is very important for countries that largely depend on foreign investments.

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JEDINSTVENI NACIONALNI POMORSKI PROZOR – ANALIZA TROŠKOVA I KORISTI NA STUDIJI SLUČAJA CRNE GORE

SAŽETAK

U ovom radu istražuju se troškovi i koristi Jedinstvenog nacionalnog pomorskog prozora (NMSW) u obalnim državama koje imaju ograničene ljudske resurse i infrastrukturu vezane za pomorski saobraćaj. Predložena je opšta metoda sprovođenja analize troškova i koristi prilikom uvođenja NMSW-a. Koristeći ovu metodu i ulazne podatke za Crnu Goru, kao primjer male obalne države, autori procjenjuju može li ulaganje u primjenu NMSW-a biti korisno za obalne države koje raspolažu ograničenim resursima.

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DRITARJA UNIKE KOMBËTARE NË DETARI – ANALIZA E SHPENZIMEVE DHE TË ARDHURAVE NË RASTIN STUDIMOR MALI I ZI

PËRMBLEDHJE

Në këtë punim hulumtohen shpenzimet dhe të ardhurat e Dritares Unike Kombëtare të Detarisë (NMSW - National Maritime Single Window) në lidhje me komunikacionin detar në shtetet bregdetare të cilat kanë burime të kufizuara në njerëz dhe infrastrukturë. Është propozuar metoda e përgjithshme e zbatimit të analizës së shpenzimeve dhe të ardhurave në rastin e implementimit të NMSW-së. Duke shfrytëzuar këtë metodë dhe të dhënat hyrëse për Malin e Zi, si shembull i një shteti të vogël bregdetar, autorët vlerësojnë se a mund të jetë i dobishëm investimi në implementim të NMSW-së për shtetet bregdetare me resurse të kufizuara.

FJALË KYÇE

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Establishing a National Maritime Single Window in Small Coastal Countries

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Abstract — **This paper researches and identifies the optimal model for establishing a National Maritime Single Window in small coastal countries, respecting their limited resources and thus building upon existing legacy maritime information and communications systems. Specifically, the authors analyze the current state of the available ICT capabilities in maritime sector of Montenegro, which is a representative of a small coastal country, and their integration into the general National Maritime Single Window platform operated on a national level by the Montenegrin Administration for Maritime Safety and Port Management. Based on this, a model for establishing a National Maritime Single Window in Montenegro is proposed, together with the system's cost-benefit analysis. The proposed model of National Maritime Single Window architecture provides a comprehensive network and two data centers layouts, development, deployment and exploitation, overall maintenance, and security requirements.**

Keywords — National Maritime Single Window, small coastal countries, legacy systems, Montenegro

I. INTRODUCTION

Contemporary maritime traffic and trade operate in highly developed information and communications technology (ICT) environment. One of the most important ongoing trends in maritime services delivery is the National Maritime Single Window (NMSW). This software platform enables fast and accurate transfer of maritime information/data between all included users in various directions (ship-ship, ship-shore, shore-ship and shore-shore) [1], [2].

NMSW is based on an integrated system for easier and facilitated unique entry of relevant maritime data and vessel documentation per arrival or departure. NMSW was initially introduced in Far East countries such as Singapore, Japan and South Korea, aiming to improve numerous maritime procedures related to cargo, vessels and passengers, where public and private stakeholders exchange relevant maritime data with national authorities [2].

At the EU level, this system is currently under development as European Maritime Single Window (EWSW) for all member states [2]. NMSW enables the digital reporting via a single portal, without duplication, of all information required by public authorities concerning the arrival, stay and departure of vessels and cargo/passengers onboard [3]. The main purpose of NMSW introduction is to facilitate maritime operation/formalities by faster documentation submission procedures operating in the more accurate and cost-efficient manner.

For maritime trade and customs, Trade Single Windows (TSW) have been designed and adapted to business needs of inland trade institutions. This type of general Single Window, described in [4] is generally implemented at national level and adapted to cover all transport modes such as air, rail and road, designed on the base of multi or bilateral trade and customs agreements, containing all necessary tariffs and documentation requirements. This system, together with NMSW creates an integrated model for establishment and seamless connection of particular ports' information systems, including Port Community System – PCS, Port Management Information system – PMIS, and Vessel Traffic Information System – VTIS, as well. The classification system or taxonomy for these information management systems is presented in [4].

Further to the technical capabilities, NMSW generally consists of essential elements such as hardware and network components with appropriate system software with the Service Oriented Architecture (SOA) design style [5], [6]. Therefore, in the process of NMSW implementation and deployment, national maritime authorities together with related stakeholders should upgrade their existing legacy IT systems in order to exchange information and electronically access the documents submitted by maritime trade operators.

The aim of this paper is to propose an optimal model for NMSW and recommend a cost-effective and reliable technical solution. The paper is structured as follows. After introductory part, Section II provides the analysis of maritime sector in Montenegro, considering the legal framework for NMSW implementation and a brief overview of available national ICT legacy systems. Section III presents a strategic approach for NMSW implementation, covering the financial efficiency aspects as well as the alternative strategies. The most important consideration on proposed model of NMSW architecture is provided in Section IV, bringing the detailed overview of hardware and software components comprising of indicative NMSW architecture, network and data centers layouts, development, operations, maintenance and security requirements for NMSW. Finally, the paper is summarized with concluding remarks.

II. MONTENEGRO MARITIME SECTOR ANALYSIS

Prior to NMSW implementation, Montenegro maritime sector should be analyzed by implementing the following activities.

A. Stakeholders mapping

The identification of relevant stakeholders and the processes to be covered within the NMSW system is the initial step of implementation, along with state-level decision making on required legislative changes. Both the public actors and the private national bodies related to the process of vessel clearance should be enumerated and their roles/capabilities determined in order to properly design the NMSW system. Specifically, in Montenegro, the most relevant governmental agencies are Harbour Masters offices at Bar and Kotor, Administration for Maritime Safety and Port Management (AMSPM) as anchored institution for operating NMSW, Police Directorate, Customs and Administration for Inspections. On the private stakeholder side, there are national ports, ship and cargo agents, shipping/passenger/cruise companies, pilot services and concessionaires. Other maritime related stakeholders are Montenegro Navy, Statistics Bureau (MONSTAT) [7] and other ministries in their own area of remit.

B. Legal framework

Formally, NMSW is operated within the boundaries defined by the EU directives, international conventions and national legislation. In relation to the EU requirements Montenegro has initiated the implementation of relevant maritime regulations/directives through systems as CleanSeaNet satellite detection system, EU LRIT (Long Range Identification Tracking) Centre, and EU regime on Port State Control [8]. Baseline directives are Directive 2010/65/EU on reporting formalities for ships arriving in and/or departing from ports of the Member States and Regulation (EU) 2019/1239 establishing a European MSW environment (EMSWe). The relevant IMO convention is the Convention on Facilitation of International Maritime Traffic [9]. This convention aims to prevent delays in maritime transport, foster cooperation between Member Countries and unify the vessel clearance and formalities by introducing the common electronic information exchange between ships and ports.

C. Ship Clearance Process

As regulated by Montenegrin Law on Navigation Safety, various pre-arrival notifications should be submitted 24 hours in advance, mainly electronically in order to grant clearance to a vessel [7]. These documents must be submitted through Port of Bar Port Community System (PCS) and e-mail (scanned paper documents, Excel/Word/PDF files), using the following steps:

- Notification of Arrival (NOA) distributed to all subject of MSW system and specifically the FAL 1-7 (to HMO), FAL 7 - Dangerous Goods Manifest (to AMSPM), FAL 5 and 6 - Crew and Passengers lists (to Police), FAL 2 – Cargo Declaration, FAL 3 – Ship's Stores Declaration, FAL 4 – Crew's Effects Declaration (to Customs), and Health Declaration to Health Authority Centre. During vessel's approach to the Montenegrin VTS zone (12 nautical miles), she must report its arrival to VTS Montenegro and the AMSPM. If everything related to the clearance process is in order, then the HMO issues "Free Pratique" for this particular port call.
- Notice of Departure (NOD) submitted to AMSPM upon departure from Montenegro waters as well as the re-submission of other documents to the mentioned authorities provided on arrival as described. If everything related to the vessel request for departure is in order, then the HMO issues "Permit of vessels departure".

D. ICT legacy systems inventory

The analysis of available national public and private stakeholder's capacities assumes the overview of IT systems inventory and operative procedures of each institution participating in the NMSW. Montenegrin agencies use numerous IT systems and versatile digital technologies that should be appropriately interconnected in order to share and transfer the entry documents in a structured form. This includes systems like LUBARIS (module upgraded as part of Port Community System framework), e-services platforms (g2c portal as a part of e-Government services) for accessing the databases generated by information centers, and the New Computerized Transit System (NCTS-P5), currently under development. Some institutions manage the administrative formalities by non-structured entry in predefined Microsoft Word and Excel forms. Commercial stakeholders use custom-built or package-based commercial ERP, CRM and IBIS systems under their own control in order to process data relevant for ships and cargo traffic management [7].

III. STRATEGIC APPROACH

A. Cost efficiency model

Considering that the MSW is based on national horizontal and vertical integration among involved stakeholders into one IT-compatible system, an economic model of its implementation with clear cost-efficiency estimation is of utmost significance. The main identified determinants of this model are costs of implementation (using feasibility studies, preparation, procurement of hardware, installation, testing, human resources training) and maintenance costs (daily operations, updating, technical and running costs, etc), which need to be punctually quantified in order to have aligned policymaking and architecture design. The other side of this model is the additional benefit of NMSW implementation: efficiency and facilitation of overall documentation and electronic forms submission process as well as communication with state authorities [3], [6].

Therefore, the cost efficiency of NMSW can be analyzed using the following implementation phases:

- The project team selection and management,
- Hardware, network, and system software components planning and design,
- Development and integration tools,

- Post-project activities and technical maintenance management.

This approach yields cost-efficient results by opening up the data exchange specifications and adaptability to future needs while the stakeholders become accustomed to using the newly developed functionalities instead of manual procedures. Also, financial sustainability should be achieved by appropriately determining the NMSW revenue model which includes the level of required investment and ongoing operational costs.

B. *Analysis of the NMSW financing model*

Following the previously defined cost categories, the financial model is set of relative technical variables and some fixed values, in detail described in [10]. In the case study made for introduction of NMSW in Montenegro, the overall costs are estimated to 957 500 EUR, having that NMSW life expectancy of 15 years is assumed. On the other side, benefits are quantified on 259 000 EUR. It must be noted that only the benefits for SOLAS ships have been quantified [10].

Based on above advantages, it is important to point out the overall impact of NMSW implementation on three aspects of sustainability (economic, environmental and social) of seaport and national maritime affairs businesses. Actually, economic sustainability manifests through long-term cost savings, data re-use, decreased processing time, reduced fees charges, document delivery and border crossing time, elimination of paper documents and acceleration of customs procedures as well as improved communication and information exchange between commercial and administrative stakeholders [2].

C. *Alternatives for NMSW implementation*

Currently, the digitalized maritime information exchange for ships calls in European ports, is regulated by EU Reporting Formalities Directive (RFD), entered into force in 2015, which simplifies and harmonizes the administrative procedures (reporting formalities from ships arriving in and/or departing from ports) applied to maritime transport. Following the continuous development of maritime ICT, this platform is planned to be superseded by the EMSWe that is expected to apply from 2025 [3]. This advanced environment for SW in Europe will fully harmonize and standardize software interfaces to ship and port operators as well as all related commercial and administrative stakeholders, with the purpose of required information provision to all across EU. The NMSW in this framework will be a coordination mechanism and specific router of all relevant information (with technical converter between data formats where needed) from and to all maritime industry operators interactively concerning the port authorities, border control agencies, SafeSeaNet administrations, statistics and customs interfaces, and other entities [2].

Specifically, for Montenegro case, several scenarios were considered and based on the evaluation criteria the most viable and sustainable alternative modes for NMSW are the following:

- Paid NMSW models (meaning that software is treated as a service for maritime transport users),
- Out-of-box (off the shelf) NMSW products. This group assumes two types of environments with specific stakeholders. The first group refers to yachts, private guests, and in general yacht marina management, which could be implemented in some future phase of NMSW, after the phase for SOLAS-covered ships is well introduced and operated. The second group consists of modules for commercial cargo management software and their functions related to shipping calls are operated by PCS, TOS (*Terminal Operator System*) or e-TMS (*electronic Transport Management System*).

Herewith, one of the most optimal scenarios for full operability of NMSW could be done by adopting the EMSWe logical framework set by the EU. Thus, using a "*top-down*" approach, where more than a decade long EU experience in the creation of the formal logical data exchange model in the maritime sector will be adapted to local needs. Also, within the alternatives range and as a result of this analysis, it is indicatively suggested as a more viable alternative solution the introduction of EMSWe logical model, built upon a custom system aligned with its base requirements. Furthermore, the availability of current EU funding at the initial stage of development of EMSWe model includes pre-set requirements for reporting and interconnectivity with SafeSeaNet and other international reporting systems. This is expected to contribute to speeding up the overall development process and facilitating avoidance of repeated engineering of functionalities that already exist [7].

IV. PROPOSED SYSTEM ARCHITECTURE

A. *Indicative NMSW architecture*

As already recognized, NMSW represents an integral and common information framework with single point of data entry for all documents needed by the relevant governmental maritime authorities and distributed among involved stakeholders. Responsible maritime authorities of Montenegro have identified the need of maritime transport stakeholders for an efficient formal documentation submission according to the national law and initiated a plan for an integrative maritime system design development accordingly. Considering the existing legacy ICT systems and available technologies used in regular operations of all involved institutions, the following structural approach proposes an indicative NMSW architecture design and deployment. Model assumption is that NMSW system is following the SOA concept, where software and hardware systems are independent, with embedded scalability and reusability of its modules. Furthermore, the use of Enterprise Service Bus (EBS) is recommended for the NMSW data processing, as a software architecture model for distributed computing. It is used to facilitate the implementation of communication between mutually interacting maritime software applications in a SOA environment [5]. Considering that guidelines for EMSW require the creation of a redundant site as a consequence of the required Service Level Agreement (SLA) [3], and the same is simultaneously a professionally identified

requirement, Montenegrin NMSW requires two locations in active-active mode.

In terms of the physical layout and components, and considering immediate availability of suitable venues in most relevant cases, NMSW system consists of the following essential elements:

- NMSW administrator's office,
- Data Centre #1 (location #1),
- Data Centre #2 (location #2),
- Education/Presentation centre.

The MSW administrator's office should be separated from other premises with NMSW servers/equipment. Data Centre #1 is a primary location of all NMSW hardware and network equipment (Web service servers, database servers, backup server, and network infrastructure) necessary to establish MSW operations with sufficient capacity to store all data backup to hard drives and then offload to tapes. This centre has to be networked to Data Centre #2, via the Internet using a separate media data link and a logical tunnel. Data Centre #2 plays the role of redundant location with all hardware and network equipment in case that Data Centre #1 fails to perform MSW functionalities due to any reason. The general layout containing the key IT components is shown in Figure 1.

NMSW will form a part of the Critical National Infrastructure after accession to the EU, and since "go-live", it will formally be its part. Other scenarios might include cloud-cloud or on-premises-cloud solutions, but at least two locations, physical or virtual (and in this case physical), are *de facto* industry standard to be implemented.

B. *Network layout*

Following the proposed basic concept of NMSW, it is assumed that Network architecture requires a pair of devices for UTM (*Unified Threat Management*), combined firewall capabilities in all applicable locations in Active-Passive cluster and full mesh configuration connected internally towards three network switches. This avoids the network's single point of failure in the primary location and ensures HA (*High Availability*). Secondary location requires a single UTM device and a pair of access switches. UTM has configured IP SLA that performs ISP link quality of service and in case of packet loss of higher latency, UTM device becomes active on the secondary location and all Internet traffic exits on that side, rendering the secondary site as active. In the case of primary site recovery, the situation is reverted back. Recovery in both directions must be automatic, without the administrator's intervention.

Both locations require a permanent data link while ISP CPE equipment should have 4G SIM cards for the over-the-air backup or use other physical media for primary link failover. Dynamic OSPF routing protocol throughout the network should be implemented. The primary location has higher priority, therefore does all the traffic routed through it.

Primary and secondary locations are directly connected using the aggregated links using a single-mode optical cable. IPSEC tunnel using WAN links could be used as a heartbeat witness for the VSAN cluster. Considering that the same network will be used in both locations, the VRRP protocol should be set on core switches. Except for the two physical IP addresses, it should have a single virtual address shared by stacks of the primary and secondary location. Virtual gateway is anticipated in the primary stack location, caused by higher priority.

C. *Data centres layout*

In both locations, a physical server needs to run virtualization capabilities. SAN (*Storage Area Network*) storage/appliance is expected, either in form of a physical

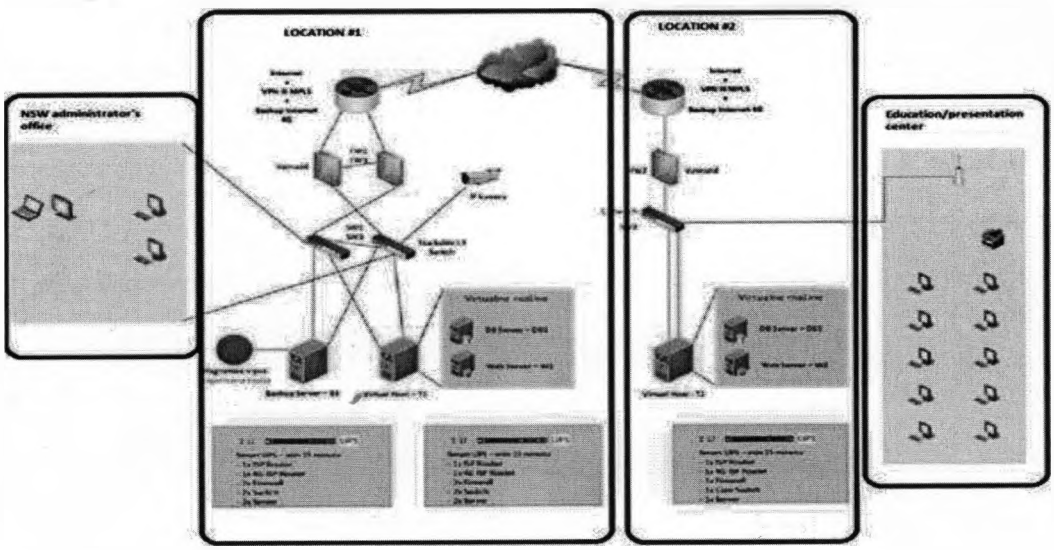

Fig. 1. NMSW design proposal: hardware and network perspective (authors)

SAN or logical (software) SAN. Furthermore, the first location needs an additional physical server for backup purposes. The required backup policy is that newer data and recent changes are offloaded to slower and cheaper local hard drives (repository) connected to the backup server.

Servers in the data centre need to have adequate capacity (storage, memory, and processing power) in order to support initial and intermediate NMSW development. First (T1) and second (T2) servers in data centres need to be physical on-premises servers. Each server needs to be a host for virtual machines running on VMWare vSphere, or similar virtualization platform. VMware vSphere Hypervisor (ESXi) Essentials Plus, or similar software needs to be installed.

Capacity needs to be dimensioned in order to allow for at least two separate environments: test (Quality Assurance/User Acceptance Testing) and production, which need to be strictly divided. The installed capacity of any resource (memory, hard drives, network) also needs to ensure easy scalability and extension when any capacity measure that is systematically overseen reaches 70 %, aligning the capacity management with industry's best practices [11]. It is expected that this infrastructure could initially serve a dozen or more virtual servers supporting integral NMSW operations, mostly concerning the following ones: servers for application, database, web services, reporting, digital signature, logging, e-mail – SMTP server and System server instances (DNS, DHCP, heartbeat). Most of these servers run on instances in both locations.

Also, one of the essential components of general NMSW is the web server should be installed on a Linux operating system or equivalent that supports a minimum of the two most common web server platforms, such as Apache, nginx, IIS or similar. User access to the web server, i.e. the content on the web server (website) must be supported by a license agreement enabling an unlimited number of users and devices that are able to access the NMSW system. Therefore, the web server must have the possibility of mirror synchronous replication (mirroring) of all web data to another location. Along with the web server, its accompanying database software must be configured in a way that is not directly accessible from the Internet, i.e. it must be located behind a firewall.

Specifically, hard drives in local software-defined storage (or separate SAN (if chosen)) need to use an adequate RAID configuration, in order to balance between speed, high availability, and capacity. The same is valid for system and other hard and flash drives in physical servers. Hard drives in local software-defined storage (or separate SAN (if chosen)) need to use an adequate RAID configuration, in order to balance between speed, high availability, and capacity. The same is valid for system and other hard and flash drives in physical servers. This hardware is also used to operate smaller system components required to have fully functioning of strong anti-virus programs, load balancing, message brokering and appropriate PKI (private key) management.

Additionally, smart-UPS devices are required in server rooms, which could power all network and server devices in the server room under full load for a minimum of 30 minutes. Smart UPSs must allow autonomous shutdown of all virtual and physical servers and other equipment in case of a power outage on the external power source that supplies the entire system.

D. NMSW development, deployment, operations and maintenance

The development phase is a complex process in which the responsible Maritime Authority introduces the NMSW by performing several interconnected activities. During initial research that included open interviews with the experts, it has been identified that the most relevant activities at this stage are the following:

- Creating detailed functional and technical documentation for the NMSW, including process, document, and data analysis of individual data element levels;
- Creating final architecture of the hardware and network equipment to be delivered, including system software to be used with them;
- Delivery, installation of the network and data centre hardware;
- Installation of the supporting system software on the data centre hardware, development services for the NMSW;
- Training services for the selected stakeholders.

After setting the above development activities, the NMSW governing authority enters the system exploitation phase in which some assistance is needed by technical companies. In this phase the following core activities can be anticipated:

- Monitoring the system for adequate operation mode;
- Performing security checks on the servers and other network equipment;
- Accepting service desk/helpdesk requests from end-users, classifying them according to priority and acting on them to full resolution;
- Monitoring accessory systems for proper functioning, both from the technical and administrative viewpoint;
- Checking the backup consistency and performing periodical restore tests;
- Continual improvement of all components.

Also, many stated NMSW hardware and software components require purchase and maintenance of the *„subscription“*, *„maintenance packs“*, *„maintenance service“* or *„care packs“*. These are software-enabled features that maintain full capability and usability of the system software, hardware and network components during their exploitation.

E. Security policy requirements

NMSW system should be designed and developed with respecting the following intrinsic requirements of data storage security policy:

1. System platform should be highly reliable and efficient.

2. Continued, smooth and independent operating of all NMSW system components in case of failure of one of the Data Centres or any of its integral parts.
3. NMSW system must contain integrated subsystems for monitoring and review of system operation, in relation to monitoring the internal performance of the system.
4. NMSW must have an integrated ability to report to system administrators the levels of critical events that trigger the notification process (automatically or via e-mail).
5. Data stored in NMSW system databases including digital content, audio, video, streaming data, text, etc. must be encrypted using appropriate encryption strength.

All these requirements need to address the following areas: Data storage, availability, security, personal data protection and classification of data requirements as prescribed in the reference document by European Commission Directorate-General for Mobility and Transport, Directorate D – Logistics, maritime & land transport and passenger rights D.1 – Maritime transport & logistics, „*National Single Window Guidelines*" [12]. In general, security policy requirements, except the listed ones, should cover also the Business Continuity Planning (BCP), Disaster Recovery Policies (DRP), compliance to professional standard ISO/IEC 27002: 2013, EU GDPR 2016/679 and Act on the Implementation of the General Data Protection Regulation (OG 42/2018), Public key system and electronic signature, and finally, the protection of intellectual property, design and delivery of program source code to the Client should be fully met.

V. CONCLUSION

The general architecture of NMSW requires an efficient set of various software systems based on available hardware components in interactive collaboration between all maritime sector participating stakeholders for the purpose of facilitation of the ship reporting formalities during its regular ship calls in seaports.

Interoperability of presented NMSW components is carefully taken into consideration having in mind the upgrading possibilities of maritime information system operated by Montenegrin commercial and administrative entities. The core assets for NMSW architecture building and its implementation within AMSPM premises are specified in a model concerning the data centers to design, the layout of all ICT components, cost-efficiency analysis, development, and operations.

Having in mind that Montenegro represents a "*small coastal state*", experiences from Montenegro can be easily transferred to other small coastal states which plan to deploy the NMSW. Future work in this area may include the research in possibilities of inclusion of cloud and hybrid cloud service providers in the model for various integration purposes, and identification of requirements they need to satisfy to be viable candidates, especially from the data custody and legal point of view. Furthermore, preliminary findings have shown that the inclusion of such technologies significantly increases the total cost of ownership, and especially its operative cost component. Therefore, a possible venue in research would be to identify the drivers and obstacles for the exploitation of various other cloud models in NSW implementation, especially considering that numerous small coastal countries do not have a local presence of reliable data centers for operations of the critical national infrastructure.

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A Taxonomy for Single Window Environments in Seaports

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Abstract

A Single Window is defined as a facility that allows traders to submit mandatory documentation through a single entry point. A seaport is an important hub for international and national trade and the single window is a critical component for facilitation of trade. In a seaport, one will almost always find a number of different information gateways that individually satisfies the definition of a single window. The World Customs Organization now uses the term "Single Window Environment" to reflect that trade related information exchanges are handled through a multiplicity of reporting gateways. This paper will identify and analyse the different types of single windows commonly found in seaports and develop a general taxonomy for the single window environment. Its purpose is to supply a simple and consistent framework for discussing different types of single windows, what roles these single windows have and how their functionality can be integrated or interconnected. The classification method can be applied in other trade hubs than seaports, but as traffic and trade systems differ between the different hubs, the taxonomy presented here will be specific for seaborne trade.

Keywords: Single Window, Trade facilitation, Ship reporting

1 Introduction

Single windows are very important mechanisms to reduce trade costs and delays. Automated electronic single windows are necessary to operate large ports efficiently and ensure low cost and fast processing of imports and exports. South Korea claims to have reduced costs for Korean companies with 2600 Billion Won (ca. USD 2.3 Billion) yearly by the implementation of their e-Trade system (Yang 2009). Also, mid-size ports could benefit by implementing port single window. Research done in Croatia has shown that even if it is a large investment, it will bring substantial savings and it will increase short sea shipping and competitiveness of ports (Tijan 2012, Bukljaš 2010). Montenegro considers single window implementation as prerequisite for further development of maritime sector in country (Kapidani 2015).

The single window is also an important complexity-reducing factor for ships in international trade. The IMO Facilitation Convention was adopted by the International Conference on Facilitation of Maritime Travel in 1965 and entered into force on March 5th 1967. This convention limits the general reporting requirements for ships entering into foreign ports and defines a number of standard reporting forms ("FAL forms") that shall be used by the contracting governments for this purpose.

IMO has introduced e-navigation as a concept and vision to harmonize navigation systems and ashore services in maritime sector in order to satisfy end-user needs. According to the IMO, one of the benefits of e-navigation will be higher efficiency and reduced costs in maritime transport. These benefits will be enabled by automated and standardized reporting formalities, leading to reduced administrative burden that could be achieved by implementing Maritime Single Window (Kapidani 2015).

In April 2016, the IMO Facilitation (FAL) Committee agreed to amend the FAL Convention to require the implementation of electronic maritime single windows on an international level by April 2019. This new electronic single window covers the trade documentation specified in the FAL Convention.

This can be seen as a follow up to the considerable efforts on simplifying reporting formalities and administrative procedures related to maritime transport that have been made at European Union level. Member states were obliged to establish National Single Window for receiving the ship port-call formalities by 1 June 2015 (EU 2010). Furthermore, the information provided to NSW should be submitted electronically and only once.

The FAL Convention amendment is among the latest events that have increased the interest in single windows and how they can be deployed. Unfortunately, in literature as well as in public discussions there have been some divergent opinions on what constitutes a single window and how the different types should be labelled and interconnected. At EU level, based on feedback from stakeholders, the introduction of NSW did not meet initial expectations. Among others, due to the lack of binding technical specifications, the expected level of simplification and harmonization was not achieved (HLSG 2015). There is now a "refit evaluation" going on in EU of the existing legislation related to NSW to identify and address inconsistencies and gaps related to simplification of ship reporting formalities and burden reduction for ship crew (Refit 2016).

The aim of this paper is to develop a consistent and simple framework for describing the components of seaport single window environments and to discuss some of the standardisation issues that may have led to the problems in implementing the single window. This paper will mainly take the viewpoint from the ship, but will also discuss how other information management systems links up to the ship related single windows.

2 Different information systems in port

Ports are the meeting places for different transport systems as well as hubs for trade and commerce. The operation of the port requires a close coordination between a large number of processes that are generally not very homogeneous. Some processes are particular to one transport mode and many are not related to transport at all. This means that a maritime shipping operation meets a large spectre of different views on their activities, even within related activities. See, e.g. Heilig and Voss (2016) for a more thorough discussion of this.

Some of the processes that are most relevant for the maritime operations are briefly described in the following paragraphs.

2.1 Nautical safety in fairways

Maintaining safety in fairways and coastal waters includes position monitoring, dangerous goods recording, traffic management etc. These processes are typically operated by competent coastal authorities, which could also implement a VTS (Vessel Traffic Service). The VTS is designed to improve the safety and efficiency of vessel traffic and to protect the environment. In this scenario we mainly consider coastal VTS that is a service provided to assist the safe and expeditious passage of shipping through coastal waters, particularly where there is a high density of maritime traffic or an area of environmental sensitivity or through difficult navigation conditions. (IALA 2016).

Information may be collected from mandatory ship reporting systems such as in the Gulf of Finland and in the Adriatic (IMO 2002), ship reports via the single window, LRIT (Long Range Identification and Tracking), maritime surveillance radars and AIS (Automatic Identification System) shore station networks.

2.2 Nautical safety in the port

This encompasses similar processes as previous, but with focus on port safety and typically run by port authorities. Information is collected in a similar way with a possibility to implement a port/harbour VTS that could ensure safety and efficiency during movement of vessels within port areas. A port/harbour VTS may promulgate port entry requirements and may issue instructions for various port operations like obligation of taking pilot, separation distance between vessels etc. (IALA 2016).

2.3 Ship clearance

This is in part a safety system, but does also cover security in the form of the mandatory ISPS (International Ship and Port Facilities Security code) report as well as early information about carried cargo, crew and passengers. It also includes the dangerous cargo manifest. These processes has been supported by the FAL forms and electronically in EU since 2015. From 2019

it will be implemented internationally as an electronic single window.

2.4 Nautical logistics in port

Assignment and management of port facilities for the ship, e.g. pilot, tugs, linesmen, anchorage, berth etc. Operations are in part planned from arrival information, but also special requests from the ship or its agent will be necessary to implement this.

2.5 Coastal safety and security

This may be military, police, customs or others that want to know from where the ships comes, where it is going, what cargo it carries and what persons are on board. This is typically using same information as nautical safety and ship clearance facilities.

2.6 Tariffs and import/export control

Customs and veterinary authorities are examples of actors in these processes. This process is based on detailed import and export declarations as well as various cargo certificates.

2.7 Cargo ownership and insurance

This process covers proper handling and insurance of cargo to protect cargo owner's interests mainly. This is part of the trade operations and may use corresponding electronic information standards.

2.8 Port or terminal operations and logistics

This includes cargo loading and discharge, storage and movement in the port. This is based on information from above systems as well as shore side transport services.

2.9 Ship supplies and services

Processes to support bunkering, fresh water supply, other supplies as well as services to crew or ship. This requires explicit orders from the ship or the ship's agent. Plain text e-mails, fax or similar mechanisms are often used.

2.10 Ship operations

Processes related to the operation of the ship includes receiving new voyage orders and providing voyage and port call reports etc. This is special format messages between ship, owner, manager and charterer. Normally, this is in plain text e-mail, fax or similar, but electronic formats are sometimes used.

2.11 Summary

All the different processes will need information management systems and it is not in general possible to support all by one common system. This is partly because the processes are quite different and require different data, although some of the data is common to several. Another factor contributing to difficulties in providing one common system is different legislation and different data protection considerations for each process. This has also caused, e.g. the World Customs Organization (WCO) to change terminology from "Single Window" (singular) to "Single Window Environment" (WCO 2015).

There are also semantic differences between the process domain that makes it challenging to establish common systems and even standardised interfaces between systems, see e.g. (Rødseth 2016).

On the other hand, there are also similarities that allow some the processes to use common or similar IT systems. This is the basis for the taxonomy.

3 Taxonomy for port information systems

Lambrou et al. (2013) investigated port information systems and developed a first version of a reference model for information management in ports. The model identifies a number of typical information management functions that occur in many ports. This paper develops a new taxonomy that builds on that model, but with an extension covering internal port information systems. We will also add another dimension to the taxonomy to cover geographic location. On the operational side, the taxonomy takes the view from the ship entering the port and only considers the main processes related to the nautical and cargo handling domains. The taxonomy has three axes as illustrated in Fig. 1.

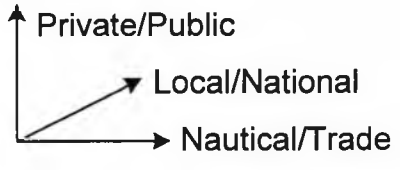

Fig. 1: Three axes of the taxonomy

One axis covers the operator of the information system's legal status. It will normally be a public system operated by the administrations or a private system operated by commercial entities. The next axis is the geographic coverage for the system. One will often find that public systems operate on national level while private systems often operate only on port level. However, some private systems can cover a number of ports and some administrations operate regional systems. The final axis describes if the system mainly is

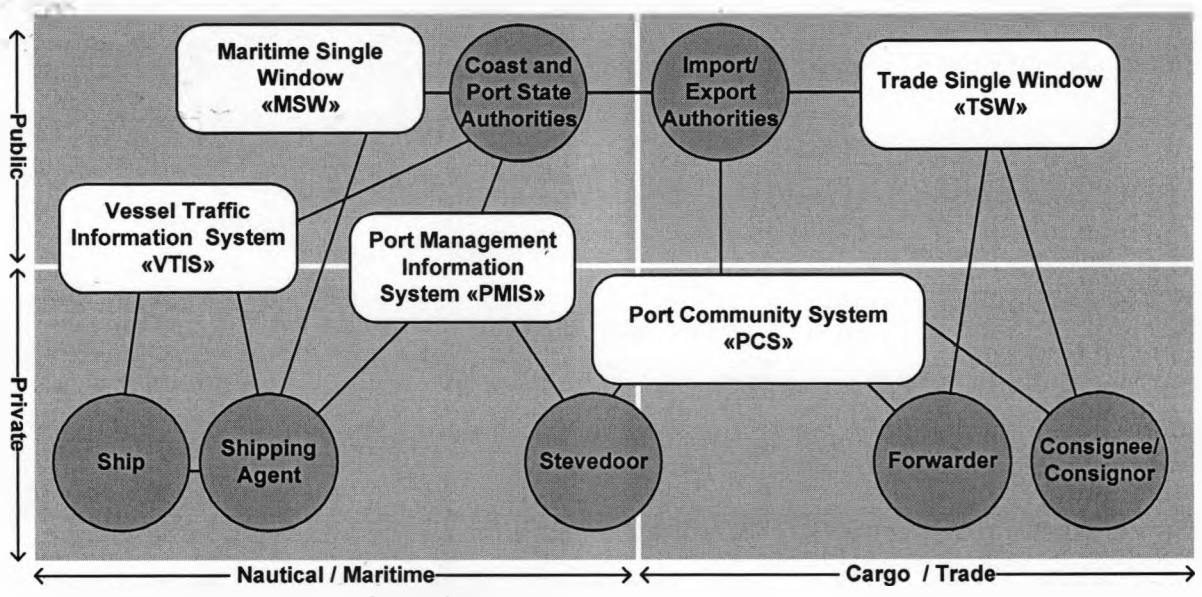

Fig. 2: Taxonomy for port information systems

concerned with the ship and nautical operations or if it is more oriented towards trade and the cargo.

The functional part of the taxonomy is graphically illustrated in Fig. 2. The circles represent some typical parties using the information management systems and the rounded rectangles are the classes in the taxonomy. The four quadrants is created by the public/private and nautical/trade axes of the classification system. The functional classes will be discussed and defined in sec. 5. The geographic axis is not included in the figure and will be discussed in the next section.

4 Geographic classification

The geographic dimension is an important factor in the port Single Window Environment. The following sections will describe the main geographic sub-division that are proposed as classification criteria in this paper.

4.1 Terminal

Most middle sized and large ports will have different terminals for different types of cargo and sometimes also for different commercial operators.

In such cases, one can find a Terminal Operating System (TOS) as a specialized case of the PCS (see next main section), typically being limited to management of terminal cargo and equipment management, see e.g. Keceli (2011).

4.2 Port

In general, one will normally see that the private information management systems in a port is designed for and operated in that particular port. This is typically the case for the PCS and PMIS components. There are, however, some exceptions to this that will be discussed below.

4.3 Regional

Public systems are based on national legislation and will most commonly be implemented nationally. However, if national legislation is regionalized or if coastal regions differ much in the need for specific traffic monitoring functions, one may expect that regional systems may be appropriate. Good examples of such system is the AIS module of SafeSeaNet system in EU. This module collects AIS data at EU level through following regional servers[1]:

- MARESΣ for the Mediterranean sea hosted by Italian Coast Guard,
- HELCOM AIS server for the Baltic sea, hosted by Danish Maritime Authority
- North Sea Regional AIS system, hosted by Danish Maritime Authority
- North Atlantic Regional AIS server hosted by Norwegian Coastal Administration,

[1] http://www.emsa.europa.eu/partnerships/operational-agreements.html

- Black Sea Regional AIS server that is expected to be implemented and connected to MAREΣ AIS server.[2]

There are also regional cooperation, e.g. between Scandinavian countries, between Finland and Russia and other places.

Private systems are at least in some cases operated regionally. One well known example is the Portbase system in the Netherland which was established in 2009 as a merger between Rotterdam's Port infolink and Amsterdam's PortNET[3].

There are also a number of suppliers of general port community system software solutions, e.g. InPort[4], Soget[5] or Phaeros[6] that supply software to several ports. However, the specific system will normally only serve the port where it is implemented and will not qualify as a regional system.

4.4 National

Public systems will normally be implemented on a national level. This does in particular apply to the MSW and TSW systems. The vessel traffic management (VTIS) can be assumed to be national, but this may in principle vary. As an example, Norway operates five VTSes along its 2500 km long coast, but all use the national VTIS data system. In other areas each VTS could have its own data system.

4.5 International

These days, with advancement of IT and electronic technologies national and/or regional port information systems, these systems could be easily integrated at international level. In order to facilitate VTIS and VTS data exchange IALA (International Association of Marine Aids to Navigation and Lighthouse Authorities) has adopted guidelines on the Inter-VTS Exchange Format (IVEF) service (IALA 2011), and has recommended to national members and other appropriate authorities and entities, introducing an IVEF Service into their shore infrastructure. Nowadays some national VTS systems, like in Montenegro (Bauk 2015, Kapidani 2012) and Croatia, are IVEF compatible and ready to exchange data using this format. IVEF is considered to be used for development of a Common Adriatic-Ionian VTS that is now recognized as one of most important actions for further development of Adriatic-Ionian region (EU 2014).

The typical example of an international information system is the European SafeSeaNet[7]. This can be classified as a VTIS and serves all the European Union members as well as other neighboring states..

5 Functional classes of the taxonomy

Each class of the taxonomy describe a general set of functions that can be implemented in an information management system. The class system is "normalized" in that the classes correspond to commonly found information management system types, which in turn correspond to logical divisions of responsibilities in the four quadrants of the classification space. The reason why there are two classes in the public/maritime quadrant is mainly because in general, the VTIS serves different functions than those that handle port call clearance (MSW). The time perspectives are also different as will be discussed later.

A specific system will often implement only parts of the functions of one class or in other cases integrate two or more class function sets into one system. To make it clear that the class is not unique or exclusive, we have used the "stereotype" notation of the Unified Modelling Language (UML) by placing the class names in guillemets (« »). The following sections describe the five stereotypes of the taxonomy.

5.1 Maritime Single Window (MSW)

A single window is defined as "*a facility that allows parties involved in trade and transport to lodge standardized information and documents with a single entry point to fulfil all import, export, and transit-related regulatory requirements. If information is electronic, then individual data elements should only be submitted once*" (UN/CEFACT 2010). The Maritime Single Window can be defined as the single window functionality needed to implement the FAL Convention (IMO 1965), or local variants as the EU directive 2010/65/EU (EU 2010) that extends the FAL convention with some specific EU and national requirements.

Thus, the MSW combines requirements from various port and coastal state authorities, such as nautical administrations, immigration, customs, military, phytosanitary, health and others into

[2] http://www.seemariner.eu/downloads/category/44-mantova-february-2013.html
[3] https://www.portbase.com/en/
[4] http://www.inport.com/
[5] http://www.soget.fr/en/
[6] http://phaeros.com/default.asp?iId=MDKML
[7] http://www.emsa.europa.eu/ssn-main.html

one reporting gateway for the ship. The main purpose of the MSW is to ensure that ships can call on the state's ports without any safety or security problems and to provide easy and rapid clearance of the ship prior to the port call.

With the EU directive 2010/65 (EU 2010) and Resolution FAL.12(40) (IMO 2016), this function has to be implemented as an electronic system from 2015 (EU) and 2019 (internationally) at the latest. This functionality is sometimes called an Electronic Port Clearance (EPC) system.

5.2 Trade Single Window (TSW)

The trade single window can also be called the customs single window as it traditionally has been operated by the customs authorities. It is also very close to what was described as the general single window in (UN/CEFACT 2010), i.e. with a view to fulfil all import, export, and transit-related regulatory requirements for the cargo. The TSW is often implemented on national level and is usually designed to handle all transport modes, i.e. road, rail, sea and air. The TSW implementation and reporting requirements will be defined by national legislation which in turn is linked to various international trade and customs agreements. Tariffs and documentation requirements can also be based on multi- or bilateral trade agreements.

5.3 Port Community Systems (PCS)

The term 'Port Community System' is today in common use and is as old as the early electronic data interchange (EDI) systems in ports from the 1980s, where systems like DAKOSY (Port of Hamburg) and FCP80 (Port of Felixstowe) were started. There are a number of definitions of PCS available in the literature, but it can be argued that the one from the International Port Community System's Association (IPCSA) may be the most authoritative: "*A Port Community System (PCS) is a neutral and open electronic platform enabling intelligent and secure exchange of information between public and private stakeholders in order to improve the competitive position of the sea and air ports' communities. It optimizes, manages and automates port and logistics processes through a single submission of data and connecting transport and logistics chains*" (IPCSA 2016).

The PCS is normally operated by a private organization on behalf of the community of port companies. The definition of PCS blurs the line between public and private operational profiles and this is a source of some confusion, particularly between large and smaller ports. In the large ports the above definition will make sense as it recognizes that the private port information systems are advanced enough to naturally take on some of the reporting formalities on behalf of the authorities. In smaller ports, the picture may be very different as is exemplified, e.g., by PortNet in Finland (Hautala 2003) where the situation is the opposite: the authorities operate an infromation system with functions also supporting public data exchanges.

In Croatia some ports, e.g. Ploče, have their own PCS, while in other ports, e.g. Rijeka, the PCS implementation was stopped after the international bidding process and the contract was signed for the new private PCS. The contract was terminated after the Croatian ministry of maritime affairs, transport and infrastructure had started with design of another system called CIMIS (Croatian Integrated Maritime Information System) that is now the Croatian National Single Window. (MPPI 2016). Also here, there are some discussions on the delimitations of functionality between the two types of systems.

The PCS functionality sometimes crosses over the border to nautical management, which is indicated in Fig. 2. Normally, the functions of the PCS are mostly related to cargo document handling and can facilitate the replacement of a long range of paper documents. The PCS will commonly also support cargo movement logistics. Some PCS include maritime oriented functions such as, e.g. Phaeros Port Management and Community System[6].

While the term PCS indicates that the system operates in one port, there are some systems that cover a number of regional or national ports, such as Portbase in Netherlands[3] and PORTIC in Spain[8].

The PCS has also from time to time been called a Port Single Window (PSW). This is in principle a misnomer as the PCS is operated by private parties and does not in itself fulfill any documentation requirements. However, the PCS will in most cases be connected to the MSW and TSW and will forward the documents to the proper single windows.

As previously mentioned, the Terminal Operation System (TOS) offers a similar function to the PCS, but is usually limited in geographic scope (one or more terminals of the port) and may be further specialized in

[8] http://www.portic.net/ENG/index_eng.shtml

functionality for cargo and terminal equipment management.

5.4 Vessel Traffic Information Systems (VTIS)

Many nautical authorities are now building integrated ship movement monitoring systems based on position reports from the ships' Automatic Identification System (AIS) as well as data from ship reporting systems. Ship reporting and the VTS functions are mainly regulated through SOLAS Chapter V, Regulation 11 and 12 (IMO 1980). The VTIS may also be integrated with Long Range Identification and Tracking (LRIT) as well as other ship movement monitoring services.

These monitoring systems will also in many cases by integrated with VTS systems that provide ships in a specific and limited area with navigational advice.

The VTIS will normally be operated by coastal state nautical authorities, but it has been placed over the border towards private as some systems may be operated for port waters alone and by private parties.

EU directive 2009/17 (EU 2009) requires European states to implement such a vessel traffic information system to link national monitoring functions to SafeSeaNet at European level.

The VTIS is normally also linked to the MSW and will provide each other with complementary information about the ships. The main difference between the two systems is that the MSW is operated by a number of authorities that are interested in ship calls to the state while the VTIS is normally operated by the maritime authorities alone to manage and monitor ship movements along the coast, independent of the ship calling in port or not. Another difference is that the MSW will have to handle advance information about ship arrivals while the VTIS mostly is a real-time monitoring system.

These systems mainly handle ship movements in areas where the state authorities have sole jurisdiction and do not normally handle operations within the port where port authorities share responsibility for safety and security.

5.5 Port Information Management System (PMIS)

The PMIS is somewhat similar to the VTIS in that it is focused on nautical operations. However, while the VTIS focuses on ship movements and safe management of traffic, the PMIS's purpose is to keep track of and plan nautical operations in the port other than traffic execution.

The PMIS will normally keep track of the ships that are expected to port or that are already in the port. The purpose is to provide information on the ships, similar to the VTIS, but also to monitor and plan the use of port resources such as pilots, linesmen, berths and anchorages. Some complex ports will often implement their own VTIS and VTS in addition to the PMIS to supervise and manage the traffic in the port.

A PMIS can be implemented as a software module in a commercial third-party port VTIS or PCS and operated by commercial parties. In other ports, it may be public parties that manage port resources and operate the PMIS to coordinate own operations. Thus, in the taxonomy the PMIS has been classified as either private or public.

6 Using the Taxonomy

The purpose of the taxonomy is to provide general concepts (stereotypes) that can be used to describe typical information management functions that are important for the operation of seaports. Due to the wide variety of ports and port information systems, it is not often that one will find an exact match between one stereotype and one particular information system. In most cases the actual systems will include characteristics from one or more stereotypes, without necessarily implementing all functions of any one stereotype. For this reason, we have also elected to provide relatively high-level descriptions of the relevant functions in each stereotype.

On the other hand, we have found the taxonomy very helpful in clarifying discussions on the similarities and differences between various information management systems in port. The general delimitation between public and private as well as between nautical and cargo coverage are two important differentiating factors.

The PMIS stereotype is a result of a further specialization of these general classification criteria. It is basically a result of splitting nautical responsibilities in the port between traffic management and port resource management.

The geographic axis is not so important in this context. It has been included mainly to point out that there are differences in geographic system coverage and that this has to be taken

into account if one wants to classify the port information systems. This is sometimes important, e.g. when a port operates its own VTS system adjacent to a national coastal VTS, which is a very common occurrence.

Note also that the taxonomy only covers those systems that are "close" to the ship. The port will also have other information systems catering to hinterland transport on various transport modes, land management and so on. As was mentioned initially, a port is a complex meeting point for many different business and transport domains.

7 Interoperability and standards

There are two issues that make information exchange standards particularly important in the port. In general, the port is a complex cross-roads for many different business and transport domains and standards are important to minimize data interfacing complexity and cost. The other issue is that ships in international trade in principle can call on several thousand different ports in the world and, in particular with the advent of electronic port clearance, it is not really feasible to do this without standardised interfaces.

The IMO FAL Compendium (2002) was published 15 years ago and defined the first international standard for electronic port clearance based on UN/EDIFACT standards. This specification has had a great impact particularly on container shipping with very complex cargo manifests that hardly can be handled without electronic data exchanges. However, it has had a limited impact in other shipping operations than containers and it is still not fully deployed internationally, even for container ships. As late as in 2013 a European ship master reported that a total of 80 different documents were needed for calls in 6 North European ports (OOW 2013).

The main international standards that are in use for ship clearance are all based on the requirements in the FAL convention or, additionally, also in EU directive 2010/65. As mentioned above, the longest living specification is based on UN/EDIFACT and is described in the FAL compendium (IMO 2001). It is also possible to use the ISO 28005 series (ISO 2011, 2013) which describes an XML based data format. In addition, World Customs Organization (WCO) is also working on a new data model that can be used for electronic port clearance. WCO, ISO and UNECE is currently looking at how the three data models can be harmonized (IMO 2016). The results of this work will be considered for inclusion in a future revision of the FAL Compendium.

8 Conclusions

In the present paper we have presented some of the processes and related information management systems that commonly appear in a seaport. We have also presented a classification system or taxonomy for these information management systems. This classification system describes the main information management function groups that need to be covered from the point of view of the ship rather than physical implementations of the information system. A physical system may implement one or more parts of the different taxonomy "stereotypes".

The authors believe that the taxonomy can be a useful tool to classify the different information systems and to clarify differences and similarities between the different systems.

We have also briefly discussed the need for international information exchange standards and given a brief overview of the state of art in this area.

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Implementation of National Maritime Single Window in Montenegro

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Abstract — **Single Window concept has been introduced as a major platform for collaboration and information exchange among different government agencies involved in international trade. In maritime sector need for automated and standardized reporting formalities is from paramount importance as it will have impact on maritime transport efficiency and safety. In order to address these issues, actions must be taken at national levels, and a solution is implementation of NMSW (National Maritime Single Window), an electronic system that allows stakeholders involved in maritime transport to provide and receive standardized information in a single entry point to satisfy all necessary reporting requirements. This paper presents an overview of NMSW development and proposes initial steps that should be taken and tools that should be used to implement it in Montenegro.**

Keywords — **enterprise service bus, maritime transport efficiency, national maritime single window, SOA.**

I. Introduction

Nowdays parties involved in maritime transport have to prepare and submit large amount of documents to various authorities in order to comply with international, national regulations and to fulfill ship reporting formalities for entering or leaving ports. Documents have to be submitted to different agencies, in paper and/or in electronic forms, and this process is very time consuming and presents a serious administrative burden to business community and governments [1].

In order to address above problem implementation of a Single Window is recommended by UN/CEFACT (United Nations Centre for Trade Facilitation and Electronic Business). Single Window is defined as a "facility that allows parties involved in trade and transport to provide standardized information and documents through a single entry point to fulfil all import, export and transit-related regulatory requirements" [1]. If information is electronic, then it is recommended that individual data elements should be submitted only once.

There are many incentives for Single Window implementation at international and EU level. At international level IMO (International Maritime Organization) has introduced E-Navigation as a concept and vision created to harmonize navigation systems and ashore services in maritime sector in order to satisfy end-user needs. According to the IMO, one of the benefits of E-Navigation will be higher efficiency and reduced costs in maritime transport. These benefits will be enabled by automated and standardized reporting formalities, leading to reduced administrative burden that could be achieved by implementing Maritime Single Window [2].

At EU level, since 1st June 2015, parties involved in maritime trade and transport are legally obliged and should be able to submit information and documents via an electronic single window to fulfil reporting formalities, while individual data elements should only be submitted only once, [3]. In order to further facilitate the implementation of NMSW (National Maritime Single Window), the European Commission initiated the AnNa project (http://www.annamsw.eu) that is still ongoing and National Single Window prototype project (http://emsa.europa.eu/nsw.html) managed by EMSA (European Maritime Safety Agency). Both of these two projects gathered a number of Member States and many of them have already implemented NMSW.

There is strong national consensus in Montenegro to improve integration of various information systems in maritime transport, like VTMIS (Vessel Traffic Monitoring and Information System) and PCS (Port Community Systems) in port of Bar and Kotor and to facilitate the exchange of data with other external information systems like SafeSeaNet (EU level vessel traffic monitoring and information system established in order to enhance maritime safety and security and marine environment protection), LRIT (Long Range Identification and Tracking of vessels using satellite communication), AIS (Automatic Identification System for vessels based on very high frequency communication), THETIS (information system that supports the new Port State Control inspection regime), Lloyd's Register etc. It is also recognized a need to integrate information systems used in maritime transport with information systems of other national agencies like Customs Administration, Police Directorate, Ministry of Health, Phytosanitary Directorate and others.

In order to achieve integration of the various components of the information systems in maritime transport and to facilitate the exchange of data with other external information systems, there is a need to implement a unified national platform for doing electronic business in maritime, actually to implement NMSW (National Maritime Single Window). Thus, in this paper we provide an overview of the solutions for implementation of NMSW, and we give some recommendations for the

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possible model of implementation of NMSW in Montenegro.

II. Steps towards implementation of NMSW

Montenegro should follow phase approach that was proposed by European Commission for implementing NMSW: development of functional specification, development of technical specification, technical implementation, testing and initial operation phase. In this paper we will focus on the first two phases. Sections II and III will focus on the first phase while Sections IV and V will focus on the second phase.

Maritime transport involves a number of different business processes that are related to movement of goods and important for development of functional specification. Each business process involves different participants or stakeholders and they have different roles in the process. First step in NMSW implementation should be to determine scope of the system. When the scope of the NMSW is determined, next step will be defining which business processes, authorities and stakeholders participate in the NMSW.

Having in mind that NMSW is very complex system, phase implementation of functional requirements is recommended. In the case of Montenegro first step of NMSW implementation should be focused on "ship single window". Procedures related to ship or vessel clearance while entering or leaving national waters and ports will be covered in "ship single window". Ship clearance means that cargo can be carried out from the ship or vessel, but still not to be imported, and that passenger may disembark in order to do border check if necessary [4]. In future, functionalities related to cargo and trade could be included to NMSW.

In the ship clearance process as main participants are ship agents as data providers and different national authorities responsible mainly for maritime safety and security.

Reference [1] provides and overview of the most common models for single window. Having in mind that most of governmental authorities have their own ICT systems that could be easily interfaced with other systems, in the case of Montenegro recommended model would be Single Automated System - Interfaced System that is shown in Fig. 1.

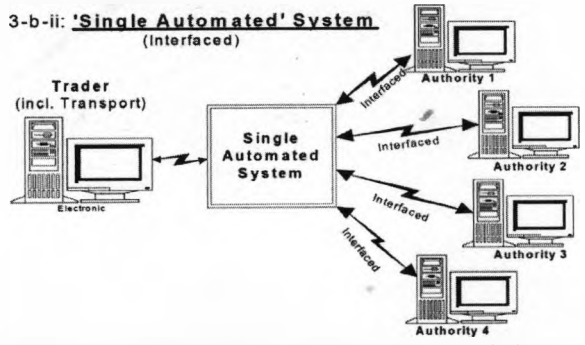

Fig. 1. Single Automated and Interfaced Single Window System for the collection and dissemination of information

Single automated system, in the center of Fig. 1, should be operated by competent national authority in Montenegro and it should be interfaced with information systems of other authorities. Trader in the Fig. 1 presents ship agent who directly access system via WEB user interface or through XML (Extensible Markup Language) interface with possibility to upload files in various format. Also authorities could access the system via WEB user interface if they do not have developed information system that could be interfaced with NMSW.

Some of authorities could have legacy systems and processes. Deliberate consideration should be paid to these systems in order to decide if they have to be changed or not, in order to achieve overall objective of simplification while not rising costs of implementation.

A. Development Methodology and Tools

Nowadays there are many modern ICT tools that could help to do NMSW design process. In this chapter will be listed some of tools that could be used for NMSW design process. Some of them are focused on the analysis and design phase while others are related to the technical implementation of NMSW. Most of them are based on UML (Unified Modelling Language) that is preferred baseline specification. In references [4], [5] and [6] following tools are proposed for NMSW modeling that will be introduced in next paragraphs.

Enterprise Architect Project (EAP) is a visual modeling and design tool produced by Sparx Systems, that was used for developing MarNIS (Maritime Navigation and Information Services) project architecture and UN/CEFACT International Supply Chain Reference Model;

UMM is a modeling standard for describing business requirements of inter-organizational business processes and is developed and maintained by the UN/CEFACT. (more information on http://umm-dev.org/).

The Zachman Framework, as the name says is a framework, not a methodology, as it does not imply any specific method or process for collecting, managing, or using the information that it describes. Main advantage is strong ability of organizing architectural artifacts like documents, specifications and models. Main disadvantage is deficiency of a structured methodology that is needed in NMSW design and implementation process.

CIMOSA is an acronym for Computer Integrated Manufacturing Open System Architecture and represents an enterprise modeling framework, which aims to support the enterprise integration of machines, computers and people. The framework is based on the system life cycle concept, and offers a modelling language, methodology and supporting technology to support these goals. Greatest disadvantage of CIMOSA is that it doesn't cover the technical implementation phase, in particular ICT architecture or software services [5].

AVE (ARIS Value Engineering) methodology was successfully used as a methodology for design of existing and future business process in order to achieve requested NMSW functionalities. AVE methodology uses ARIS platform that is according to Gartner (world's leading information technology research and advisory company)

among best tools for modeling and design of business process [6].

SoaML (Service-oriented architecture Modeling Language) is an open source specification project from the Object Management Group, for the modeling and design of services within a SOA (Service Oriented Architecture). SoaML has many advantages for using for NMSW as it is focused on services and offers close connection between design and implementation phase. Legacy systems or third party systems could be described in intuitive way using SoaML, which facilitate their interface with NMSW. On other hand SOA is a software design methodology and a modern approach that can be exploited to meet the need for implementing an information system comprising interoperable, reusable services.

Nowadays, many information systems in maritime domain (SafeSeaNet, Montenegro VTMIS etc) are based on SOA, so using SOA in NMSW implementation is highly recommended.

III. USING SOA FOR TECHNICAL SPECIFICATION OF NMSW

Currently there are many definitions of SOA. One of definitions for SOA derives from Open Group [7]. According to Open Group SOA is an architectural style that supports service-orientation. Service-orientation is a way of thinking in terms of services and service-based development and the outcomes of services. A service is a logical representation of a repeatable business activity that has a specified outcome and it is self-contained, may be composed of other services and is a "black box" to consumers of the service [7].

It is important to note that SOA is not a concrete architecture, tool or framework. It is something that leads to a concrete architecture and it could be called a paradigm, concept, representation or style. So SOA might be understood as an approach and a way of thinking that leads to software architecture design [8].

SOA is a concept for designing large distributed IT systems, allowing an easy scalability and expandability of the whole system. If NMSW of Montenegro should be based on SOA concept, the overall effort required to integrate software modules already developed and used like VTMIS system in Montenegro will be reduced. Having in mind that VTMIS system and its submodules like AIS national network, LRIT, ADRIREP (mandatory ship reporting system in the Adriatic Sea) and SafeSeaNet are based on SOA concept, it is higly recomended that also NMSW should follow SOA concept during design and impllementation. SOA concept will facilitate NMSW to remain scalable and flexible while growing and will help to bridge the gap between maritime business and IT.

IV. PROPOSED SYSTEM ARCHITECTURE - ENTERPRISE SERVICE BUS

NMSW system architecture based on SOA concept should be independent of hardware systems and should enable scalability and reusability of its modules when system will be expanded. All necessary business processes and low-level functions should be defined as simple service components that will be stored in a service repository. Service components can be used as they are or assembled into more complex services. Service repository should be accessible using standard communication protocols such as TCP/IP (Transmission Control Protocol/Internet Protocol), HTTP (Hypertext Transfer Protocol), web service and SMTP (Simple Mail Transfer Protocol). System should also enable users a web access through web server. To process the data transmitted to and from NMSW, it is highly recommend usage of ESB (enterprise service bus) as it is shown in Fig. 2. The set of services needed to process data, and the sequence in which they are executed, are determined by additional external logic typically written in Java or any other object-oriented language [4].

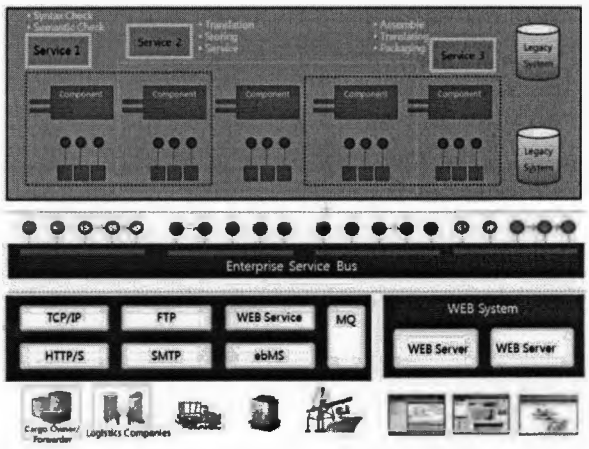

Fig. 2. Single Window architecture based on ESB

ESB has some attributes of client server model, while main advantages are agility and flexibility with regard to communication between applications in heterogeneous and complex enterprise environment. It should act as a stable central point for internal and external data exchange and will facilitate connection of various applications with data they need, with high level of availability. In other words ESB takes care of implementation of business processes and rules. ESB should also be responsible to keep data updated and to ensure that data are taken from source, more precisely from organization that is responsible for collection of particular data set. Thus, it is not necessary to create local copy of data.

When choosing commercial product for ESB many challenges have to be addressed. ESB should be able to serve large number of connections to existing and future applications, handling different data formats and communication protocols, implement business rules in consistent manner and handle applications written in different programing languages that run in parallel in different platforms.

ESB, as a software architecture model for distributed computing, will facilitate implementation of communication between mutually interacting maritime software applications in a SOA environment. Each application will communicate only with the ESB that is responsible for routing application messages, possible change of communication protocols and delivery of confirmation of receipt of the original application. ESB system enables deployment of business process and

message orchestration. It will ensure compliance with business rules, format conversion and other functions necessary for the integration of individual maritime software components into a NMSW.

In front of ESB are many functional requirements that have to be fulfilled. Security of the system should be ensured by taking following actions: authentication and authorization of the sender must be implemented, guaranteeing message integrity using digital signatures, keeping confidentiality of messages deploying encryption for recipients and by having proper log system and IT audit system in place for analysis of possible incidents. Reliable delivery of messages should be ensured with the mechanisms of retry delivery and with the "durable messaging" that uses message queue to compensate for long-term loss of network connections between application systems. System should support at least standard transport protocols like HTTP, HTTPS (Secure HTTP), FTP (File Transfer Protocol), SMTP etc. as shown in Fig. 2., and should support communication with mostly used web service open standards like XML used to tag the data, SOAP (Simple Object Access Protocol) used to transfer the data, WSDL (Web Services Description Language) used for describing the services available and UDDI (Universal Description, Discovery and Integration) that lists what services are available.

Integrated platform for implementing NMSW based on ESB as central component platform should contain following components with associated functionalities that will be briefly described:

A. Business Rules Repository

All business rules that have an impact on the performance of business processes or related to services for external users should be defined in the Business Rules Repository;

B. XML Schema Repository

XML schema repository stores XML schemes of all documents and other messages that are used for communication in the system. Bus provides the ability to convert message formats when required in business process.

C. Catalog of services

Catalog of services that will be carried out on the platform stores crucial information regarding services and applications in a central repository to prevent duplication and promote reuse. Catalog of services makes it easy to promote reuse by making it easy to discover and access the right services for a task. The owner of the service establishes service by implementing a web service with strictly defined interface. Web service interface is defined as an XML scheme. Creating XML schema is performed in accordance with the guidelines for the development of the services in the platform.

D. Register of users

Register of all users of the platform, their role related to services act as a focal point for the registration of all users of the services provided on the platform. In the register are recorded all individual users as well as their links with a catalog of services that user could use.

E. Converter and validator

Converter and validator are important parts of the system that enable interoperability of different systems involved in the process of exchange of electronic documents and data. They should support conversion using XSLT (Extensible Stylesheet Language Transformations) templates while validation of the syntax of business documents should be done using XML scheme.

F. BAM (Business Activity Monitoring)

The ESB must contain a system to monitor and track business activities and represent them in convenient way, so all the parameters important for functioning of the system could be monitored. BAM main purpose is to aid in monitoring of business activities that are implemented in NMSW. BAM should be an enterprise solution primarily intended to provide a real-time summary of business activities.

V. CONCLUSION

NMSW is not only prerequisite for further development of maritime sector in Montenegro but also requirement toward accession to the European Union. In this paper some aspects of NMSW implementation in Montenegro are elaborated that could be helpful for preparing a roadmap for its implementation. Roadmap should be based on phased approach consisting of following five phases: development of functional specification, development of technical specification, technical implementation, testing and initial operation phase. During all these phases lessons learned and experiences of other EU countries during NMSW implementation should be carefully taken in consideration.

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MARITME SINGLE WINDOW AS A SOLUTION OF E-NAVIGATION

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ABSTRACT

E-Navigation is a concept and vision led by International Maritime Organization (IMO) created to harmonize navigation systems and ashore services in maritime sector in order to satisfy end-user needs [8]. IMO has defined E-Navigation concept and it is anticipated to have substantial results associated to ship based, shore based and communication systems [8]. According to the IMO Strategy, one of the benefits of E-Navigation is expected to be higher efficiency and reduced costs in maritime transport. These benefits will be enabled by automated and standardized reporting formalities, leading to reduced administrative burden that could be achieved by implementing Maritime Single Window (MSW). MSW is defined as an electronic system that allows stakeholders involved in maritime transport to provide and receive standardized information and documents in a single entry point to satisfy all necessary reporting requirements. This paper presents an overview of the E-navigation and MSW developments and their interconnection. The expected developments in both fields will be briefly presented.

Key words: E-Navigation, Maritime Single Window, maritime safety, e-maritime, maritime cloud.

1 BACKGROUND

Since 2005, several IMO member countries (Japan, the Marshall Islands, Netherlands, Norway, Singapore, UK and USA) have submitted a paper [1] to the Maritime Safety Committee (MSC) on the development on an E-Navigation strategy. Submitted paper proposed adding E-Navigation as a new topic to the work programme of the Safety of navigation (NAV) and Radio communications and Search and Rescue (COMSAR), both sub committees of IMO. The main purpose of that paper was to initiate development of strategic vision for the utilization of existing and new navigational tools, in particular electronic tools, in a holistic and systematic manner. Even if the scope of the proposal was broad, it was anticipated that IMO will "develop a broad strategic vision for incorporating the use of new technologies in a structured way and ensuring that their use is compliant with the various electronic navigational and communication technologies and services that are already available" [18]. Submitted paper also noted a possibility of E-Navigation strategy to support IMO Facilitation Committee (FAL) for development of a solution for simplification and facilitation of ship reporting formalities [1].

On 2009, IMO MSC on its 85th session came out with Strategy for the development and implementation of E-Navigation and defined it as "the harmonized collection, integration, exchange, presentation and analysis of marine information on board and ashore by electronic means to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment." [2].

After considerable work carried out not only by IMO, but also by numerous organizations like International Association of Lighthouse Authorities (IALA), International Hydrographic Organization (IHO), IMO came out with preliminary list of nine main categories and practical E-Navigation solutions [3]. When members of Correspondence Group (CG) on E-Navigation to NAV were tasked to prioritize and propose a list of five out of the nine predefined categories of E-Navigation solutions, they prioritized solutions that focus on efficient transfer of marine information/data between all appropriate users (ship-ship, ship-shore, shore-ship and shore-shore) [6]. Namely, solutions S2 (Means for standardized and automated reporting) and S4 (Integration and presentation of available information in graphical displays received via communication equipment) were most voted solutions among members of CG. This result was expected having in mind that there are a lot of online reporting systems globally and the systems are not harmonized, often duplicated, and based on different formats and platforms. Driven from these reasons IMO has indicated application of MSW as a priority among planed outputs, on its proposals for the high-level action plan of the organization and priorities for the 2016-2017 biennium for the FAL [4]. Within the European Union (EU), need for MSW implementation is defined in Reporting Formalities Directive (RFD) that was adopted on 2010. The important element of RFD is that each Member State must introduce a MSW, so that ships arriving at EU ports can submit standard messages once, to a single point and that information will be disseminated as required to all authorities that need access to it. Furthermore, from 1 June 2015 the directive prohibits acceptance of reporting formalities in paper form so everything from that date will have to be submitted electronically [5].

2 CURENT SITUATION RELATED TO E-NAVIGATION

In last year's we have seen huge developments in Information and Communication Technology (ICT) that had great positive impact within maritime navigation and communication systems. Nowadays, technical support systems for mariners are developing rapidly and therefore there is a need to coordinate systems and harmonise standards in maritime sector. Currently vessels are equipped with various systems like Global Satellite Navigation Systems (GNSS) and Electronic Chart Displays and Information Systems (ECDIS). These on board systems need further improvement in order to be able to integrate with various systems that are installed on other vessels or ashore [6]. Also there are a lot of other electronic navigational and communication technologies and services available. Mariners and supporting staff on shore are now familiar, to a greater or lesser extent, with other systems like: Automatic Identification System (AIS), Integrated Bridge Systems and Integrated Navigation Systems (IBS/INS), Automatic Radar Plotting Aids (ARPA), Long Range Identification and Tracking (LRIT), Vessel Traffic Service (VTS), Global Maritime Distress and Safety System (GMDSS) and other ICT systems used in maritime sector. Also latest advancement in ICT related to data processing, storing and visualisation should be used also in maritime industry. E-Navigation offers a vision for the integration of existing and new navigational tools in a holistic and systematic manner.

2.1 IMO's E-Navigation concept

IMO has developed E-Navigation Strategy Implementation Plan (SIP) that sets up a list of tasks and specific timelines for the implementation of prioritized E-navigation solutions during the period 2015-2019, facilitating a coordination of efforts by relevant Sub-Committees, related international organisations, Member States, relevant regional bodies and the maritime industry [6].

After it was introduced to Navigation Communication Search and Rescue (NCSR) sub-committee, SIP was presented to MSC for approval at end of 2014. Following are five E-Navigation solutions that SIP gives importance:

- solution S1 related to bridge system design,
- solution S2 dedicated to standardized and automated reporting,
- solution S3 is focused to improve consistency and integrity of bridge system equipment and navigation information,
- solution S4 aims to integrate and present different layers of available information in graphical displays received from communications equipment and
- solution S9 objective is to improve communication of VTS Service Portfolio [6].

Solutions S2, S4 and S9 focus on efficient transfer of marine information and data between all appropriate users (ship-ship, ship-shore, shore-ship and shore-shore) [6].

As part of each one of the above prioritized E-Navigation solutions, several sub-solutions were identified. In this paper we will present sub solutions for solution S2, means for standardized and automated reporting, that are important for MSW implementation. They are illustrated in table 1 alongside with their descriptions, task actions and task identifiers.

Table 1: Required regulatory framework and technical requirements for implementation (tasks) for solution 2: Means for standardised and automated reporting [6]

Sub-Solution	Description	Task Action	Task Identifier (see Table 2)
S2.1	Single-entry of reportable information in single-window solution	Develop test beds demonstrating the use of single window for reporting along with S2.4.	**T8** **T15**
S2.2	Automated collection of internal ship data for reporting	Much data is already collected in the navigation equipment – investigate the use of this data for reporting of ship navigational information.	**T9**
S2.3	Automated or semi-automated digital distribution/communication of required reportable information, including both "static" documentation and "dynamic" information	Review the original AIS long range port facility as well as the new long range frequencies made available at WRC 2012 described in the latest revision of ITU-R M.1371-5, the revised IEC 61993-2, or the developments within VDES (VHF Data Exchange System) and see if the information could be used for no cost or low cost automated or semi-automated reporting. The long range port was not used during the development of LRIT due to the cost to ship-owners of sending this information.	**T9** **T15**
S2.4	All national reporting requirements to apply standardized digital reporting formats based on recognized internationally harmonized standards such as IMO FAL Forms or SN.1/Circ.289	Liaise with all Administrations and agree on standardised formats for ship reporting so as to enable "single window" worldwide. In this respect national and regional harmonisation is the first step.	**T8**

Task identifiers from table 1, that are related to sub solutions of S2, are presented in table 2, alongside with their tasks, expected deliverables, transition arrangements and implementation schedule.

Table 2: Tasks, expected deliverables, transition arrangements and implementation schedule [6]

Task No	Task	Expected Deliverable	Transition Arrangements	Prioritised Implementation Schedule
T8	Member States to agree on standardised format guideline for ship reporting so as to enable "single window" worldwide (SOLAS regulation V/28, resolution A.851(20) and SN.1/Circ.289)	Updated Guidelines on single window reporting.	National/Regional Arrangements	2019
T9	Investigate the best way to automate the collection of internal ship data for reporting including static and dynamic information.	Technical Report on the automated collection of internal ship data for reporting.	None	2016
T15	Identify and draft guidelines on seamless integration of all currently available communications infrastructure and how they can be used (e.g. range, bandwidth etc.) and what systems are being developed (e.g., maritime cloud) and could be used for E-Navigation. The task should look at short range systems such as VHF, 4G and 5G as well as HF and satellite systems taking into account the 6 areas defined for the MSPs	Guidelines on seamless integration of all currently available communications infrastructure and how they can be used and what future systems are being developed along with the revised GMDSS.	Use existing on board communications infrastructure	2019

SIP clearly recognised the need for identifying shore-based functions and services. There are many different types of services in maritime sector. In order to harmonise and standardise these service, in SIP are introduced the Maritime Service Portfolios (MSPs). MSPs have been identified as the means of providing electronic information in a harmonised way. In SIP are proposed 16 MSPs where are identified various services like: VTS Information Service (IS), Navigational Assistance Service (NAS), Traffic Organisation Service (TOS), Local port Service (LPS), Maritime Safety Information Service (MSI), pilotage, tug, vessel shore reporting, Tele medical Assistance Service (TMAS), Maritime Assistance Service (MAS), nautical chart service, nautical publications service, ice navigation service, meteorological information service, real time hydrographic and environmental information service and last but not least Search and Rescue Service (SAR) [6].

For vessel shore reporting (MSP8) as service providers are identified National Competent Authority (NCA), Ship-owner, Operator and Master. Furthermore the aim of MSP8 is to "safeguard traffic at sea, ensure personnel safety and security, ensure environmental protection and increase the efficiency of maritime operations" [6]. Single Window is recognised as one of the most important solutions to reduce the mariner's workload (amount of time spent on preparing and submitting reports to shore-based authorities). To achieve this, reports should be automatically generated as much as possible from on board systems. Some other important possibilities for vessel shore reporting system may include [6]:

- single-entry of reportable information in single-window solution,
- automated collection of internal ship data for reporting,
- all national reporting requirements to apply standardized digital reporting formats based on IMO FAL forms and
- automated or semi-digital distribution/communication of required reportable information.

2.2 IALA's role in the E-Navigation concept

IMO as leading agency of the E-Navigation concept has expressed an interest in the contribution other outside organizations like IALA, IHO and others to the work on E-Navigation. At the request of IMO, IALA is supporting IMO in the development and implementation of E-Navigation by offering architecture proposals for coordinated review by IMO [8]. For that purpose IALA Council have established an E-Navigation Committee (e-NAV) as they had considered that a subject of E-Navigation was relevant to the aims of IALA and it needed further study, clarification or discussion. Furthermore e-NAV is created with purpose of developing recommendations and guidelines on shore-based E-Navigation systems and services. The e-NAV is mainly dealing with technical aspects of E-Navigation relating to aids to navigation (AtoN). Main objective of e-NAV is to develop IALA documents like guidelines and recommendations related to AIS, DGNSS and AtoN systems. It is evident the E-Navigation concept is complex so the technical solution will not be simple. Several steps are required to arrive at a suitable technical solution. The first steps were taken in IALA recommendation [9], while other consecutive IALA Recommendations on E-Navigation are based upon this one.

The e-NAV closely cooperates with other international organizations and manufacturers, distributors who are industrial members of IALA, in order to contribute to E-Navigation concept and supports IMO by providing technical expertise. E-NAV committee is consisted of following working groups:

- Operations group dealing with ashore activities,
- Position, Navigation, and Timing (PNT) group is focused on shore side sensors and radio navigation,
- AIS and Communications group is covering technical aspects of AIS and communications spectrum and closely cooperates with International Telecommunication Union (ITU) and International Electrotechnical Commission (IEC),
- Technical Architecture group is focused in creating shore side perspective of E-Navigation architecture and
- Data Modelling and Interfaces group is cooperating with IHO in order to prepare product specifications for IHO S-100 GI Registry [10].

Another important role of IALA is in its efforts to provide a guideline in reporting of results of E-Navigation testbeds. IALA has issued a document that offers guidance on the reporting of results of E-Navigation testbeds [11]. This document includes initial considerations that have to be reflected when planning a testbed and a reporting template for results in order to ensure that results are valuable to the E-Navigation development community. A testbed itself is a platform for trialling development projects and in principle involve rigorous, transparent and replicable testing of scientific theories, computational tools and new technologies.

Various administrations and organisations have conducted testbeds related to E-Navigation. Some of them are ongoing. List of E-Navigation testbeds could be found in [11] and [12].

2.3 Overarching E-Navigation architecture

IMO has defined an overarching architecture for E-Navigation as given in the following Figure 1.

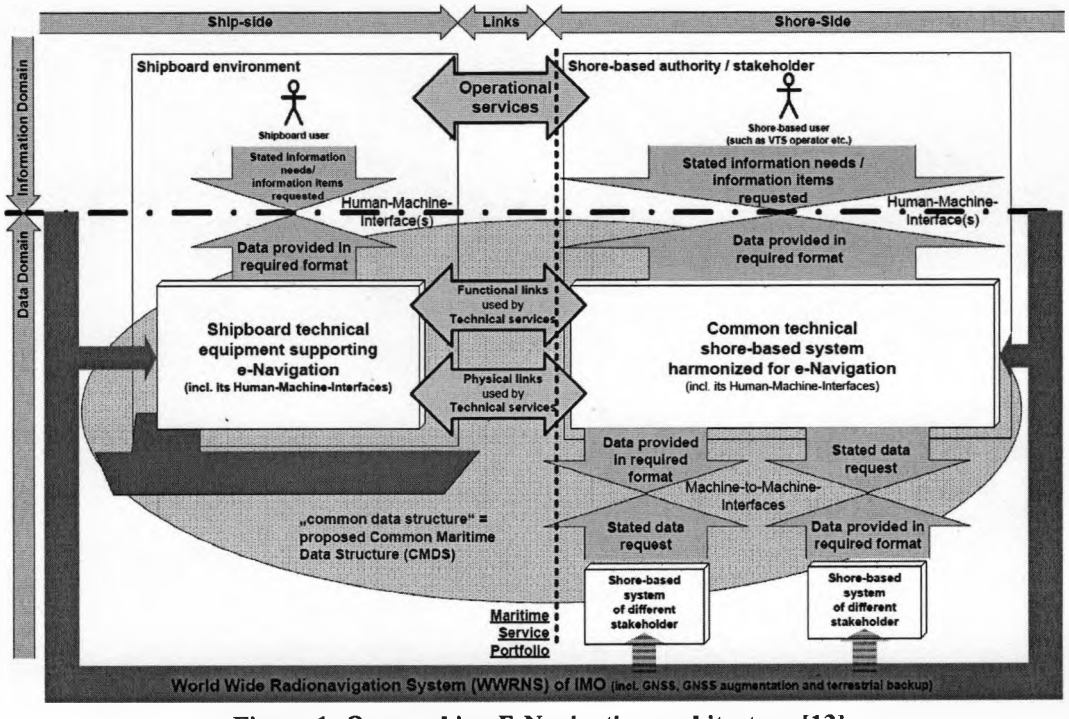

Figure 1: Overarching E-Navigation architecture [13]

On figure 1 it is easy to notice in horizontal level three most important parts of E-Navigation: ship side and shore side structures are connected with communication links in between. In vertical level are illustrated information and data domain with human and machine interfaces in between.

The figure also presents one important feature that is also important for MSW implementation. The shaded ellipsoid in the background represents Common Maritime Data Structure (CMDS) that extends through whole horizontal level. CMDS should be most important factor that will have impact on harmonization among different shipboard and ashore technical systems [13]. It is worth mentioning that IHO S-100 data model will play a key role in achieving above mentioned harmonization [6].

3 PREPEARING FOR MSW IMPLEMENTATION

Single Window concept has been introduced as a major platform for collaboration and information exchange among different government agencies involved in international trade. In 2005 the United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT) summarized the Single Window concept in its Recommendation 33 [14] as a "facility that allows parties involved in trade and transport to lodge standardized information and documents with a single entry point to fulfil all import, export, and transit-related

regulatory requirements. If information is electronic, then individual data elements should only be submitted once".

As regard for MSW, IMO addresses this issue, which is related to facilitation of international maritime traffic, through FAL Committee. Work of FAL Committee, among other topics, is focused on simplification of formalities, documentary requirements and procedures on the arrival and departure of ships and harmonization of documents required by the public authorities. Main result of work of this Comities are standardized IMO FAL Forms. Having in mind that most of literature available on the single window concept is mostly concerned with trade and cargo related issues, IMO has published guidelines for setting up a single window system in maritime transport [15]. These guidelines attempt to provide more specific guidance on maritime transport clearance, including the clearance of the ship. Guidelines are built upon general single window concepts and characteristics which have been expanded to integrate the requirements of maritime transport.

According to IMO, MSW would be focused on facilitating the clearance of ships, passengers and crew members, and on connecting the cargo-related information with the single window on cargo clearance already in place, using the information provided in the IMO FAL Forms [4].

3.1 EU initiative – Reporting Formalities Directive

Unlike international level where MSW is still a concept that is broadly discussed, in EU level there is clear road map and predefined dates for MSW implementation. RFD imposes to EU member states to implement MSW, linking it with SafeSeaNet[1], e-Customs and other electronic systems, where all information will be reported once and made available to various competent authorities and the member states. There are three types of reporting formalities referred to RFD [5]:

1. Reporting formalities resulting from legal acts of the EU that includes information which shall be provided like:
   - Notification for ships arriving in and departing from ports of the EU,
   - Border checks on persons,
   - Notification of dangerous or polluting goods carried on board,
   - Notification of waste and residues,
   - Notification of security information,
   - Entry summary declaration.
2. FAL forms and formalities resulting from international legal instruments
   - FAL form 1: General Declaration
   - FAL form 2: Cargo Declaration
   - FAL form 3: Ship's Stores Declaration
   - FAL form 4: Crew's Effects Declaration
   - FAL form 5: Crew List
   - FAL form 6: Passenger List

[1] SafeSeaNet is a EU platform for vessel traffic monitoring and information exchange between member states maritime authorities established in order to enhance maritime safety, port and maritime security, marine environment protection and the efficiency of maritime traffic and maritime transport.

- FAL form 7: Dangerous Goods
- Maritime Declaration of Health

3. Any other relevant national legislation

RFD also require from each member states to ensure that the reporting formalities at their ports are requested in a harmonised and coordinated manner. According to RFD, MSW must be interoperable, compatible and accessible to the SafeSeaNet system and, where applicable, with other paperless systems for customs and trade.

4 FUTURE TRENDS

A common feature of E-Navigation and MSW is to provide seamless transfer of information across all available communication systems needed for their implementation. One of proposed solution to achieve 'Common technical shore based system harmonized for E-Navigation' (figure 1.) is Maritime Cloud. Maritime Cloud is defined as: "A communication framework enabling efficient, secure, reliable and seamless electronic information exchange between all authorized maritime stakeholders across available communication systems" [16]. Relevant IMO bodies also noted that the Maritime Cloud could complement MSW concept. It is important to note that Maritime Cloud is not a 'storage cloud' containing all information about every ship or cargo, nor is it referring to 'cloud computing' [19]. 'Maritime Cloud' is envisaged as an enabler of seamless information exchange between various systems and across different communication links in the maritime sector, that will enable realization of communication infrastructure necessary for E-Navigation and MSW [19].

On EU level is present E-Maritime initiative that aims to foster the use of advanced information technologies for working and doing business in the maritime transport sector. E-Maritime envisages facilitating the movement of goods over sea, by using of ICT technology to accelerate processes and services in maritime sector [17]. MSW that should be implemented at EU level could be considered as a part of E-Maritime initiative. It is noted that E-Maritime and E-Navigation could contribute to the development of each other. One of views of coherence between E-Navigation and E-Maritime (including MSW) is that main aim of E-Navigation is "to enhance the navigation capabilities of a ship without compromising its efficiency", while "e-Maritime aimed to increase its profitability without compromising its safety" [17].

5 CONCLUSION

Nowadays there is an increasing demand by national maritime authorities to ask for more information from vessels calling their ports and transiting waters under their jurisdiction in order to manage possible safety, security and environmental risks. Moreover, ports and coastal states are implementing more rules, requirements and mandatory reporting for vessels arriving in or transiting waters within their jurisdiction. Number of regional and bilateral agreements among coastal states related to maritime safety and environmental protection is also increasing. Most of these agreements seek for additional reporting. All this impose to stakeholders in maritime transport additional burden and workload. With implementation of E-Navigation and MSW administrative burden, on board and on shore, will be reduced, that will improve navigational safety and reduction of risks of accidents at sea.

Both concepts, E-Navigation and MSW, have common key words: harmonization, standardization and facilitation. In front of stakeholders, international bodies and industry

there is a great challenge, in coming years, in producing a unified strategies and latter develop specific systems to meet needs for harmonization, standardization and facilitation in maritime transport. If this will be achieved it will have great impact on maritime safety, security and marine environmental protection.

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Biografija – Nexhat Kapidani

Nexhat Kapidani je rođen u Ulcinju 06.07.1972. godine. Osnovnu školu je završio u rodnom Ulcinju, a gimnaziju „Niko Rolović" u Baru - smjer prirodno matematički. Školske 1990/1991. upisao je studije na Elektrotehničkom fakultetu u Sarajevu (Bosna i Hercegovina) – smjer informatika. Zbog izbijanja rata 1992. godine, studije nastavlja na Elektrotehničkom fakultetu u Podgorici - smjer elektronika. Fakultet završava u roku, u junu 1995. godine, kada stiče zvanje diplomiranog inženjera elektrotehnike – smjer elektronika. Magistarske studije je završio na Pomorskom fakultetu u Kotoru 2014. godine, kada je i upisao doktorske studije.

Nakon diplomiranja obavljao je mnoge odgovorne poslove iz oblasti IT i pomorstva. Tokom rada se usavršavao i stekao mnoga stručna zvanja poput MCP- *Microsoft Certified Proffesional*, MCSA - *Microsoft Certified System Asministrator*, MCSE- *Microsoft Certified System Engineer* i MCT – *Microsoft Certified Trainer*. Od 01. juna 2008. godine do danas radi u Upravi pomorske sigurnosti i upravljanja lukama, prvo kao savjetnik direktora, a kasnije kao pomoćnik direktora, gdje obavlja najsloženije poslove iz oblasti rada Uprave za koje je potrebna posebna stručnost i samostalnost u radu. Zadužen je za planiranje, održavanje i unapređenje informacionih i telekomunikacionih sistema iz oblasti pomorstva poput VHF, GMDSS, AIS, LRIT, VTMIS, NMSW i dr. Tokom rada u Upravi imenovan je u mnogim nacionalnim i međunarodnim ekspertskim radnim grupama koje se bave nadzorom mora i sigurnošću na moru. Tokom rada u Upravi rukovodio je sledećim projektima:

1. Implementacija LRIT-a u Crnoj Gori (2009)
2. Implementacija AIS infrastrukture u Crnoj Gori (2010)
3. Razmijena AIS podataka sa međunarodnim institucijama NATO, IALA i EMSA (2015)
4. MEDESS-4MS projekat iz MED programa (2012-2014)
5. Implementacija VTMIS u Crnoj Gori (2015)
6. COMPASS2020 H2020 projekat (2019-2021)
7. ANDROMEDA H2020 projekat (2019-2021)
8. EFFECTOR H2020 projekat (2020 – 2022)
9. RESPOND-A H2020 projekat (2020-2023)
10. ePIcenter H2020 projekat (2020-2023)
11. EUREKA InterregAdrion projekat (2020 – 2023)

Kompletna bibliografija:

Master teza:

1. **Kapidani N.** Implementacija VTMIS-a u Crnoj Gori, MSc teza, Univerzitet Crne Gore, 2014

Vodeći časopisi (SCI/SCIE lista):

1. **Kapidani, N.**, Bauk, S., Davidson, I.E.A. „Developing Countries' Concerns Regarding Blockchain Adoption in Maritime" MDPI J.Mar. Sci. Eng.2021,9, 1326, novembar 2021 https://doi.org/10.3390/jmse9121326
2. **Kapidani N.**, Bauk S., Davidson I, "Digitalization in Developing Maritime Business Environments towards Ensuring Sustainability", Sustainability 2020, MDPI, november 2020, https://doi.org/10.3390/su12219235
3. **Kapidani, N.**, Tijan E., Jović M., Kočan E., National Maritime Single Window: Cost-Benefit Analysis of Montenegro Case Study, "Promet – Traffic & Transportation", Zagreb – Hrvatska, jul 2020. DOI: https://doi.org/10.7307/ptt.v32i4.3422

Drugi međunarodni, regionalni i nacionalni časopisi:

1. Mihailovic A., **Kapidani N.**, Kočan E., Delgado D., Räsänen J., „Analysing the prospect of the maritime common information sharing environment's implementation and feasibility in Montenegro" , Scientific Journal of Maritime Research 35 (2021), Rijeka – Croatia https://doi.org/10.31217/p
2. Bauk S., **Kapidani N.,** Sousa, L., Lukšić, Ž., Spuža, A. „Advantages and disadvantages of some unmanned aerial vehicles deployed in maritime surveillance", Journal of Maritime Research, 2020, 17(3), pp. 81–87, URL: https://www.jmr.unican.es/index.php-/jmr/article/view/635/666 (ISSN: 1697-4840; ISSNe: 1697-9133. Paper presented at 8th International Maritime Conference on Maritime Transport, Barcelona, Spain, 17-18.09.2020
3. Bauk S., **Kapidani N.**, Lukšić Ž., Rodrigues F., Sousa L., „Autonomous marine vehicles in sea surveillance as one of the COMPASS2020 project concerns", Journal of Physics: Conference Series, 2019, 1357(1), 12045, DOI: https://doi.org/10.1088/1742-6596/1357/1/012045 (ISSN:1742-6588; e-ISSN:1742-6596); Maritime and Port Technology and Development Conference (MTEC) and The International Conference on Maritime Autonomous Surface Ships (ICMASS) Trondheim Norway 13-14

Međunarodne konferencije:

1. Paladin Z., **Kapidani N.**, Lukšić Ž., Mihailović A., Scrima P., De Naurois Ch., Laudy C.,Rizogiannis C, . Astyakopoulos A., Blum A., „Combined AI Capabilities for Enhancing Maritime Safety in a Common Information Sharing Environment", 35th Bled eConference, June 26-29, 2022, Bled, Slovenia, rad je prihvaćen
2. Paladin Z., **Kapidani N.**, Lukšić Ž., Nicoletti T., Moutzouris M., Blum A., „A Maritime Big Data Framework Integration in a Common Information Sharing Environment", 45th International Convention on Information, Communication and Electronic Technology - MIPRO 2022 Opatija, Hrvatska, maj 2022;
3. Aksentijević S., Tijan E., **Kapidani N.**, Mujalović R., „Dynamic identification of modular shipping containers", 45th International Convention on Information, Communication and Electronic Technology - MIPRO 2022 Opatija – Hrvatska, may 2022;
4. Mihajlović A., **Kapidani N.**, Lukšić Ž., Toutnier R., Vella G., S., Moutzouris M., Souse B., Blum A., Paladin Z., „Planning a Case for Shared Data Retrieval across the European Maritime Common Information Sharing Environment", 26th International Conference on Information Technology (I.T.), Zabljak Montenegro, 15.02.2022
5. **Kapidani N.,** Aksentijević S., Tijan E., Kočan E., "Establishing a National Maritime Single Window in Small Coastal Countries," 2021 44th International Convention on Information, Communication and Electronic Technology (MIPRO), 2021, pp. 1448-1453, doi: 10.23919/MIPRO52101.2021.9596744 .
6. Paladin Z., Mihailović A., Kapidani N., Delgado D., Nogueron J., Vella G., Moutzouris M., Leuzzi R. „Augmenting maritime Command and Control over a regional Common Information Sharing Environment implementation: Montenegro Case", NMIOTC Journal Issue 22, pp. 20-29. 1st Issue 2021 ISSN:2242-441X
7. Mihajlović A., **Kapidani N.**, Kočan E., Lukšić Ž., Delgado D, Antonopoulos S., Moutzouris M., „A Framework for Incorporating a National Maritime Surveillance System into the European Common Information Sharing Environment", 25th International Conference on Information Technology (I.T.), Zabljak Montenegro, 17.02.2021
8. **Kapidani N.,** Belojević A., Haçkaj A. Otašević Đ, Metaj E., Kardović E. „South-Adriatic connectivity governance as one of the SAGOV project concerns", The 1st International Conference on Maritime Education and Development (ICMED), Durban, South Africa 23-24 November 2020,
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13. Bauk S., **Kapidani N.**, Schmeink A., Holtham C., „Concerning intelligent ICT exploitation in some maritime business organisations: A pilot study", Our sea: International Journal of Maritime Science & Technology, Dubrovnik-Croatia, 2017, Vol.64 No.2;
14. Rødseth O.J., **Kapidani N.** 2017. „A Taxonomy for Single Window Environments in Seaports", proc. of the MTEC2017, 26-28 April 2017, Singapore;
15. **Kapidani N.**, Kočan E., „Implementation of National Maritime Single Window in Montenegro", 23rd Telecommunications Forum TELFOR 2015 - IEEE Conference, Belgrade, Serbia, 24-26.11.2015;
16. **Kapidani N.**, „Importance of LRIT for maritime safety and security", 3rd International Maritime Symposium – IMCI 2015, Vlore, Albania, 23-24.10.2015, ISBN: 978-9928-4108-2-5, pp 79-84;
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18. **Kapidani N**, „Maritime Single Window as a solution of E-navigation", 17th International conference on transport science ICTS 2015, Portorož, Slovenia, 2015
19. Georgoudis E. **Kapidani N**. „Risk assessment methodology on oil spills", Proc. of the 8th International; Conference: Ports and Waterways – POWA, Zagreb, Croatia, 3rd October 2013. (ISSN: 1848-252x), pp. 1-10;
20. **Kapidani N.**, Bauk S., „Strengthening Maritime Safety in Montenegro According to the Response on Oil Spill Pollution", TECHNO-EDUCA 2012, Zenica, Bosnia and Hercegovina 2012, pp. 96-101;
21. **Kapidani N.**, Bauk S., „Implementation of VTS/VTMIS in Montenegro", Proc. of the 7th International Conference: Ports and Waterways – POWA, Zagreb, Croatia, 2012, pp. 1-10;

Spisak radova sa rezultatima iz doktorske teze – MSc Nexhat Kapidani

Vodeći naučni časopisi (SCI/SCIE lista):

1. **Kapidani, N.**, Tijan E., Jović M., Kočan E., National Maritime Single Window: Cost-Benefit Analysis of Montenegro Case Study, "Promet – Traffic & Transportation", Zagreb – Hrvatska, vol. 32, no. 4, pp. 543-557, Jul. 2020. DOI: https://doi.org/10.7307/ptt.v32i4.3422

Međunarodne konferencije:

1. **Kapidani N.**, Aksentijević S., Tijan E., Kočan E., "Establishing a National Maritime Single Window in Small Coastal Countries," 2021 44th International Convention on Information, Communication and Electronic Technology (MIPRO), 2021, pp. 1448-1453, DOI: 10.23919/MIPRO52101.2021.9596744
2. Rødseth O.J., **Kapidani N.** 2017. A Taxonomy for Single Window Environments in Seaports. proc. of the MTEC2017, 26-28 April 2017, Singapore;
3. **Kapidani N.**, Kočan E., Implementation of National Maritime Single Window in Montenegro, 23rd Telecommunications Forum TELFOR 2015 - IEEE Conference, Belgrade, Serbia, 24-26.11.2015;
4. **Kapidani N.**, Maritime Single Window as a solution of E-navigation, 17th International conference on transport science ICTS 2015, Portorož, Slovenia, 2015

Kočan Enis - biografija

Enis Kočan je rođen 1979. godine u Beranama, gdje je završio osnovnu školu i Gimnaziju. Nosilac je diploma Luča za odlične uspjehe u osnovnoj i srednjoj školi, a proglašen je za najboljeg đaka generacije beranske Gimnazije. Elektrotehnički fakultet u Podgorici je završio juna 2003. godine, U toku studija bio je korisnik stipendije za talentovane studente opštine Berane. Po završetku studija, zaposlio se kao saradnik u nastavi na Elektrotehničkom fakultetu (ETF) u Podgorici, i upisao je magistarske studije u oblasti telekomunikacija. Magistarsku tezu je odbranio 29.09.2005. godine. Na doktorske studije se upisao u septembru 2007. godine, a doktorirao je 28.01.2011. godine, takođe na ETF-u u Podgorici, odbranom doktorske teze pod nazivom "Rješenja za poboljšanje performansi OFDM relay sistema kroz permutaciju podnosilaca". Dio doktorskih istraživanja je sproveo na Aristotel Univerzitetu u Solunu na poziv profesora George Karagiannidisa.

U junu 2014. godine je izabran u zvanje docenta na predmetima Radiokomunikacije i Radiotehnika na Elektrotehničkom fakultetu, kao i na predmetu Pomorske telekomunikacije na Pomorskom fakultetu u Kotoru. U zvanje vanrednog profesora Univerziteta Crne Gore za oblast Telekomunikacije na Elektrotehničkom fakultetu, izabran je u junu 2019. godine.

Oblasti naučno-istraživačkog interesovanja Enisa Kočana uključuju: mobilne radiokomunikacione sisteme, rješenja za mreže nakon 5G, IoT komunikaciona rješenja, pomorske komunikacione sisteme, rješenja za smanjenje nivoa zračenja u bežičnim komunikacionim sistemima, itd. Autor je 85 naučnih radova, među kojima su 10 radova objavljenih u časopisima sa SCIE liste, kao i rad nagrađen sa "Best Paper Award" na međunarodnoj konferenciji WPMC 2013, u Atlantic City-u, SAD. Pored toga, koautor je stručne knjige objavljene 2012. godine na engleskom jeziku, od strane međunarodnog izdavača River Publishers. Recenzirao je radove za 14 međunarodnih naučnih časopisa sa SCIE liste, uključujući i najprestižnije časopise iz oblasti telekomunikacija, obrade signala i računarskih nauka, kao što su kao što su 6 časopisa izdavača IEEE, zatim časopisi izdavača Elsevier, Wiley, Springer, itd. Bio je mentor u izradi 5 MSc teza, kao i većeg broja specijalističih radova.

Enis je koordinirao realizacijom jednog H2020 projekta, a učestvovao je, odnosno i dalje učestvuje, u realizaciji većeg broja međunarodnih projekata (3 H2020 projekta, 4 FP7 projekta, 3 COST akcije, SCOPES, UNESCO projekat, itd.). Kao lider jednog od radnih paketa učestvovao je u realizaciji projekta prvog Centra izvrsnosti u Crnoj Gori (BIO-ICT), zatim u 4 projekta bilateralne naučne saradnje, kao i 2 nacionalna naučno-istraživačka projekta. U toku rada na međunarodnim projektima, kao istraživač je boravio na većem broju univerziteta širom Evrope (EPFL u Lozani, Tehnički Univerzitet u Beču, Univerzitet u Aalborgu, Univerzitet u Gentu, itd.)

Učestvovao je u realizaciji velikog broja stručnih projekata iz oblasti telekomunikacija, u izradi studija i elaborata za potrebe privrede i Vladinih tijela i agencija. Učestvovao je u izradi više od 60 elaborata o uticaju zračenja baznih stanica na životnu sredinu. Zamjenik je rukovodioca

Laboratorije akreditovane za mjerenje elektromagnetnih emisija. Kao član tima je učestvovao u mjerenjima na više od 150 lokacija, kao i u izradi Izvještaja o ispitivanju nivoa elektromagnetnih emisija.
U periodu od 2015. do 2017. godine Enis Kočan je bio član Savjeta za naučnoistraživačku djelatnost Crne Gore, kao i predstavnik Crne Gore u H2020 Programskom komitetu za ERC–FET–MSCA. Od kraja avgusta 2019. godine obavlja funkcije prodekana za finansije na Elektrotehničkom fakultetu.

Školovanje

BSc, jul 2003. – Univerzitet Crne Gore, Elektrotehnički fakultet

MSc, septembar 2005. - Univerzitet Crne Gore, Elektrotehnički fakultet

PhD, januar 2011. - Univerzitet Crne Gore, Elektrotehnički fakultet

Doktorska disertacija: "Rješenja za poboljšanje performansi OFDM zasnovanih relay systema kroz permutaciju podnosilaca"

Oblast: Telekomunikacije.

Istraživačke mobilnosti

Jun - Septembar 2008.: Aristotle University of Thessaloniki, Greece

Jun 2013.: École polytechnique fédérale de Lausanne - EPFL, Switzerland

Jun 2014.: Center for Teleinfrastruktur, Aalborg University, Denmark

Septembar 2014.: École polytechnique fédérale de Lausanne - EPFL, Switzerland

Maj 2016.: Jozef Stefan Institute - Ljubljana, Slovenia.

Bibliografija

Knjiga

1. M. Pejanovic-Djurisic, **E. Kocan**, R. Prasad: *"OFDM based relay systems for future wireless communications"*, River Publishers, Denmark, 2012, (ISBN: 9788792329271)

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1. N. Kapidani, E. Tijan, M. Jovic, **E. Kocan**, National Maritime Single Window: CostBenefit Analysis of Montenegro Case Study, Promet-Traffic&Transportation, vol. 32, no. 4, pp. 543-557, 2020. (ISSN 0353-5320). Available online via: https://doi.org/10.7307/ptt.v32i4.3422
2. M. Vucinic, T. Chang, B. Skrbic, **E. Kocan**, M. Pejanovic–Djurisic, T. Watteyne, *Key* Performance Indicators of the Reference 6TiSCH Implementation in Internet-of-Things Scenarios, IEEE Access, vol. 8, no. 1, pp. 79147 – 79157. (ISSN: 2169-3536), Available online via: http://ieeexplore.ieee.org/document/9078083
3. **E. Kocan**, A. Lopusina, M. Pejanovic–Djurisic, Macro diversity for mmWave cellular communications in indoor environment, Computer Networks, vol. 161, pp. 161-169, October 2019. (ISSN: 1389-1286)
   Available online via https://doi.org/10.1016/j.comnet.2019.06.016
4. G. Sheng, S. Dang, Z. Zhang, **E. Kocan**, M. Pejanovic–Djurisic, OFDM with Index Modulation Assisted by Multiple Amplify-and-Forward Relays, IEEE Wireless Communication Letters, vol. 8, no. 3, pp. 789-792, June 2019. (ISSN: 2162-2337) Available online via https://ieeexplore.ieee.org/document/8612925
5. **E. Kocan**, B. Domazetovic, M. Pejanovic–Djurisic, Range Extension in IEEE 802.11ah Systems Through Relaying, Wireless Personal Communications, vol. 97, no 2, pp. 1889-1910, November 2017. (ISSN: 0929-6212) Available online via http://dx.doi.org/10.1007/s11277-017-4334-9
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7. Y. Huang, N. Varseir, S. Niksic, **E. Kocan**, M. Pejanovic–Djurisic, et al. Comparison of average global exposure of population induced by a macro 3G network in different geographical areas in France and Serbia, Bioelectromagnetics (ISSN: 0197-8462), vol. 37, no. 6, pp. 382-390, Sept. 2016.
   Available online via http://onlinelibrary.wiley.com/doi/10.1002/bem.21990/abstract
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9. **E. Kocan**, M. Pejanovic–Djurisic, *Performance Improvement of Dual-Hop OFDM Decode-and-Forward Relay System*, Wireless Personal Communications, vol. 93, no. 3, pp. 769-778, April 2017. (ISSN: 0929-6212). Available online via http://dx.doi.org/10.1007/s11277-014-2227-8
10. **E. Kocan**, M. Pejanovic–Djurisic, D. S. Michalopoulos, G. K. Karagiannidis, *Performance evaluation of OFDM Amplify-and-Forward Relay System with Subcarrier Permutation*, IEICE Trans. on Communications, Vol.E93-B, No.05, pp. 1216-1223, May 2010. (ISSN: 0916-8516). Available online via https://doi.org/10.1587/transcom.E93.B.1216

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1. A Mihailovic, N Kapidani, **E Kočan**, D Merino Delgado, J Räsänen, *Analysing the prospect of the maritime common information sharing environment's implementation and feasibility in Montenegro*, Pomorstvo, vol. 35, no. 2, pp. 256-266. (ISSN: 1332-0718).
2. **E. Kocan**, M. Pejanovic–Djurisic, *OFDM AF FG Relaying as an Energy Efficient Solution for the Next Generation Mobile Cellular Systems*, Journal of Green Engineering, vol. 3, no. 2, pp. 147-165, Jan. 2013. (ISSN: 1904-4720).
3. M. Pejanovic–Djurisic, **E. Kocan**, M. Ilic–Delibasic, *Energy Efficient Wireless Communications through Cooperative Relaying*, Journal of Green Engineering, vol. 3, no. 1, pp. 71-90, Oct. 2012. (ISSN: 1904-4720).
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Međunarodne konferencije u poslednjih 5 godina:

1. Jelena Crnogorac, Jovan Crnogorac, **E. Kočan,** M. Vučinić, *Experimental evaluation of distributed sniffer solution for wireless sensor networks*, in Proc. of 26th International conf. Information Technology (IT 2022), pp. 1-4, Žabljak, Montenegro, February 2022.
2. N. Kapidani, S. Aksentijević, E. Tijan, **E. Kočan**, *Establishing a National Maritime Single Window in Small Coastal Countries*, in Proc. of 44th International Convention on Information, Communication and Electronic Technology (MIPRO), Opatija, Croatioa, September 2021.
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5. J. Kovač, J. Crnogorac, **E. Kočan**, M. Vučinić, *Sniffing multi-hop multi-channel wireless sensor networks*, 28th Telecommunications Forum (TELFOR), pp. 1-4, Belgrade, Serbia, November 2020.
6. A. Mihailovic, N. Kapidani**, E. Kocan**, A. Nadziejko, A. B. Monteiro, *Towards Augmenting Maritime Surveillance Capabilities via Deployments of Unmanned Aircrafts and Autonomous Underwater Vehicles*, 14th NATO Operations and Research Conference, Oct. 2020.
7. N. Šepić, **E Kočan**, M. Pejanović-Djurišić, *Evaluating spatial reuse in 802.11ax networks with interference threshold adjustment*, in Proc. of 24th International conf. on Information Technology (IT 2020), Žabljak, Montenegro, February 2020.
8. N. Šepić, **E Kočan**, Z. Veljović, M. Pejanović-Djurišić, *Assessment of novel solutions for throughput enhancement in IEEE 802.11 ax networks*, in Proc. of 27th IEEE conf. TELFOR 2019, Belgrade, Serbia, November 2019.
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10. N. Marvučić, **E. Kočan**, *Overview of communication solutions for Internet of Things in Maritime Industry*, International Conference of Maritime Science & Technology NAŠE MORE 2019, October 2019, Dubrovnik, Croatia
11. M. Vucinic, B. Skrbic, **E. Kocan**, M. Pejanovic-Djurisic, T. Watteyne, *OpenBenchmark: Repeatable and Reproducible Internet of Things Experimentation on Testbeds*, in Proc. of 2019 IEEE INFOCOM WKSHPS: CNERT 2019: Computer and Networking Experimental Research using Testbeds, Paris, France, April 2019.
12. J. Mrkic, **E. Kocan**, M. Pejanovic-Djurisic, *Hybrid OFDM-IM system for BER performance improvement*, in Proc. of IEEE conf. TELFOR 2018, Belgrade, Serbia, November 2018.
13. B. Domazetovic, **E. Kocan**, *Packet error rate in IEEE 802.11ah use case scenarios*, in Proc. of IEEE conf. TELFOR 2017, Belgrade, Serbia, November 2017.
14. **E. Kocan**, M. Pejanovic-Djurisic, *Transmit antenna selection in OFDM relay system as a solution for energy efficiency improvement*, IEEE WiMOB 2017 conference, Rome, Italy, October 2017.
15. J. Mrkic, **E. Kocan**, M. Pejanovic-Djurisic, *Index Modulation Techniques in OFDM Relay Systems for 5G Wireless Networks*, in Proc. of 40th IEEE conf. TSP 2017, pp. 208-211, Barcelona, July 2017.
16. A. Lopusina, **E. Kocan**, M. Pejanovic-Djurisic, *Macrodiversity for Performance Improvement of mmWave Cellular Wave Communications*, in Proc. of 40th IEEE conf. TSP 2017, pp. 174-177, Barcelona, Spain, July 2017.

Međunarodni projekti

1. *Intelligence-Enabling Radio Communications for Seamless Inclusive Interactions – INTERACT*, COST CA20120 action, Management Committee member, 2021 -
2. *European Network on Future Generation Optical Wireless Communication Technologies - NEWFOCUS*, COST CA11911 action, Management Committee member, 2020 –
3. An End to end Interoperability Framework For MaritimE Situational Awareness at StrategiC and TacTical OpeRations – EFFECTOR, H2020 project, International consortium, Montenegrin team member, 2020 – 2022.
4. *National Initiatives for Open Science – Europe – NI4OS-Europe*, H2020 project, International consortium, Montenegrin team member, 2019 –
5. *An Enhanced Common Information Sharing Environment for Border Command, Control and Coordination Systems – ANDROMEDA*, H2020 project, International consortium, Montenegrin team member, 2019 – 2021.
6. *6TiSCH Open Data Action - SODA*, H2020 project funded by Fed4Fire+ consortium, Project coordinator, 2018- 2019.
7. *Inclusive Radio Communication Networks for 5G and beyond - IRACON*, COST CA15104 action, Montenegrin representative in Management Committee, 2016-2020
8. *eWall for Active Long Living - eWALL*, EU FP7 funded project, International consortium, Montenegrin team member, 2013-2016.

9. *Fostering innovation based research for e-Montenegro - FORe-MONT*, EU FP7 funded project through REGPOT scheme, project team member, 2013-2016.
10. *Low EMF Exposure Future Networks - LEXNET* EU FP7 funded project, International consortium, Montenegrin team member, 2012-2015.
11. *Cooperative radio communications for green smart environments*, COST IC1004 action, Montenegrin team member, 2011-2014.
12. *RF/Microwave Communication Subsystems for Emerging Wireless Technologies (RFCSET)*, COST IC0803 project, Montenegrin team member.
13. *Fostering development of an ICT centre of excellence in Montenegro*, SCOPES "Scientific co-operation between Eastern Europe and Switzerland" programme, project team member 2011-2014.
14. *Promoting ICT Cooperation Opportunities and Policy Dialogue with the Western Balkan Countries (ICT-WEB-PROMS)*, EU FP7 funded Project, International consortium, Montenegro, January 2009.- 2011.
15. *Space for Science*, project initiated by UNESCO and funded by the European Space Agency (ESA) within the framework of the reconstruction of scientific cooperation in South-East Europe.Faculty of Electrical Engineering was one of the two partners from the University of Montenegro (team members: M. Pejanovic-Djurisic, E. Kocan), 2005-2006.

Nacionalni projekti, projekti bilateralne saradnje

1. *Centre of Excellence in Bioinformatics - BIO-ICT*, funded by Montenegrin Ministry of Science, work package leader for Hiring staff & mobilities, 2014-2017.
2. *Advanced solutions for performance improvement of cooperative wireless e-service infrastructures*, research project funded by Montenegrin Ministry of Science, project team member, 2012-2015.
3. *Performance analysis of OFDM relay and OFDM cooperative diversity systems*, research project funded by Montenegrin Ministry of Education and Science, project team member, 2009-2011.
4. *Fostering Development of an ICT Centre of Excellence in Montenegro* in cooperation with EPFL (Ecole polytechnique federale de Lausanne), within SCOPES (Scientific cooperation between Eastern Europe and Switzerland) funding scheme
5. *Advanced technologies for next generation mobile broadband communication systems*, bilateral scientific cooperation Slovenia-Montenegro, project team member, 2012-2014.
6. *Comparative analyses of OFDM cooperative diversity and wideband MIMO systems in future wireless communication networks*, bilateral scientific cooperation MontenegroAustria, project team member, 2011-2013.
7. *Performance analyses of OFDM based relay systems*, bilateral scientific cooperation Croatia-Montenegro, project team member, 2011-2013.
8. *On the development of efficient reception techniques for mobile DVB-T systems*, bilateral scientific cooperation Montenegro-Greece, project team member, 2006-2008.

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Broj / Ref 03 - 1681

Datum / Date 04. 06. 2019

Crna Gora
UNIVERZITET CRNE GORE
ELEKTROTEHNIČKI FAKULTET

Primljeno: 07.06.2019			
Org. jed.	Broj	Prilog	Vrijednost
02/1	863		

Na osnovu člana 72 stav 2 Zakona o visokom obrazovanju („Službeni list Crne Gore“ br. 44/14, 47/15,40/16,42/17,71/17 55/18 i 3/19) i člana 32 stav 1 tačka 9 Statuta Univerziteta Crne Gore, Senat Univerziteta Crne Gore, na sjednici održanoj 04. juna 2019.godine, donio je

O D L U K U
O IZBORU U ZVANJE

Dr ENIS KOČAN bira se u akademsko zvanje **vanredni profesor Univerziteta Crne Gore za oblast Telekomunikacije na Elektrotehničkom fakultetu Univerziteta Crne Gore,** na period od pet godina.

SENAT UNIVERZITETA CRNE GORE
PREDSJEDNIK

Prof.dr Danilo Nikolić, rektor

europass

Edvard Tijan

Date of birth: 13/04/1972

Nationality: Croatian

Gender: Male

CONTACT

Studentska 2, null
51000 Rijeka, Croatia

etijan@pfri.hr

(+385) 922828964

https://www.linkedin.com/in/edvard-tijan-phd-09111b25/?originalSubdomain=hr

WORK EXPERIENCE

2006 – CURRENT

Head of Logistics and Management department, Associate Professor

University of Rijeka, Faculty of Maritime Studies, Rijeka, Croatia

Lecturing, research (EU and domestic scientific and professional projects), training courses for seafarers (STCW convention)

Rijeka

2005 – 2006

Branch Manager

AutoZubak, Pula, Croatia

Managing a sales and service center (20+ employees) for Volkswagen group vehicles (N&U sales, service, body shop, paint shop, spare parts, car wash)

Pula

2004 – 2005

Advisor to the general manager

Ruting, Rijeka, Croatia

Economic and legal advice, drafting and correcting of contracts, coordinating activities between manufacturer and importer, etc.

Rijeka

1996 – 2004

Manager/co-owner

Megavision, Rijeka, Croatia

Finance, management, supervision of production and broadcasting of TV commercials, animations and music videos, management of sales teams, etc.

Rijeka

EDUCATION AND TRAINING

2012 – Rijeka

PhD - Intelligent Transport Systems and Logistics

University of Rijeka, Faculty of Maritime Studies

Principal subject: Seaport Community Systems – Integral ICT Systems

Thesis: Integral Model of Electronic Data Interchange in Seaport Clusters

2010 – Rijeka

MSc (2nd level) – Management

University of Rijeka, Faculty of Economics

Principal subject: E-business

Thesis: E-business as a Rationalization Factor in Croatian Insurance Companies

BSc - Maritime Electronics and ICT

University of Rijeka, Faculty of Maritime Studies

Principal subject: Maritime Electronics and ICT

Thesis: E-business in Container Management

2003 – Rijeka, Croatia

MSc - Maritime Transport Engineering

University of Rijeka, Faculty of Maritime Studies

Principal subject: Maritime Transport – Navigational Sciences

Thesis: Optimization of Shipping Companies' Operations via Internet Applications

2001 – Rijeka

BSc - Maritime Transport Engineering

University of Rijeka, Faculty of Maritime Studies

Principal subject: Maritime Electronics and Communications

Thesis: Internet Applications in Maritime Transport

1993 – Rijeka

BSc - Electrical Engineering

University of Rijeka – Faculty of Engineering

Principal subject: Electrical Engineering

Thesis: Reduction of Peak Power Surges in Shipyards using Computer Controlled Diesel Generators

LANGUAGE SKILLS

MOTHER TONGUE(S): Croatian

OTHER LANGUAGE(S):

English

Listening	Reading	Spoken production	Spoken interaction	Writing
C2	C2	C2	C2	C2

Italian

Listening	Reading	Spoken production	Spoken interaction	Writing
B1	B2	B1	B1	B1

DIGITAL SKILLS

Microsoft Word / Microsoft Excel / Outlook / Microsoft Powerpoint / Microsoft Office / Google Drive / Microsoft Teams / Social Media / Google Docs / Zoom / LinkedIn / Skype / Organizational and planning skills / Decision-making / Analytical skills / Written and Verbal skills / Good listener and communicator / Conflict resolution / Team-work oriented / Data analysis / Motivated / Research and analytical skills / Critical thinking / Strategic Planning / Detail-Oriented / Presenting / Responsibility / Excellent writing and verbal communication skills / Flexibility / Reliability / Creativity / Research / Good time management / Cross cultural skills / Project management / Ability to Work Under Pressure

PUBLISHED PAPERS

Books, book chapters, scientific and professional articles

3 Editor's books, 2 book chapters, over 110 scientific papers (out of which 40 scientific journal papers and 70 papers published in conference proceedings with international peer-review), 25 professional articles , 4 scientific articles currently under review. An up-to-date list of published articles can be found at http://bib.irb.hr/lista-radova?autor=292541&lang=EN

INTERNATIONAL SCIENTIFIC AND PROFESSIONAL PROJECTS

Most relevant projects:

Project manager: INTERREG V-A Italy-Croatia project DIGitalisation of multimodal transport in the Adriatic SEA **- DIGSEA**, 2022 - 2023

Project partner: HORIZON-CL3-2021-INFRA-01 project Improved resilience of Critical Infrastructures AgainsT LArge scale transNational and sysTemic rISks – **ATLANTIS**, 2022 - 2025

External expert: INTERREG V-A Italy-Croatia project **Blue technology - Developing innovative technologies for sustainability of Adriatic Sea - InnovaMare**, 2020 - 2023

External expert: H2020 project **Enhanced Physical Internet-Compatible Earth-frieNdly freight Transportation answER - ePIcenter**, 2020 - 2023

Project manager (Lead partner): INTERREG V-A Italy-Croatia project **Dig italising Logistics processes - DIGLOGS**, 2019 - 2021

Project manager: ERASMUS + Sport project **Athletes Friendly Education - AFE**, 2019 - 2020

External expert: INTERREG V-A Italy-Croatia project **Blue enhancement action for technology transfer - BEAT**, 2018 - 2019

Project partner: EU Framework project ***REACT: Supporting Research on Climate-friendly Transport,*** Seventh Framework Programme (FP7), 2008 – 2011

Project partner - WP4 leader: EU Framework project ***STARNETRegio: STARring a trans-regional network of REGIOnal research-driven marine clusters***, Seventh Framework Programme (FP7), 2008 –2010

Project partner - WP6 leader: EU Framework project ***mGBL: Mobile Game Based Learning***, Sixth Framework Programme (FP6), 2005 –2008

Project partner: **Perspectives On Inter-Regional Transport Unitary System: Development of Integrated Logistic System between the main central and northern Adriatic Ports and their connection with existing Pan-European Corridors and Axis - PORTUS**, INTERREG Cards/Phare, 2007 -2008

DOMESTIC SCIENTIFIC PROJECTS

Most relevant projects:

Researcher: **Promoting skills excellence for the labour market through the institutionalization of professional practice in maritime education (PANDORA)**, Operational programme Efficient Human Resources *2014-2020*, European Social Fund, 2020 - 2022

Project manager and lead researcher: **Information management in seaport clusters** – financed by University of Rijeka, 2017 - 2020

Project manager: **Electronic Transportation Management System e-TMS**, New products and services as a result of research, development and innovation - IRI, Operational Programme Competitiveness and Cohesion, 2018 - 2020

Researcher: **Maritime EDUcation Standard for Shipping and Ship Management Ability (MEDUSA)**, European Social Fund - Operational Programme "Effective Human Resources", 2019 - 2021

Researcher: **Development of qualifications and innovative methods of competence acquisition in Logistics and Maritime transport (KIKLOP)**, European Social Fund, Human resources development, 2015 – 2016

Researcher: **Electronic-logistic seaport cluster –business process orchestration**, financed by the Croatian Ministry of science, 2006 – 2012

Researcher: **Electronic-logistic seaport cluster – hybrid business structures**, financed by the Croatian Ministry of science, 2003 - 2006

PROFESSIONAL PROJECTS

Most relevant projects:

Consultant - key expert: **Upgrade of the Rijeka port infrastructure – Port Community Information System (POR2CORE - PCS)**, CEF Transport, 2019 - 2020

Lead author: **Development of National Single Window for the maritime traffic formalities (NSW)** – Contractor: Croatian Ministry of Sea, Transport and Infrastructure, 2017

Consultant: Assesment and evaluation of bids for the **Supply and Installation of the Electronic Data Interchange (EDI) System for the Port of Rijeka** (Rijeka Gateway Project), Contractor: Rijeka Port Authority 2010 – 2012

Researcher: **APLOMB** and **ADRIAFORM** maritime traffic business projects with the aim of developing EU projects (INTEREG IIIA), 2008

Researcher: **Sustainable development of cruising tourism in the Republic of Croatia**, Lead research institution: Institute for Tourism Zagreb, Contractor: Association of Croatian Port Authorities, 2006

MEMBERSHIPS

Most relevant memberships:

Chair: **Digital Economy and Digital Society** International Scientific Co nference, MIPRO, Opatija, Croatia, 2008 – 2023

Member of **University Senate** – University of Rijeka (representing PhD students), 2008 – 2011, **Board of Postgraduate Studies Evaluation** and **Legal Framework Board** - University of Rijeka, 2009 – 2012

Member of editorial board or **scientific committee** of several international scientific journals and conferences

Matični odbor za područje tehničkih znanosti
- polja strojarstva, brodogradnje, tehnologije prometa i transporta, zrakoplovstva, raketne i svemirske tehnike

KLASA: UP/I-640-03/17-01/1253
URBROJ: 355-06-04-18-0002
Zagreb, 17. siječnja 2018.

Na temelju članka 33. i 35. Zakona o znanstvenoj djelatnosti i visokom obrazovanju (NN 123/03, 198/03, 105/04, 174/04, 46/07, 45/09, 63/11, 94/13, 139/13, 101/14 i 60/15) Matični odbor za područje tehničkih znanosti – polja strojarstva, brodogradnje, tehnologije prometa i transporta, zrakoplovstva, raketne i svemirske tehnike, na 3. sjednici održanoj 17. siječnja 2018. donosi

O D L U K U
o izboru u znanstveno zvanje

Dr.sc. EDVARD TIJAN, docent Pomorskog fakulteta Sveučilišta u Rijeci, izabire se u znanstveno zvanje višeg znanstvenog suradnika u znanstvenom području tehničkih znanosti – polje tehnologija prometa i transport.

O b r a z l o ž e n j e

Sukladno članku 33. i 35. Zakona o znanstvenoj djelatnosti i visokom obrazovanju pristupnik dr.sc. Edvard Tijan, podnio je dana 26. listopada 2017. Pomorskom fakultetu Sveučilišta u Rijeci zahtjev za izbor u znanstveno zvanje višeg znanstvenog suradnika u znanstvenom polju tehnologija prometa i transport.

Na prijedlog Stručnog povjerenstva imenovanog na sjednici Fakultetskog vijeća Pomorskog fakulteta Sveučilišta u Rijeci, dana 3. studenog 2017., koje je za pristupnika dalo svoje mišljenje o ispunjenju uvjeta iz Pravilnika o uvjetima za izbor u znanstvena zvanja – čl.1. tč.2. tehničke znanosti (NN 84/05, 100/06, 138/06, 120/07, 71/10, 116/10, 38/11), Fakultetsko vijeće Pomorskog fakulteta Sveučilišta u Rijeci na svojoj sjednici održanoj 13. studenog 2017. utvrdilo je da pristupnik ispunjava sve uvjete za izbor u znanstveno zvanje višeg znanstvenog suradnika u znanstvenom području tehničkih znanosti – polje tehnologija prometa i transport.

Matični odbor prihvatio je prijedlog Fakultetskog vijeća Pomorskog fakulteta Sveučilišta u Rijeci te na 3. sjednici održanoj 17. siječnja 2018. izabrao pristupnika u znanstveno zvanje višeg znanstvenog suradnika.

UPUTA O PRAVNOM LIJEKU: Protiv Odluke o izboru u znanstveno zvanje pristupnik nema pravo žalbe, ali može pokrenuti upravni spor pred Upravnim sudom u Zagrebu u roku od 30 dana od dana dostave pristupniku. Tužba se predaje Upravnom sudu u Zagrebu neposredno u pisanom obliku, usmeno na zapisnik ili se šalje poštom odnosno dostavlja elektronički.

Predsjednik Matičnog odbora

Prof. emeritus dr.sc. Mladen Franz

Odluka se dostavlja:
1. dr.sc. Edvard Tijan
2. Pomorski fakultet u Rijeci
3. Ministarstvo znanosti i obrazovanja

REPUBLIKA HRVATSKA
NACIONALNO VIJEĆE ZA ZNANOST

Matični odbor za područje društvenih znanosti - polje informacijske i komunikacijske znanosti

Klasa: 640-03/13-01/0074
Ur. broj: 355-02-09-13-0002
Zagreb, 21. ožujka 2013.

Na temelju članka 33. i 35. Zakona o znanstvenoj djelatnosti i visokom obrazovanju (NN 123/03, 198/03, 105/04, 174/04, 46/07, 45/09 i 63/11) Matični odbor za područje društvenih znanosti – polje informacijske i komunikacijske znanosti, na 13. sjednici održanoj 21. ožujka 2013. donosi

O D L U K U
o izboru u znanstveno zvanje

Dr.sc. EDVARD TIJAN, viši asistent Pomorskog fakulteta Sveučilišta u Rijeci, izabire se u znanstveno zvanje znanstvenog suradnika u znanstvenom području društvenih znanosti – polje informacijske i komunikacijske znanosti.

O b r a z l o ž e n j e

Sukladno članku 33. i 35. Zakona o znanstvenoj djelatnosti i visokom obrazovanju pristupnik dr.sc. Edvard Tijan, podnio je Filozofskom fakultetu Sveučilišta u Zagrebu zahtjev za izbor u znanstveno zvanje.

Na prijedlog Stručnog povjerenstva imenovanog na sjednici Fakultetskog vijeća Filozofskog fakulteta Sveučilišta u Zagrebu dana 05. rujna 2012., koje je za pristupnika dalo svoje mišljenje o ispunjenju uvjeta iz Pravilnika o uvjetima za izbor u znanstvena zvanja – čl.1.tč.5. društvene znanosti (NN 84/05), Fakultetsko vijeće Filozofskog fakulteta Sveučilišta u Zagrebu na sjednici održanoj 20. prosinca 2012. utvrdilo je da pristupnik ispunjava sve uvjete za izbor u znanstveno zvanje znanstvenog suradnika u znanstvenom području društvenih znanosti – polje informacijske i komunikacijske znanosti.

Matični odbor prihvatio je prijedlog Fakultetskog vijeća Filozofskog fakulteta Sveučilišta u Zagrebu te na 13. sjednici održanoj 21. ožujka 2013. izabrao pristupnika u znanstveno zvanje znanstvenog suradnika.

POUKA O PRAVNOM LIJEKU: Protiv Odluke o izboru u znanstveno zvanje pristupnik nema pravo žalbe, ali može pokrenuti upravni spor.

Predsjednica Matičnog odbora

Prof. dr. sc. Jadranka Lasić-Lazić

Odluka se dostavlja:
1. dr.sc. Edvard Tijan
2. Filozofski fakultet u Zagrebu
3. Ministarstvo znanosti, obrazovanja i sporta

REPUBLIKA HRVATSKA
NACIONALNO VIJEĆE ZA ZNANOST

Matični odbor za interdisciplinarno područje (znanost; umjetnost)

Klasa: 640-03/12-01/1536
Ur. broj: 355-02-09-13-0004
Zagreb, 20. ožujka 2013.

Na temelju članka 33. i 35. Zakona o znanstvenoj djelatnosti i visokom obrazovanju (NN 123/03, 198/03, 105/04, 174/04, 46/07, 45/09, 63/11) Matični odbor za interdisciplinarno područje (znanost; umjetnost), na 9. sjednici održanoj 20. ožujka 2013. donosi

O D L U K U
o izboru u znanstveno zvanje

Dr.sc. EDVARD TIJAN, viši asistent Pomorskog fakulteta Sveučilišta u Rijeci, izabire se u znanstveno zvanje znanstvenog suradnika u interdisciplinarnom području znanosti.

O b r a z l o ž e n j e

Sukladno članku 33. i 35. Zakona o znanstvenoj djelatnosti i visokom obrazovanju pristupnik dr.sc. Edvard Tijan, podnio je zahtjev za izbor u znanstveno zvanje.

S obzirom da niti jedna znanstvena organizacija nije ovlaštena za provođenje dijela postupka izbora u znanstvena zvanja u interdisciplinarnom području (znanost; umjetnost), Matični odbor na temelju članka 33. st. 4., članka 35. st.11. Zakona o znanstvenoj djelatnosti i visokom obrazovanju imenovao je na svojoj 8. sjednici održanoj 20. prosinca 2012. stručno povjerenstvo za izbor dr.sc. Edvarda Tijana u znanstveno zvanje.

Imenovano stručno povjerenstvo utvrdilo je da pristupnik ispunjava uvjete iz Pravilnika o uvjetima za izbor u znanstvena zvanja (NN 84/05, 138/06, 120/07, 71/10 i 116/10) za izbor u znanstveno zvanje znanstvenog suradnika u interdisciplinarnom području znanosti (ekonomija, temeljne tehničke znanosti).

Na temelju mišljenja i prijedloga stručnog povjerenstva Matični odbor je na 9. sjednici održanoj 20. ožujka 2013. izabrao pristupnika u znanstveno zvanje znanstvenog suradnika.

POUKA O PRAVNOM LIJEKU: Protiv Odluke o izboru u znanstveno zvanje pristupnik nema pravo žalbe, ali može pokrenuti upravni spor.

Predsjednik Matičnog odbora

Prof. dr.sc. Ivo Nejašmić

REPUBLIKA HRVATSKA 9 ZAGREB NACIONALNO VIJEĆE ZA ZNANOST

Odluka se dostavlja:
1. dr.sc. Edvard Tijan
2. Ministarstvo znanosti, obrazovanja i sporta

Biografija - Dlabač Tatijana

Tatijana Dlabač (rođena Vučković) rođena je 1.6.1969. god. na Cetinju. Osnovnu i srednju školu je završila u Kotoru. Dobitnik sje diplome "Luča" kao i velikog broja nagrada i plaketa na republičkim i saveznim takmičenjima iz prirodnih nauka.

Elektrotehnički fakultet, odsjek Elektronike, upisala je 1987.godine u Titogradu. Diplomski rad "Primjena grafova u analizi elektronskih kola" kod mentora dr Zorana Mijanovića odbranila je 16. 7. 1992. godine sa ocjenom 10. Prosječna ocjena u toku studija je 8,51. Poslijediplomske studije na smjeru Robotika i vještačka inteligencija na Elektrotehničkom fakultetu u Podgorici upisala je 1992. godine. Položila je sve ispite na poslijediplomskim studijama predviđene Pravilnikom o poslijediplomskim studijama, sa prosječnom ocjenom 10. Magistarski rad pod nazivom "Projektovanje i analiza sistema za prepoznavanje govornika pomoću glasa u realnom vremenu" odbranila je 18.7.1996. godine na Elektrotehničkom fakultetu u Podgorici. Doktorske studije na Elektrotehničkom fakultetu u Podgorici upisala je 2007. godine. Doktorsku disertaciju pod nazivom „Analiza efekta blizine u sistemima više paralelnih provodnika“ odbranila je 11.11.2013. godine pod mentorstvom prof. dr Dragana Filipovića, redovnog profesora Univerziteta Crne Gore.

Od 1.3.1993. do 31.12. 1996. godine je radila na Elektrotehničkom fakultetu u Podgorici u zvanju stručnog saradnika pripravnika na Katedri za elektroniku i električna mjerenja. Od 1.1.1996. do kraja šk.1995/96 je nastavila rad na istoj Katedri kao stipendista Ministarstva prosvjete i nauke. Od 1.12. 1996. godine je nastavila rad na Fakultetu za pomorstvo u Kotoru gdje je birana u zvanje asistenta, a kasnije saradnika u nastavi. Na Fakultetu je je bila angažovana na izvođenju računskih i laboratorijskih vježbe iz skoro svih predmeta elektro struke. U akademsko zvanje docent i vanredni profesor Univerziteta Crne Gore birana je 26.3.2015. godine i 12.3.2020. godine, respektivno.

U periodu od 2006. do 2011. godine bila je rukovodilac akademskog studijskog programa Pomorske nauke. Od aprila 2015. godine do kraja septembra 2017. godine obavljala je dužnost prodekana za nastavu Pomorskog fakulteta Kotor. Od oktobra 2017. godine je rukovodilac akademskog studijskog progama Pomorska elektrotehnika. Od septembra 2016. godine do septembra 2020. godine bila je član UO UCG. Od septembra 2019. godine je prodekan za razvoj i inovacije Pomorskog fakulteta Kotor. Od februara 2020. godine obavlja funkciju rukovodioca obuka za pomorce koje se realizuju u Centru za obuku pomoraca Pomorskog fakulteta Kotor. Član je Sektorske komisije za saobraćaj i komunikacije od 17.12.2019. godine.

Oblasti istraživanja prof. dr Tatijane Dlabač su teorijska i primijenjena elektrotehnika (brodska elektrotehnika i elektronika), edukacija, e-učenje i evaluacije praktične nastave u inženjerstvu.

Objavila je oko 80 naučnih i stručnih radova u medjunarodnim časopisima i na medjunarodnim i domaćim konferencijama. Koautor je univerzitetskog udžbenika „Osnovi elektrotehnike“. Bila je koordinator jednog Erasmus+ projekta i član radnih timova na nekoliko međunarodnih projekata. Član je radnih timova dva Erasmus+ projekata čija je realizacija u toku na Univerzitetu Crne Gore i koordinator jednog bilaterlanog projekta.

PERSONAL INFORMATION

Tatijana Dlabač

Džordža Vašingtona 6, 81000, Podgorica, Montenegro

Business – Faculty of Maritime Studies, Put I Bokeljske brigade 44, 85330, Kotor, Montenegro

+38232303184 +38269043133; +38267619333

tanjav@ucg.ac.me;

Sex Female | Date of birth 01/06/1969 | Nationality Montenegrin

WORK EXPERIENCE

From 1993 up to now

Teaching Assistant / Associate Professor

University of Montenegro, Faculty of Maritime Studies (Put I Bokeljske brigade 44, Kotor, 85330, Montenegro)

- Associate Professor and researcher in the following fields: Marine electrical engineering, Ship's measurements, theoretic and applied electromagnetics, and engineering education.

Business or sector: High-education institution

EDUCATION AND TRAINING

2013

PhD

PhD

University of Montenegro, Faculty of Electrical Engineering, Podgorica, Montenegro

- Theoretical electromagnetics

1996

Master of Sciences

MSc

University of Montenegro, Faculty of Electrical Engineering, Podgorica, Montenegro

- Speech recognition

1992

Bachelor of Sciences

BSc

University of Montenegro, Faculty of Electrical Engineering, Podgorica, Montenegro

- Electronics

[4/11/2021] till [10/11/2021] ERASMUS + teaching mobility at University of Kragujevac, Faculty of Technical Sciences Čačak, Serbia

PERSONAL SKILLS

Mother tongue(s) Montenegrin

Other language(s)

UNDERSTANDING	SPEAKING	WRITING

	Listening	Reading	Spoken interaction	Spoken production	
English	B1	B1	B1	B1	B1

Levels: A1/2: Basic user - B1/2: Independent user - C1/2 Proficient user
Common European Framework of Reference for Languages

Communication skills
- Very good

Organisational / managerial skills
- Good ability for teamwork; Vice-dean for development and innovations, Head of Marine electrical engineering Department at Faculty of Maritime Studies, University of Montenegro; Head of Training Center for seafarers at the Faculty of Maritime Studies Kotor since February 2020.

Computer skills
- Microsoft Office and Internet applications (regular Internet user)

Driving licence
B category

ADDITIONAL INFORMATION

- Able to communicate concisely and accurately.
- Able to network formally and informally.
- Able to take initiative and work independently and proactively.
- Excellent organizational skills.
- Willingness to work hard.
- Attends a lot of conferences about electronics and IT.

Publications
Presentations
Projects
Conferences
Seminars
Honours and awards
Memberships
References

Projects:

- 2019-2021: An approach to forming a model for evaluating a practical Internet based education (Ministriy of Science of Montenegro and Ministry of Education, Science and Technological Development of Serbia, Project coordinator on behalf of University of Montenegro
- ERASMUS+ project "School-to-Work Transition for Higher education students with disabilities in Serbia, Bosnia & Herzegovina and Montenegro" project No. 561847-KA2-CBHE (15/10/2015-14/10/2018), Project coordinator on behalf of University of Montenegro;
- Montenegro Sustainable Maritime Competence Development Initiative, HERD Maritime 2010-2014, Higher education, research and development in the Western Balkans - Maritime Sector Programme 2012-2014. Project partner UoM Maritime Faculty Kotor, Project Leader for partner Prof. Dr. Danilo Nikolić, collaboration between Maritime Faculty Kotor with Alesund University College, Norway (June 2013 – June 2015);
- Modernizing and harmonizing maritime education in Montenegro and Albania – MarED, TEMPUS IV – 6th Call for proposals, project coordinator UofM Maritime Faculty Kotor, Project Leader Prof. Dr. Danilo Nikolić (01/12/2013 - 30/11/2016);
- Labour Market Oriented Curriculum (LMOC) – Advances in Marine Technologies, with support of the World University Service (WUS) - Austria (2009-2010);
- Developing an E-learning Module at Maritime Faculty (Kotor, Montenegro), supported by Montenegrin Ministry of Science; collaboration with Academy for New Media and Knowledge Transfer, University of Graz – Austria (2011-2012).

Books:

- Filipović D., Vučković T., Osnovi elektrotehnike, Elektrotehnički fakultet, Univerzitet Crne Gore, Podgorica, 1997., ISBN 86-81039-61-X
- Filipović D., Vučković T., Zbirka zadataka iz osnova elektrotehnike, Pergamena, Podgorica, 2001.
- Vučković T., Stojanović R., Dedić A., Praktikum laboratorijskih vježbi iz elektronike, Elektrotehnički fakultet, Podgorica, 1996.

Papers/reviews published in journals:

- Filipović D., Dlabač T., »Proximity Effect in a Thin Two-layer Tubular Conductor Caused by a Parallel Filamen«, Serbian Journal of Electr. Eng., Vol. 17, No. 1, February 2022, pp. 57-66, DOI: 10.2298/SJEE2201057F, http://www.journal.ftn.kg.ac.rs/Vol_19-1
- Dževerdanović Pejović M., Dlabač T., »The Challenges Of Teaching English To The Marine Electrical Engineering Students«, Pedagogika-Pedagogy, Volume 93, Number 6s, 2021 pp. 101-111.
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- Filipović D., Dlabač T., »Green's Function for the Semi-Infinite Strip in Terms of an Improper Integral«, Serbian Journal of Electr. Eng., Vol. 17, No. 2, June 2020, pp. 235-246, DOI: 10.2298/SJEE2002235F, http://www.journal.ftn.kg.ac.rs/Vol_17-2/
- Beškovnik B., Zanne M., Dlabač T., Ivošević Š., »Green Transport Chains Analysis: Pollution vs. Price and Time Elements on Asia – Eastern Adriatic Trade«, Naše more - International Journal of Maritime Science and Technology, Vol. 67, No.1, pp. 36-44., 2019. https://doi.org/10.17818/NM/2020/1.6, http://www.nasemore.com/green-transport-chains-analysis-pollution-vs-price-and-time-elements-on-asia-eastern-adriatic-trade/
- Krčum M., Zubčić M., Dlabač T., Electromechanical Analysis of the Medium Voltage Earthing Switch due to Short-Time and Peak Withstand Current Test, Energies 2019, 12(16), 3189; https://doi.org/10.3390/en12163189, ISSN 19961073 https://www.mdpi.com/journal/energies
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- P Vidan, S Vukša, T Dlabač, Practice of And Attitudes Toward Familiarisation on Board: Survey of Croatian and Montenegrin Maritime Officers, Brodogradnja: Teorija i praksa brodogradnje i pomorske tehnike Vol. 69, No 3, pp. 97-110, Septebmer 2018.
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- Perovich S.M., Đukanovic M. Đ., Dlabač T., Nikolić D., Ćalasan M. P., " Concerning A Novel

Mathematical Approach To The Solar Cell Junction Ideality Factor Estimation", Applied Mathematical Modelling, Vol. 39 (2015), pp. 3248-3264 (ISSN: 0307-904X)
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- I. Knežević, N. Pudar, T. Dlabač, and Š. Ivošević, “Behavior of CuAlNi alloys in different marine environments”, 26th International Conference on Information Technology (IT 2022), 16-18 February 2022, Žabljak, Montenegro.
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- Kraguljac V., Milošević D., Dlabač T., Security of the Most Frequently Used Web Content Management Systems, International Conference on Applied Internet and Information Technologies, October 3-4, 2019, Zrenjanin, Serbia
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O D L U K U
O IZBORU U ZVANJE

Dr Tatijana Dlabač bira se u akademsko zvanje vanredni profesor Univerziteta Crne Gore za **oblast Brodska elektrotehnika i elektronika,** na Pomorskom fakultetu Univerziteta Crne Gore, na period od pet godina.

SENAT UNIVERZITETA CRNE GORE
PREDSJEDNIK

Prof. dr Danilo Nikolić, rektor