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Transactions on Maritime Science (ToMS) is a scientific journal with international peer review which publishes papers in the following areas:

~ Marine Engineering,
~ Navigation,
~ Safety Systems,
~ Marine Ecology,
~ Marine Fisheries,
~ Hydrography,
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The journal is published in English both as an open access journal, and as a classic paper journal (in limited editions).

ToMS aims at presenting major maritime research all over the world, particularly focusing on the Mediterranean area. Articles will be double-blind reviewed by three reviewers. ToMS also promotes scientific collaboration with talented students at a beginning of their scientific careers. These papers also undergo strict peer reviews. Furthermore, the Journal publishes short reviews on significant papers, book reviews and workshops in the fields of maritime science.

The views and opinions expressed in the papers are those of individual authors, and not necessarily those of the ToMS editors. Therefore, each author will take responsibility for his or her contribution as presented in the paper.

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Contents

From Editor-in-Chief

Ivica Kuzmanić

Dear Readers,

You have before you the recent issue of the internationally double-blind peer-reviewed scientific journal *Transactions on Maritime Science*. It is published by the Faculty of Maritime Studies of the University of Split. As always, the Journal is published in the printed and electronic, open access form.

From this issue onwards, the journal can boast an updated website. The journal has been entirely integrated in the Open Journal System, which enables a simpler application of the papers, as well as a simpler monitoring process of the paper publication.

The authors who wish to collaborate are now encouraged to submit papers according to the guidelines published on the new website, along with the indispensable technical support data.

The present issue features as many as ten papers, written by twenty-six scholars. Authors from Australia and Sweden have contributed with their respective papers for the first time. The papers' topics belong to almost all scientific areas covered by our journal. The readers are entitled to decide on their quality.

Due to a large number of papers, we have incorporated a smaller number of texts in the "Contribution" section. However, two deserve a special mention.

The first features a review of an extremely valuable edition of the *English-Croatian Maritime Dictionary*, written by the teachers at the Faculty of Maritime Studies, Bisera Plančić and Tomislav Skračić.

The second refers to a contribution towards the preservation of the Croatian cultural heritage. It is the only contribution presented both in English and the dialect that has, unfortunately, almost sunk into oblivion, the Chakavian island idiom. It contains a poem written by Mr. Elio Žuvela, born in Vela Luka on the Island of Korčula. In the pertaining audio section the poet recites his poem, exhibiting all the marvelous accents of his native island. The extremely demanding task of translating the poem into English has, once again, been entrusted to our permanent collaborator Mirna Čudić.

We always remain in the hope that the papers we publish will meet with your interests and encourage your cooperation.

Shipowner's Impact on Planned Maintenance System Database Quality Grades Resemblance Equalization

Ladislav Stazić[a], Ivan Komar[a], Luka Mihanović[b], Antonija Mišura[c]

This paper analyzes the shipowner's role in the development process of ship's computerized planned maintenance system database, paying specific attention to his/her impact on database quality grades resemblance equalization. The paper describes the database development process from the realization that the database is needed to the installation on board vessel, and all shipowner's and developer's actions in the process.

The computerized databases of five shipping companies were tested using questionnaire developed for this purpose. The evaluation results are shown in several tables to facilitate overview and comparison of data. The paper provides the data of office user's workload with regard to the administration and correction of data besides database quality grades: that data serves to portrait the relation between data quality in the databases and importance given to the process of development and maintenance of the databases. The analysis of the results yields numerical values as indicators of shipowner's input on the resemblance of grades of both scenarios and on the database quality grades resemblance equalization.

The conclusion shows how the shipowner affects the ship's computerized planned maintenance system database and what actions should be performed to obtain the final product (database, i.e. data in the database) as good as possible and, thus, maintenance of the ship and the whole system.

The expected results of the paper are:

- To analyze in detail the database ordering and development process,
- To pinpoint controlling areas for the database quality,
- To analyze the shipowner's impact on the database quality grades resemblance equalization.

KEY WORDS

~ Database
~ Planned maintenance
~ Questionnaire
~ Quality evaluation

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1. INTRODUCTION

The database developer (database development team) and the shipowner are two major factors that influence ship's computerized planned maintenance system database quality. The database developer's interests in the process are to fulfill the shipowner's requests as soon as possible with the costs as low as possible. During the database development, i.e. data entry process, deficiencies in the database may appear (Wang

and Strong, 1996), (Rabin, 2002). The deficiencies depend upon the database development team, their expertise, knowledge, abilities, etc. As the database development team will modify the data entry and database development according to their characteristics and abilities, the deficiencies created by the team will be present in all their databases. The quality evaluation grades of the databases made by one development team will therefore have quite a great resemblance which will tend toward equivalence (resemblance of 100 %).

The shipowner's interests in the database development process are to procure a database as good as possible, made according to his needs and requirements, with the price as low as possible. The shipowner influences the database quality by establishing a precise list of database requirements and by measuring the quality of data entered. With these actions he provides a certain amount of uniformity of company databases. The measurement of data quality "*helps during the course of a project, to assess its progress, to take corrective action based on this assessment, and to evaluate the impact of such action*" (Basili et al., 1994).

Testing of the evaluation methodology for ship's Planned Maintenance System database was performed on five databases and their resemblance was analyzed (Table 1).

Table 1.
Resemblance of grades of Methodology testing (in %).

	Database 1	Database 2	Database 3	Database 4	Database 5
Database 1	100	98.33	96.66	97.50	90.00
Database 2	98.33	100	95.00	95.83	90.83
Database 3	96.66	95.00	100	99.17	86.66
Database 4	97.50	95.83	99.17	100	87.50
Database 5	90.00	90.83	86.66	87.50	100

The evaluated databases had resemblance of quality grades varying from 95 to 100 % when compared within one company (databases 1 to 4) and 86.66 to 90.83 % when compared with a database of a different provider (database 5). The resemblance difference of only 5 % during the comparison of grades of two different shipowners was unexpectedly low and created several questions: whether the results were interpreted wrongly, whether the results were accidental due to a small sample, are the results such because of the inactivity of the shipowner, or something else. The evaluated databases, besides a high resemblance of grades, had similar characteristics and deficiencies. That was pointing towards a lack of the established data quality measurement and supervision system for the database and, therefore, a flaw made by the shipowner. The reason for the shipowner's flaw can be traced to the resistance towards changes in the work process, not knowing the system, and accidental mistakes. Introducing new systems (costs) in the maintenance process without creating new values can lead to resistances in the system (Gackowski, 2006), especially in the shipping industry which shows a high level of conservatism (Manuel, 2012). Identifying place and the moment of creation of data quality problems will direct the search focus to solving these problems (Strong et al., 1997).

The sample size during testing of evaluation methodology was small, nobody "*gambles his research hypotheses on small samples without realizing that the odds against him are unreasonably high*" (Tversky and Kahneman, 1971). New, larger research was performed with the intention to establish why small sample results were unexpected and how evaluation grades will look on the larger sample. New research had the primary task to determine where and how the data in databases became deficient and why the same or similar deficiencies appear for different companies in the database development process.

Chapter 2 presents the analysis of the development process of ship's computerized planned maintenance system database together with the sequence diagram of the shipowner's (and developer's) actions which influence database quality and which are shown in the diagram.

The overview of the research starts with the results of database evaluation of five shipping companies. The databases for ship's computerized planned maintenance system were evaluated using the dedicated questionnaire developed for the purpose (Table 2). The research is divided into two scenarios shown in separate chapters.

Chapter 3 presents the evaluation grades according to the first scenario. The scenario replicates the conditions of research during *Evaluation methodology testing* (Table 1) where all the databases were built by the same development team. Sixteen databases from three companies were evaluated during this stage of research. The research according to the first scenario had the purpose to establish how the shipowner's actions affect

creation of database specific features and database quality grades resemblance equalization.

The second scenario covers two companies developing their databases by different development teams. The scenario is described in Chapter 4; twenty-eight databases were evaluated during this phase of the research. The research according to the second scenario had the purpose to establish how the shipowner's actions affect equalizing of quality grades of databases which were very different initially.

Insight into the number of office users and their workload with regard to administration and correction of data in the database is also shown in the paper to enable an additional shipowner's influence.

An analysis of the data in discussion was performed by calculation of the average grade value, calculation and analysis of the resemblance of databases and comparison of the noted major deficiencies. The results are analyzed and compared on company levels and all together, among all the companies.

The conclusion of the paper gives the answer how shipowner's actions influence data quality in the database and explains the results of the research during *Evaluation methodology testing*.

As shipping companies allowed access to their databases and real data strictly under no disclosure condition, in the paper they will be named as companies A, B, C, D, E.

2. DATABASE DEVELOPMENT PROCESS

Database development process (Beynon-Davies, 2004), (Watt and Eng, 2014) is modified and applied for ship planned maintenance (Figure 1). The whole process starts with the decision of the shipowner that it is necessary to order creation of ship's Planned Maintenance System (PMS) database, followed with determination of requirements which the database must fulfill.

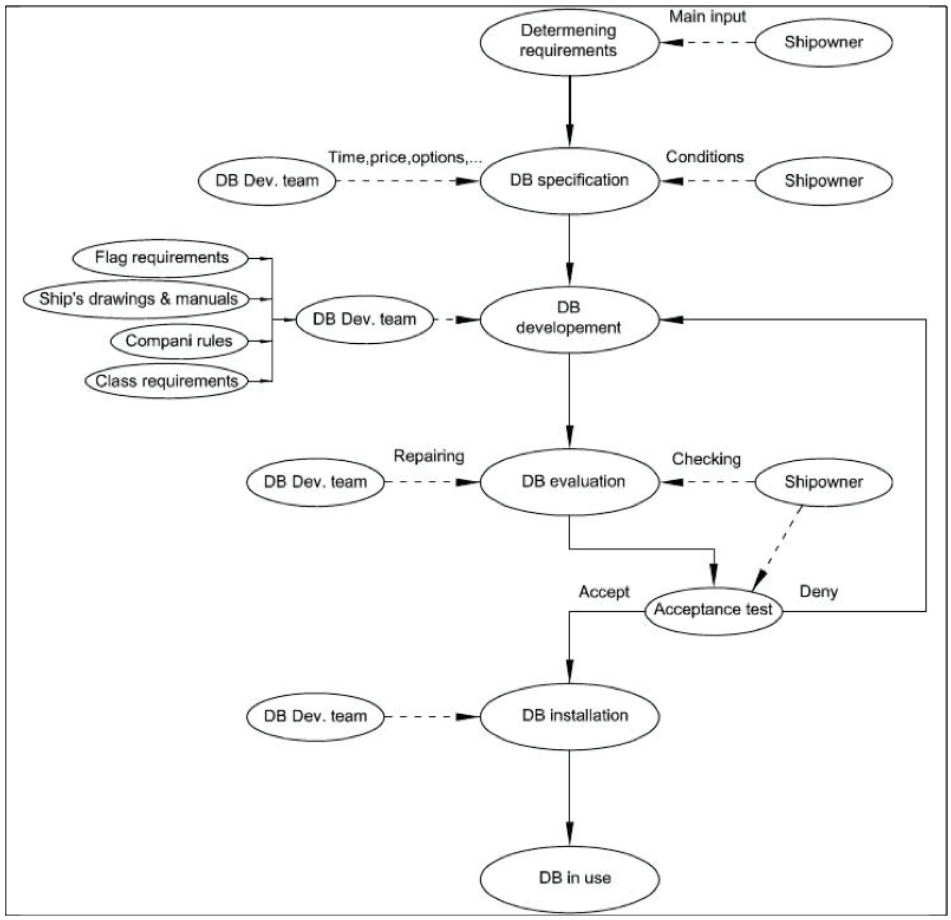

Figure 1.
PMS DB (Planned Maintenance System Database) development process sequence diagram (based on Watt and Eng, 2014).

The determination of requirements is performed by the shipowner and can be performed with four methods: asking, deriving from an existing information system, synthesis from characteristics of the utilized system, discovering from experimentation with an evolving information system application (Davis, 1982), (Davis and Olson, 1985).

Contracting of the database is the second important step in the database development process and it is performed by both sides, the shipowner and the developer. During the negotiations, they must agree on quite a number of details such as DB data content, price, development time, date of delivery (installation), modes of control, modes of delivery, etc. The shipowner and the developer must specify in detail all the sources of information to be included in DB to avoid receiving of inadequate final product (bad databases).

In the next phase, the shipowner must take care to deliver to the development team complete documentation needed for the insertion of data into DB, consisting of: maker's Instruction manuals for the ship's equipment; the shipowner's company policies and rules; the classification society requirements for the vessel, for example American Bureau of Shipping (ABS rules for conditions of classification, 2016), Det Norske Veritas Germanischer Lloyd (DNV rules for classification of ships, 2003), or Croatian Register of Shipping (CRS rules for classification of ships, 2014); ship's flag state requirements (Guidelines for flag State inspections under the Maritime Labour Convention, 2006).

As data insertion is performed manually, it is susceptible to a significant amount of errors. The most common source of data inaccuracy is the person entering the data and that will always remain a significant problem of data entry (Maydanchik, 2007). After DB developer finishes insertion of data into the database, the shipowner should organize the inspection of data in DB and discover mistakes and deficiencies which should be rectified before the final DB acceptance test.

The final or acceptance test is a test arranged by the shipowner to verify if the whole process of the development was complete and correct (Rogers, 2004). That is a crucial action for the success of the whole project (Miller and Collins, 2001), in case of a positive assessment, DB is installed on board while in case of a negative assessment DB is returned to the developer to rectify the deficiencies.

3. RESULTS OF THE FIRST QUALITY EVALUATION OF DATABASES

As the law of large numbers guarantees that very large samples will indeed be highly representative (Tversky and Kahneman, 1971), quality evaluation of more databases was arranged. The evaluation was performed using the questionnaire specially developed for the purpose (Table 2).

The evaluation grades of three shipping companies are linked together for an easier overview (Table 3). The evaluations of databases A-1, A-2, A-3, C-1, C-2, C-3, C-4, C-5, C-6, C-7, C-8 were performed by employees of the shipping companies familiar with the computerized PMS and ship's maintenance, therefore the condition of knowing DB structure and data as well as the company rules with regard to ship's maintenance was fulfilled. Analysis of databases B-1, B-2, B-3, B-4, B-5 was performed by one of authors of the paper. Since the evaluator was not familiar with the company rules, evaluation grades might have certain amount of subjectivity.

As an addition to this research there is data about the companies A, B, and C office user's workload with regard to the administration and correction of data (Table 4), given in average daily manhours per DB.

4. RESULTS OF THE SECOND QUALITY EVALUATION OF DATABASES

The second scenario follows the database quality evaluation grades when the shipowner is the same and the database development team different. The databases of two shipping companies, D and E, were evaluated according to this scenario. The company D's database evaluation (Table 5) was performed by their PMS administrator.

In cooperation with office users, data were collected about the company D's office user's workload with regard to the administration and correction of databases (Table 6), given in average daily manhours per database.

The company E's database evaluation (Table 7) was performed by their junior superintendent who is involved in the maintenance of vessels and works with computerized PMS on daily basis.

The company E's office user's workload with regard to the administration and correction of databases (Table 8) was also taken into consideration; it is presented in the average daily manhours per database.

Table 2.
Computerized PMS database evaluation questionnaire.

Area		Question	Grade
Machinery and equipment	01.	Is all the machinery and equipment included in the database?	
	02.	Is all the included equipment marked properly and uniquely, according to their shipboard location and markings?	
	03.	Is all the necessary machinery divided to subcomponents (to smaller subsystems) in a logical manner?	
	04.	Does the machinery or equipment have a larger number of subcomponents than necessary?	
	05.	Is there equipment or machinery listed in the database more than once, or do they have the same markings or names?	
	06.	Is the data about the manufacturer, type and serial number entered to all the relevant items?	
	07.	Do all the equipment and machinery entries have the same style, abbreviations, and markings?	
Jobs inside DB	08.	Do all the devices in the DB have linked maintenance plan according to the manufacturer's recommendation?	
	09.	Are the manufacturer's recommendations grouped according to devices, periods and company maintenance rules?	
	10.	Are all the jobs required by the company policy included in the DB? (e.g. SMS – Safety Management System)?	
	11.	Are all the jobs based on the manufacturer's recommendation changed due to the company policy (if exists)?	
	12.	Are all the jobs required by flag state rules and regulations included in the DB?	
	13.	Are all the jobs required by class society included in the DB?	
	14.	Is there a number of smaller jobs which can be grouped together?	
Special jobs and rules - DB jobs general	15.	Is fire detection sensor list inserted into the DB together with the testing plan?	
	16.	Is the alarm system and its testing program entered in the DB?	
	17.	Is PMS self-improvement program inserted into the DB, and is there control mechanism for PMS DB self-improvement program?	
	18.	Is the critical equipment marked according to company SMS?	
	19.	Are job descriptions written clearly and straightforward?	
	20.	Are jobs created and grouped according to multiplier principle?	
	21.	Are all the same type jobs coming from different sources synchronized?	
	22.	Are all the same jobs resulting from different requirements (sources) merged?	
Spare parts	23.	Are all the required spare parts included in the database?	
	24.	Are spare parts distributed to proper equipment and machinery?	
	25.	Are all the spare parts properly marked; do they have sufficient data for ordering?	
	26.	Is the company critical spare parts list inserted in the DB?	
	27.	Do all the spare parts have the same style, abbreviations, markings, etc.?	
	28.	Are there spare parts entered several times?	
Miscellaneous	29.	Are all the users inserted in the DB, and are all the access rights defined in order?	
	30.	Is there any other deficiency noted in the computerized PMS database?	

Table 3.
Results of the first quality evaluation of databases.

Question	Database															
	A-1	A-2	A-3	B-1	B-2	B-3	B-4	B-5	C-1	C-2	C-3	C-4	C-5	C-6	C-7	C-8
01.	5	3	5	5	4	5	5	4	5	5	4	5	5	5	4	5
02.	4	3	4	5	5	5	5	5	4	4	5	4	4	4	4	4
03.	5	5	5	4	4	5	4	5	4	4	5	5	4	4	4	5
04.	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
05.	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
06.	4	3	4	4	4	4	4	4	4	4	3	3	4	4	3	4
07.	5	5	5	5	5	5	5	5	4	4	4	5	4	4	4	5
08.	5	3	4	5	5	5	5	5	5	4	5	5	5	5	5	5
09.	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4
10.	4	4	4	5	5	5	5	5	4	4	4	4	4	4	4	4
11.	5	5	5	4	4	4	4	4	2	3	2	2	3	2	1	3
12.	4	4	4	5	5	5	5	5	3	3	3	3	3	3	3	3
13.	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
14.	4	4	4	5	5	5	5	5	4	4	4	4	4	4	4	4
15.	5	1	3	5	5	5	5	5	5	5	5	1	5	5	1	5
16.	5	1	2	5	5	5	5	5	5	5	5	3	5	5	1	5
17.	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
18.	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
19.	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4
20.	4	4	4	3	3	3	3	3	4	4	4	4	4	4	4	4
21.	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4
22.	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4
23.	5	2	4	5	5	5	5	5	4	4	4	3	4	4	3	4
24.	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
25.	5	2	4	5	5	5	5	5	4	4	4	4	4	4	4	4
26.	4	4	4	3	3	3	3	3	5	5	5	5	5	5	5	5
27.	5	2	4	5	5	5	5	5	5	5	5	5	5	5	5	5
28.	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5
29.	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
30.	5	5	5	5	5	5	5	5	4	4	4	3	4	4	3	4

Table 4.
Office user's workload with regard to administration and correction of the data.

Database	A-1	A-2	A-3	B-1	B-2	B-3	B-4	B-5	C-1	C-2	C-3	C-4	C-5	C-6	C-7	C-8
Work hrs.	0.3	0.3	0.3	1.5	1.5	1.5	1.5	1.5	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8

Remarks: Data were collected in cooperation with PMS DB administrators in the shipping companies. The number under Work hours represents average daily manhours used per administration and correction of each database.

Table 5.
Company D's database evaluation grades.

Question	Database																		
	D-1	D-2	D-3	D-4	D-5	D-6	D-7	D-8	D-9	D-10	D-11	D-12	D-13	D-14	D-15	D-16	D-17	D-18	D-19
01.	3	4	4	4	4	5	5	4	3	4	4	4	5	4	4	3	4	4	4
02.	3	5	5	5	4	5	5	4	3	5	5	5	5	5	5	3	4	5	5
03.	2	4	4	3	4	5	5	4	5	5	4	5	5	5	5	4	4	4	4
04.	5	4	4	4	2	5	5	4	5	5	4	5	4	4	4	5	2	4	4
05.	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
06.	2	4	4	3	4	5	5	4	3	4	4	5	4	5	5	3	4	4	4
07.	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
08.	3	5	4	4	3	5	5	5	2	5	5	5	4	5	5	2	4	4	3
09.	3	5	4	4	4	4	4	4	2	4	5	5	4	4	4	3	4	4	4
10.	1	2	2	2	2	2	2	2	1	2	1	2	1	2	2	1	2	2	2
11.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13.	1	1	1	1	1	1	4	1	1	4	1	1	1	1	1	1	1	4	1
14.	1	1	4	1	1	1	4	2	2	4	1	1	1	3	1	1	1	4	2
15.	2	1	4	1	2	1	4	3	3	4	1	1	1	4	1	2	1	5	3
16.	1	1	3	1	1	1	3	1	2	3	1	1	2	3	1	2	1	3	2
17.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
18.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19.	4	4	5	4	4	5	5	4	4	5	5	5	5	5	4	4	4	5	4
20.	2	5	5	3	4	5	5	4	2	4	4	4	5	4	5	2	3	5	4
21.	2	4	4	3	4	5	5	4	3	4	4	4	5	4	4	3	4	5	4
22.	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
23.	1	4	5	2	4	4	2	5	1	4	2	4	5	4	4	1	4	3	3
24.	1	4	5	4	4	4	4	5	1	5	4	4	5	4	4	1	4	4	3
25.	1	4	4	3	3	4	4	5	1	4	5	4	5	4	4	1	4	4	4
26.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
27.	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
28.	5	4	4	5	3	4	4	5	4	5	5	5	4	5	5	5	5	5	5
29.	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
30.	1	5	5	5	1	5	5	5	1	5	5	3	5	5	5	1	5	3	1

Table 6.
Company D's office user's workload with regard to administration and correction of the database.

Database	D-1	D-2	D-3	D-4	D-5	D-6	D-7	D-8	D-9	D-10	D-11	D-12	D-13	D-14	D-15	D-16	D-17	D-18	D-19
Work hrs.	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06

Remark: The number under Work hours represents the average daily manhours used per administration and correction of each database.

Table 7.
Company E's database evaluation grades.

Question	Database								
	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9
01.	5	5	5	5	5	5	5	5	5
02.	5	5	5	5	5	5	5	5	5
03.	5	5	5	5	5	5	5	5	5
04.	5	5	5	5	5	5	5	5	5
05.	5	5	5	5	5	5	5	5	5
06.	4	4	4	4	4	4	4	4	4
07.	4	4	4	4	4	4	4	4	4
08.	5	5	5	5	5	5	5	5	5
09.	4	4	4	4	4	4	4	4	4
10.	5	5	5	5	5	5	5	5	5
11.	4	4	4	4	4	4	4	4	4
12.	4	4	4	4	4	4	4	4	4
13.	5	5	5	5	5	5	5	5	5
14.	1	1	1	1	1	1	1	1	1
15.	5	5	5	5	5	5	5	5	5
16.	5	5	5	4	4	5	5	4	4
17.	5	5	5	5	5	5	5	5	5
18.	5	5	5	5	5	5	5	5	5
19.	5	5	5	5	5	5	5	5	5
20.	5	5	5	5	5	5	5	5	5
21.	4	4	4	4	4	4	4	4	4
22.	5	5	5	5	5	5	5	5	5
23.	4	5	5	5	4	5	5	4	4
24.	5	5	5	5	5	5	5	5	5
25.	4	4	4	4	4	4	4	4	4
26.	5	5	5	5	5	5	5	5	5
27.	5	5	5	5	5	5	5	5	5
28.	4	4	4	4	4	4	4	4	4
29.	5	5	5	5	5	5	5	5	5
30.	5	5	5	5	5	5	5	5	5

Table 8.
Company E's office user's workload with regard to the administration and correction of database.

Database	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9
Work hrs.	1	1	1	1	1	1	1	1	1

Remark: The number under Work hours represents the average daily manhours used per administration and correction of each database.

5. ANALYSIS OF DATABASE EVALUATION RESULTS

Analysis of the database evaluation results is a step that follows the process of evaluation. The analysis started by the calculation of summation of grades and the average grade value for all the databases. The results are shown separately for the first quality evaluation (Table 9) and the second quality evaluation (Table 10 and Table 11).

Table 9.
Summation of grades and the average grade value for the first quality evaluation.

Database	A-1	A-2	A-3	B-1	B-2	B-3	B-4	B-5	C-1	C-2	C-3	C-4	C-5	C-6	C-7	C-8
Sum. of grades	142	119	133	143	142	144	143	143	131	131	131	124	132	131	118	134
Av. grade value	4.733	3.967	4.433	4.767	4.733	4.800	4.767	4.767	4.367	4.367	4.367	4.133	4.400	4.367	3.933	4.467

Table 10.
Summation of grades and the average grade value for company D.

Database	D-1	D-2	D-3	D-4	D-5	D-6	D-7	D-8	D-9	D-10	D-11	D-12	D-13	D-14	D-15	D-16	D-17	D-18	D-19
Sum. of grades	74	101	110	92	89	106	115	105	79	115	100	103	106	110	103	78	95	111	96
Av. grade value	2.467	3.367	3.667	3.067	2.967	3.533	3.833	3.500	2.633	3.833	3.333	3.433	3.533	3.667	3.433	2.600	3.167	3.700	3.200

Table 11.
Summation of grades and the average grade value for company E.

Database	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9
Sum. of grades	137	138	138	137	136	138	138	136	136
Av. grade value	4.567	4.600	4.600	4.567	4.533	4.600	4.600	4.533	4.533

The resemblance analysis of the evaluation grades was made according to Equation 1 (Stazić at al, 2017) as the next step of the analysis:

$$S = 100 - \frac{100}{nQ} \sum \left| Ri_{bj} - Ri_{bk} \right| \cdot \frac{1}{nG - 1} [\ \%\ ] \qquad (1)$$

where:
S – resemblance of grades of two databases
nQ – total number of questions
Ri–answer on i^{th} question (i = 1, 2 ... n)
bj – j^{th} evaluated database,
bk – k^{th} evaluated database; (j, k = 1, 2 ... m, j ≠ k)
nG – total number of grades

The calculated results are divided into three tables, one for the first quality evaluation (Table 12), and the other two for the second quality evaluation (Table 13 and Table 14).

The final part of the analysis of quality evaluation results is made with an overview of the questions which received grades 1, 2 or 3 (i.e. received lower grades). Different characteristics of databases are noted during this part of analysis. Company E database evaluation grades (Table 7) have only one area with a lower grade (question 14 in Table 2). The first scenario evaluation grades (Table 3) have several questions with lower grades, which are grouped into one excerpt for an easier overview (Table 15). The company D's evaluation grades (Table 5) present a huge number of questions with lower grades and that excerpt is much larger (Table 16).

Table 12.
Resemblance analysis of the evaluation grades for the first quality evaluation (%).

	A-1	A-2	A-3	B-1	B-2	B-3	B-4	B-5	C-1	C-2	C-3	C-4	C-5	C-6	C-7	C-8
A-1	100	80.83	92.50	92.50	91.67	93.33	92.50	92.50	87.50	87.50	85.83	81.67	88.33	87.50	76.67	90.00
A-2	80.83	100	88.33	73.33	74.17	74.17	73.33	75.00	71.67	73.33	73.33	79.17	72.50	71.67	79.17	74.17
A-3	92.50	88.33	100	85.00	84.17	85.83	85.00	85.00	83.33	85.00	81.67	84.17	84.17	83.33	80.83	85.83
B-1	92.50	73.33	85.00	100	99.17	99.17	100	98.33	85.00	85.00	83.33	77.50	85.83	85.00	74.17	85.83
B-2	91.67	74.17	84.17	99.17	100	98.33	99.17	99.17	84.17	84.17	84.17	76.67	85.00	84.17	75.00	85.00
B-3	93.33	74.17	85.83	99.17	98.33	100	99.17	99.17	84.17	84.17	84.17	78.33	85.00	84.17	73.33	86.67
B-4	92.50	73.33	85.00	100	99.17	99.17	100	98.33	85.00	85.00	83.33	77.50	85.83	85.00	74.17	85.83
B-5	92.50	75.00	85.00	98.33	99.17	99.17	98.33	100	83.33	83.33	85.00	77.50	84.17	83.33	74.17	85.83
C-1	87.50	71.67	83.33	85.00	84.17	84.17	85.00	83.33	100	98.33	96.67	90.83	99.17	100	89.17	97.50
C-2	87.50	73.33	85.00	85.00	84.17	84.17	85.00	83.33	98.33	100	95.00	89.17	99.17	98.33	87.50	97.50
C-3	85.83	73.33	81.67	83.33	84.17	84.17	83.33	85.00	96.67	95.00	100	90.83	95.83	96.67	89.17	95.83
C-4	81.67	79.17	84.17	77.50	76.67	78.33	77.50	77.50	90.83	89.17	90.83	100	90.00	90.83	95.00	91.67
C-5	88.33	72.50	84.17	85.83	85.00	85.00	85.83	84.17	99.17	99.17	95.83	90.00	100	99.17	88.33	98.33
C-6	87.50	71.67	83.33	85.00	84.17	84.17	85.00	83.33	100	98.33	96.67	90.83	99.17	100	89.17	97.50
C-7	76.67	79.17	80.83	74.17	75.00	73.33	74.17	74.17	89.17	87.50	89.17	95.00	88.33	89.17	100	86.67
C-8	90.00	74.17	85.83	85.83	85.00	86.67	85.83	85.83	97.50	97.50	95.83	91.67	98.33	97.50	86.67	100

Remark: The green squares represent the resemblance analysis of the evaluation grades within each company.

Table 13.
Resemblance analysis of the evaluation grades for company D (%).

	D-1	D-2	D-3	D-4	D-5	D-6	D-7	D-8	D-9	D-10	D-11	D-12	D-13	D-14	D-15	D-16	D-17	D-18	D-19
D-1	100	72.50	66.67	81.67	79.17	70.00	64.17	72.50	90.83	65.83	75.00	74.17	68.33	68.33	72.50	95.00	75.83	67.50	80.00
D-2	72.50	100	89.17	90.83	88.33	94.17	83.33	91.67	71.67	85.00	94.17	93.33	90.83	89.17	96.67	74.17	93.33	83.33	87.50
D-3	66.67	89.17	100	83.33	82.50	86.67	89.17	90.83	70.83	92.50	85.00	84.17	90.00	93.33	87.50	70.00	85.83	90.83	86.67
D-4	81.67	90.83	83.33	100	85.83	86.67	79.17	87.50	77.50	80.83	91.67	87.50	85.00	85.00	90.83	81.67	92.50	80.83	80.83
D-5	79.17	88.33	82.50	85.83	100	84.17	75.00	86.67	78.33	78.33	84.17	86.67	82.50	82.50	86.67	80.83	91.67	80.00	90.83
D-6	70.00	94.17	86.67	86.67	84.17	100	89.17	87.50	70.83	85.83	90.00	94.17	93.33	90.00	95.83	71.67	89.17	82.50	83.33
D-7	64.17	83.33	89.17	79.17	75.00	89.17	100	81.67	70.00	93.33	82.50	83.33	84.17	90.83	85.00	67.50	78.33	91.67	80.83
D-8	72.50	91.67	90.83	87.50	86.67	87.50	81.67	100	73.33	88.33	90.83	88.33	89.17	90.83	91.67	74.17	91.67	83.33	89.17
D-9	90.83	71.67	70.83	77.50	78.33	70.83	70.00	73.33	100	70.00	72.50	73.33	70.83	72.50	71.67	95.83	73.33	70.00	82.50
D-10	65.83	85.00	92.50	80.83	78.33	85.83	93.33	88.33	70.00	100	84.17	86.67	84.17	94.17	86.67	69.17	83.33	91.67	84.17
D-11	75.00	94.17	85.00	91.67	84.17	90.00	82.50	90.83	72.50	84.17	100	92.50	90.00	88.33	92.50	76.67	90.83	82.50	86.67
D-12	74.17	93.33	84.17	87.50	86.67	94.17	83.33	88.33	73.33	86.67	92.50	100	87.50	90.83	95.00	75.83	90.00	83.33	87.50
D-13	68.33	90.83	90.00	85.00	82.50	93.33	84.17	89.17	70.83	84.17	90.00	87.50	100	86.67	90.83	71.67	87.50	82.50	83.33
D-14	68.33	89.17	93.33	85.00	82.50	90.00	90.83	90.83	72.50	94.17	88.33	90.83	86.67	100	92.50	71.67	87.50	89.17	88.33
D-15	72.50	96.67	87.50	90.83	86.67	95.83	85.00	91.67	71.67	86.67	92.50	95.00	90.83	92.50	100	74.17	93.33	83.33	87.50
D-16	95.00	74.17	70.00	81.67	80.83	71.67	67.50	74.17	95.83	69.17	76.67	75.83	71.67	71.67	74.17	100	77.50	70.83	83.33
D-17	75.83	93.33	85.83	92.50	91.67	89.17	78.33	91.67	73.33	83.33	90.83	90.00	87.50	87.50	93.33	77.50	100	81.67	87.50
D-18	67.50	83.33	90.83	80.83	80.00	82.50	91.67	83.33	70.00	91.67	82.50	83.33	82.50	89.17	83.33	70.83	81.67	100	87.50
D-19	80.00	87.50	86.67	80.83	90.83	83.33	80.83	89.17	82.50	84.17	86.67	87.50	83.33	88.33	87.50	83.33	87.50	87.50	100

Table 14.
Resemblance analysis of the evaluation grades for company E (%)

	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9
E-1	100	99.17	99.17	98.33	99.17	99.17	99.17	99.17	99.17
E-2	99.17	100	100	99.17	98.33	100	100	98.33	98.33
E-3	99.17	100	100	99.17	98.33	100	100	98.33	98.33
E-4	98.33	99.17	99.17	100	99.17	99.17	99.17	99.17	99.17
E-5	99.17	98.33	98.33	99.17	100	98.33	98.33	100	100
E-6	99.17	100	100	99.17	98.33	100	100	98.33	98.33
E-7	99.17	100	100	99.17	98.33	100	100	98.33	98.33
E-8	99.17	98.33	98.33	99.17	100	98.33	98.33	100	100
E-9	99.17	98.33	98.33	99.17	100	98.33	98.33	100	100

Table 15.
Questions for the first quality evaluation with lower evaluation grades.

Question	Database															
	A-1	**A-2**	**A-3**	**B-1**	**B-2**	**B-3**	**B-4**	**B-5**	**C-1**	**C-2**	**C-3**	**C-4**	**C-5**	**C-6**	**C-7**	**C-8**
01.	5	3	5	5	4	5	5	4	5	5	4	5	5	5	4	5
02.	4	3	4	5	5	5	5	5	4	4	5	4	4	4	4	4
06.	4	3	4	4	4	4	4	4	4	4	3	3	4	4	3	4
08.	5	3	4	5	5	5	5	5	5	4	5	5	5	5	5	5
10.	4	4	4	5	5	5	5	5	4	4	4	4	4	4	4	4
11.	5	5	5	4	4	4	4	4	2	3	2	2	3	2	1	3
12.	4	4	4	5	5	5	5	5	3	3	3	3	3	3	3	3
14.	4	4	4	5	5	5	5	5	4	4	4	4	4	4	4	4
15.	5	1	3	5	5	5	5	5	5	5	5	1	5	5	1	5
16.	5	1	2	5	5	5	5	5	5	5	5	3	5	5	1	5
20.	4	4	4	3	3	3	3	3	4	4	4	4	4	4	4	4
21.	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4
23.	5	2	4	5	5	5	5	5	4	4	4	3	4	4	3	4
25.	5	2	4	5	5	5	5	5	4	4	4	4	4	4	4	4
26.	4	4	4	3	3	3	3	3	5	5	5	5	5	5	5	5
27.	5	2	4	5	5	5	5	5	5	5	5	5	5	5	5	5
30.	5	5	5	5	5	5	5	5	4	4	4	3	4	4	3	4

Remark: The red grades are the grades with lower evaluation result, where improvement is possible.

Table 16.
Company D's questions with lower evaluation grades.

Question	Database																		
	D-1	D-2	D-3	D-4	D-5	D-6	D-7	D-8	D-9	D-10	D-11	D-12	D-13	D-14	D-15	D-16	D-17	D-18	D-19
01.	3	4	4	4	4	5	5	4	3	4	4	4	5	4	4	3	4	4	4
02.	3	5	5	5	4	5	5	4	3	5	5	5	5	5	5	3	4	5	5
03.	2	4	4	3	4	5	5	4	5	5	4	5	5	5	5	4	4	4	4
04.	5	4	4	4	2	5	5	4	5	5	4	5	4	4	4	5	2	4	4
06.	2	4	4	3	4	5	5	4	3	4	4	5	4	5	5	3	4	4	4
08.	3	5	4	4	3	5	5	5	2	5	5	5	4	5	5	2	4	4	3
09.	3	5	4	4	4	4	4	4	2	4	5	5	4	4	4	3	4	4	4
10.	1	2	2	2	2	2	2	2	1	2	1	2	1	2	2	1	2	2	2
11.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13.	1	1	1	1	1	1	4	1	1	4	1	1	1	1	1	1	1	4	1
14.	1	1	4	1	1	1	4	2	2	4	1	1	1	3	1	1	1	4	2
15.	2	1	4	1	2	1	4	3	3	4	1	1	1	4	1	2	1	5	3
16.	1	1	3	1	1	1	3	1	2	3	1	1	2	3	1	2	1	3	2
17.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
18.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
20.	2	5	5	3	4	5	5	4	2	4	4	4	5	4	5	2	3	5	4
21.	2	4	4	3	4	5	5	4	3	4	4	4	5	4	4	3	4	5	4
23.	1	4	5	2	4	4	2	5	1	4	2	4	5	4	4	1	4	3	3
24.	1	4	5	4	4	4	4	5	1	5	4	4	5	4	4	1	4	4	3
25.	1	4	4	3	3	4	4	5	1	4	5	4	5	4	4	1	4	4	4
26.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
28.	5	4	4	5	3	4	4	5	4	5	5	5	4	5	5	5	5	5	5
30.	1	5	5	5	1	5	5	5	1	5	5	3	5	5	5	1	5	3	1

Remark: The red grades are the grades with lower evaluation result, where improvement is possible.

6. DISCUSSION

As all the first scenario databases are made by same development team, it was expected that the evaluation would present very similar results to the results obtained during testing of evaluation methodology for ship's *Planned Maintenance System* database. The expected results should be equalized to the summation of grades, i.e. average grade value, quite big resemblance of the grades, and a similar list of questions with grades 1, 2, and 3.

The analysis of company A's databases showed unevenness in the quality of the data as well as in the deficiencies. The average grade value ranges from 3.967 to 4.733, and the resemblance of grades varies from 80 to 92 %. As there are only three databases in the company, the sample is too small to define any reliable finding (Tversky and Kahneman, 1971).

The analysis of company B's database evaluation results shows a remarkable overall uniformity, in the average grade, resemblance (Figure 3), and deficiencies. The average grade difference is very small, varying from 4.733 to 4.800, resemblance from 98.33 % to 100 %, major deficiencies are noted in questions 20 and 26 with all company databases.

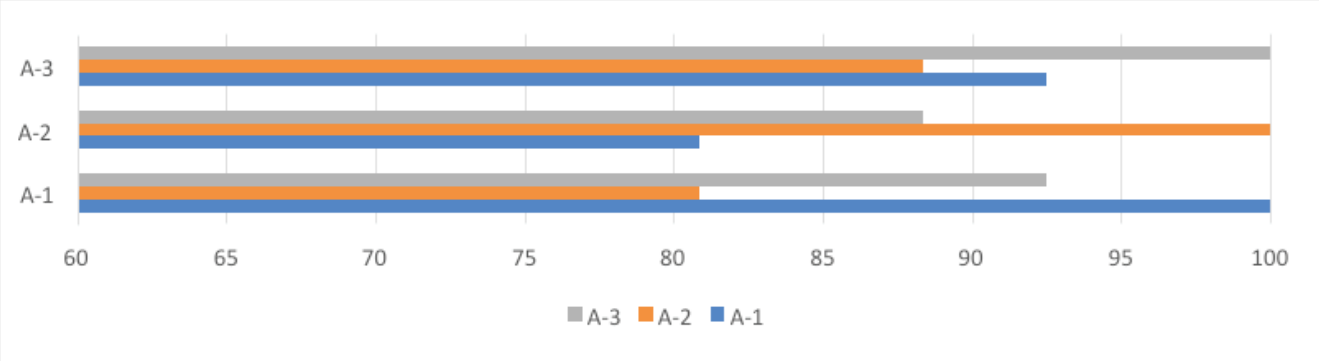

Figure 2.
Company A's resemblance of grades (in %).
Remark: The colour bar (The colour for each database is shown in small squares bellow the diagram) indicates the resemblance of the databases compared with the databases indicated on the ordinate.

The analysis of company B's database evaluation results shows a remarkable overall uniformity, in the average grade, resemblance (Figure 3), and deficiencies. The average grade difference is very small, varying from 4.733 to 4.800, resemblance from 98.33 % to 100 %, major deficiencies are noted in questions 20 and 26 with all company databases.

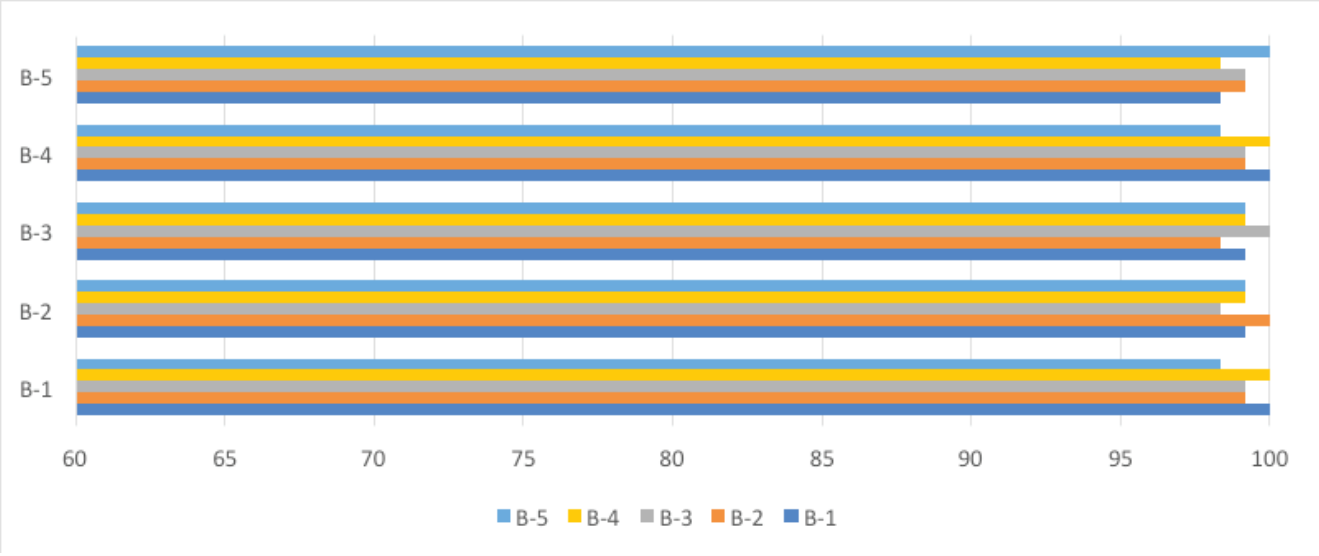

Figure 3.
Equalization of company B's resemblance of grades (in %).
Remark: The color bar (The color for each database is shown in the small squares below the diagram) indicates the resemblance of the databases compared, with the databases indicated on the ordinate.

The analysis of company C's database evaluation results shows a significant overall similarity with exception of the databases C-4 and C-7 (Figure 4). The average grade of database evaluation results (without C-4 and C-7) is between 4.367 and 4.467, and the resemblance between 95.00 and 100 % (Figure 4). Major deficiencies are the same for all the databases tested (with questions 11 and 12, Table 15) with minimal deviations.

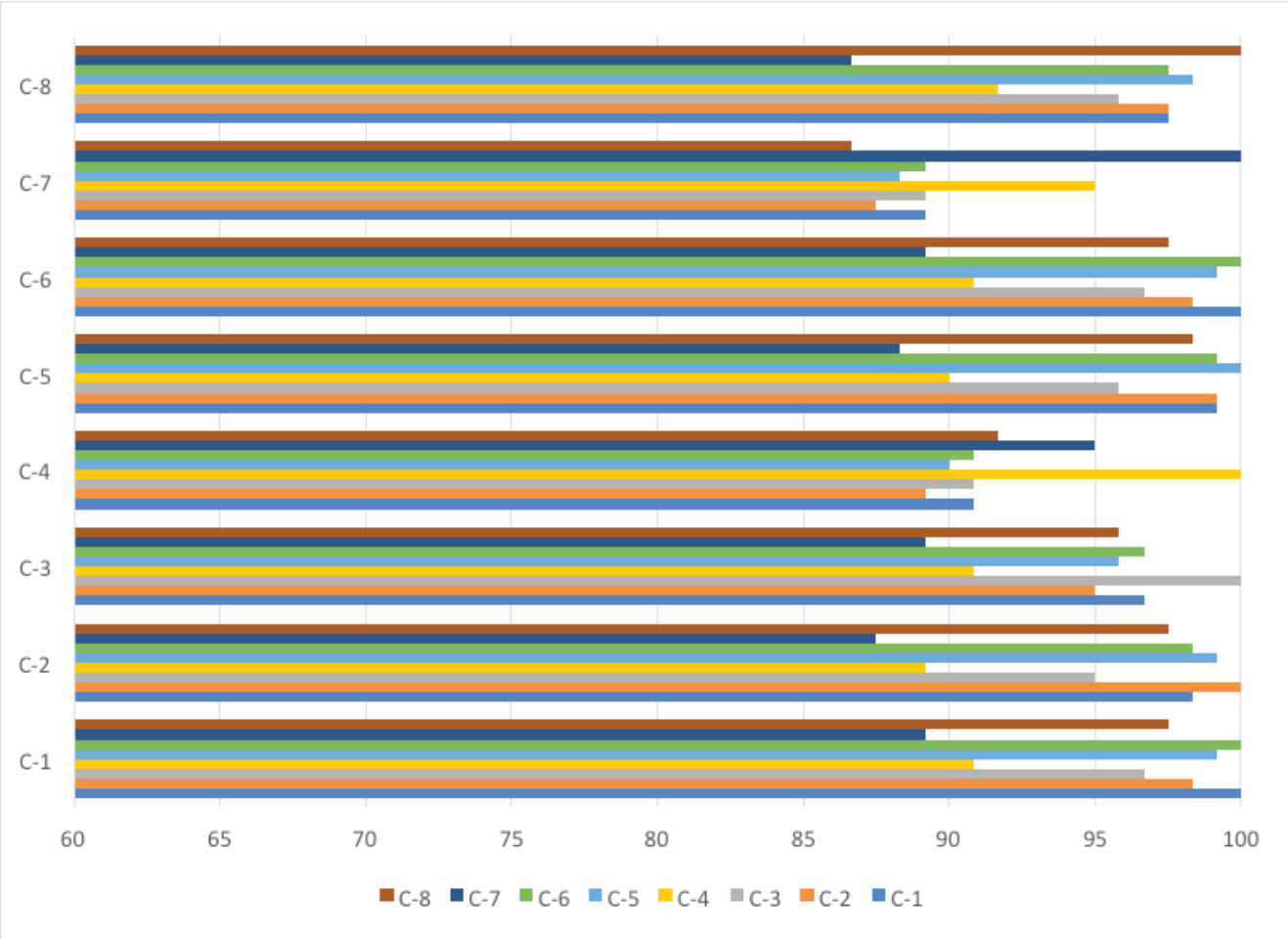

Figure 4.

Company C's resemblance of grades (in %).

Remark: The colour bar (The colour for each database is shown in the small squares below the diagram) indicates the resemblance of the databases compared, with the databases indicated on the ordinate.

The deviations of results, i.e. the deficiencies noted during the evaluation of databases A-2, C-4 and C-7, are connected to the lack of ship's instruction books and documents during the database development. The lack of documents is quite a common case when the database is developed for the second-hand vessels where some instruction books and technical documentation are often missing.

The comparison of the evaluation grades of the databases tested according to the first scenario shows resemblance of grade (and equivalence of the average grade) drops when compared with the databases of different companies (Figure 5).

The comparison shows that the databases developed by same team will have significant overall resemblance, which varies between 80 % and 90 % (Table 12 and Figure 5), when developed for different shipowners. The resemblance increases to over 90 % when the databases are developed for the same shipowner. This is emphasized in case of company B, where the grades for some databases are the same (Figure 5). The analysis of major deficiencies shows that the deficiencies differ from company to company. All this points to an existing control on the shipowner's side (shipping companies) and to a uniformity of quality within each company.

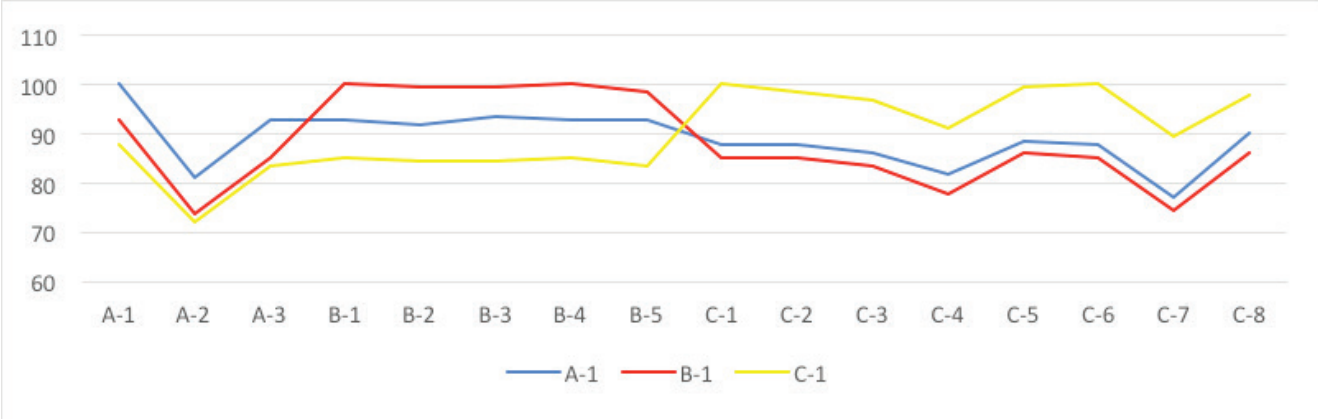

Figure 5.
Comparison of the first scenario database evaluation grades resemblance (in %).
Comment: One database per company is shown for a better overview.

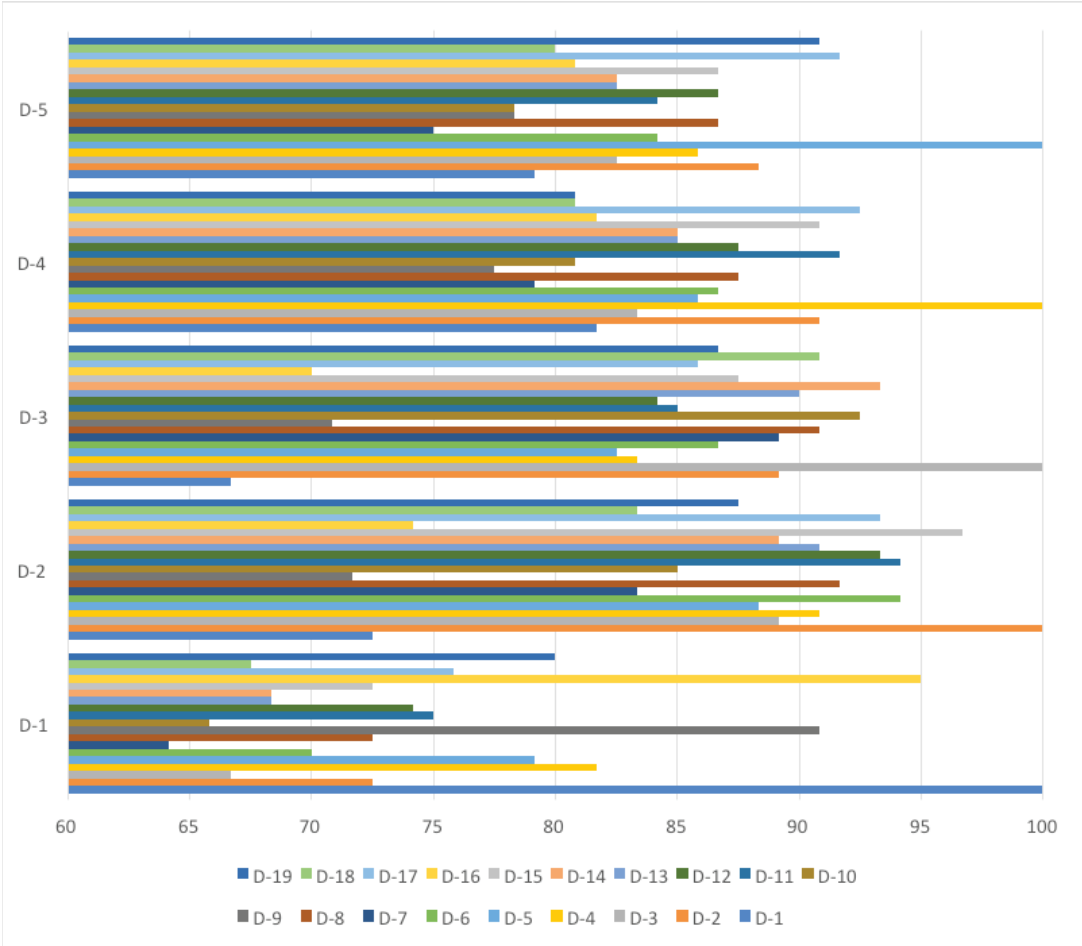

Figure 6.
Company D resemblance of grades (in %).
Comment: Due to size issues, comparison of the first five databases is given in the diagram.
Remark: The colour bar (The colour for each database is shown in the small squares below the diagram) indicates the resemblance of the databases compared, with the databases indicated on the ordinate.

The analysis of the evaluation grade results for the second scenario shows two completely different findings. The company D evaluation grades show a bad condition in general, which is obviously represented by a bad average grade (from 2,467 to 3,833), a larger number of noted deficiencies and big differences of resemblance analysis - from 64 to 95 % (Figure 6), as well as the differences of questions with noted deficiencies. The databases of this company are made by several development teams, each having their own rules, mistakes, criteria, etc. Big differences of evaluation grades signify that during the development of the databases, a corrective mechanism for equalizing quality did not exist. Some databases, like D-7 and D-10, have a relatively good average grade and with little effort would be acceptable. At the same time, D-1 and D-16 need a huge effort to improve their quality to an acceptable level.

The resemblance of the grades across the company E (Figure 7) is very high (from 98.33 to 100 %) as well as the uniformity of the average grades (from 4.533 to 4.600). The conformity of all the results continues with the questions with lower grades, the only noted question is 14. As this company also develops their databases by several development teams, obtaining results like this is possible only if all the teams have clearly marked guidelines and a well-organized and performed database checking.

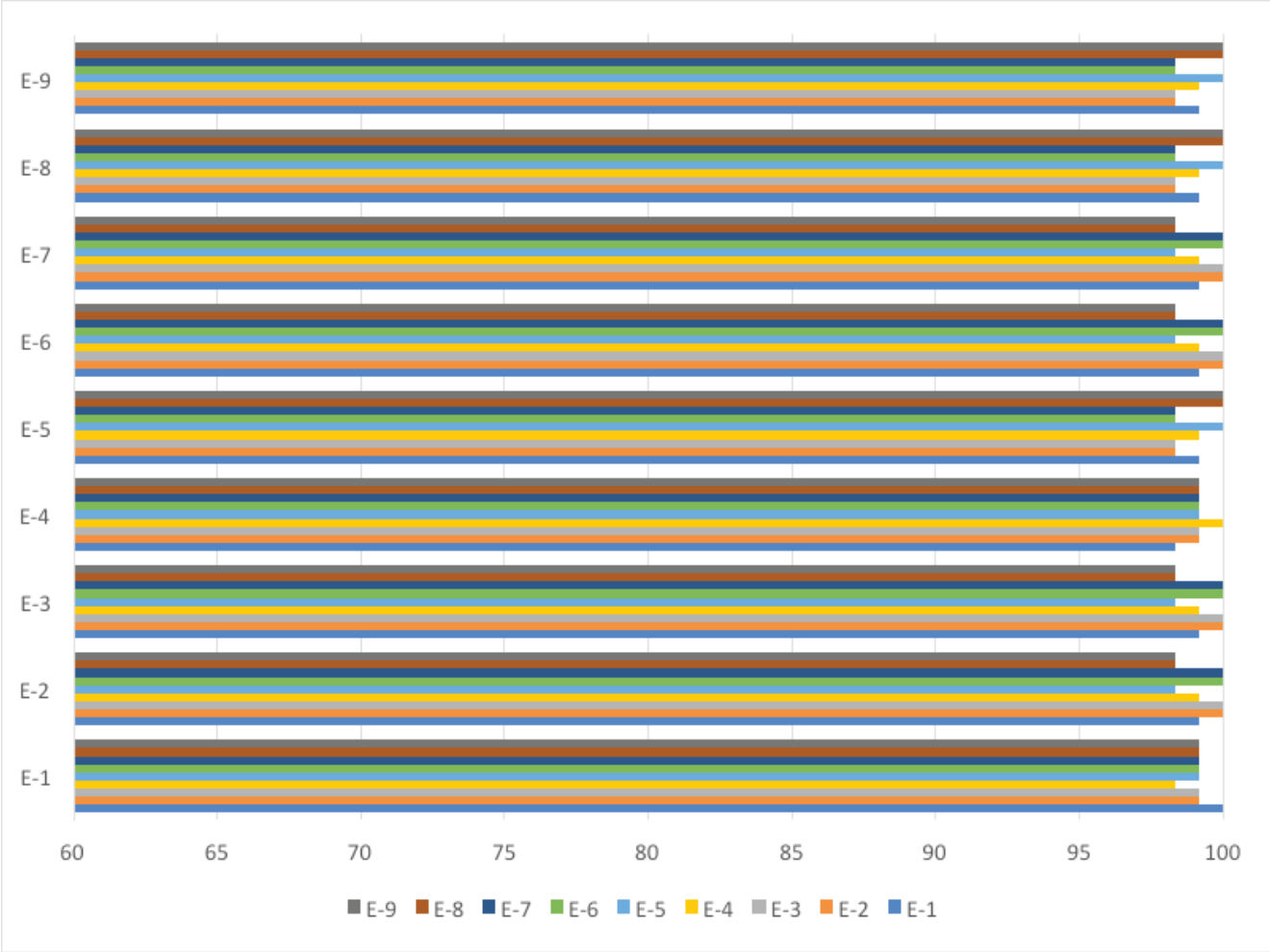

Figure 7.
Company E's resemblance of grades (in %).
Remark: The colour bar (The colour for each database is shown in the small squares below the diagram.) indicates the resemblance of the databases compared, with the databases indicated on the ordinate.

Time used for administration and correction of database should be considered with certain dose of reserve because it depends upon shipboard user access rights policy and what shipboard user can perform in the system. If the shipboard user has restrictive user rights, the office user will work more and vice versa. This time vary from 0.3 hours per day in the company A to 1.5 hours per day in the company B. An exception is company D where that time is negligible, and it is not enough for even a basic oversight of performed activities in the system, i.e. supervision of shipboard users. Adding this information to very bad condition of company D databases, it becomes obvious that there is neglect of computerized *Planned Maintenance System*, i.e. neglect of shipowner's role during database development process.

The company E's results showed that there was a high-quality supervision and check of the data entered, which increased the quality of the data in the database and, consequently, increased efficiency and reliability, reduced errors and user training, increased system and information acceptance (Bias and Mayhew, 1994) (Karat et. al., 1992).

7. CONCLUSION

Database ordering and development sequence diagram show mutual dependence of the shipowner and the developer during the whole process. It also describes the points and shipowner's actions which directly influence the quality of data in computerized planned maintenance database. The research shows in detail how the shipowner affects database quality grades and how this influence can be numerically expressed.

The first scenario evaluated the databases built by one development team for three different shipowners. The research shows that database quality grades have an overall resemblance from 80 to 100 %. If the resemblance of grades is compared for different shipowners, it varies from 80 % to 90 %, and with one shipowner it goes from 90 % to 100 %. The impact of the shipowner towards quality evaluation grades, according to findings, can be measured as increase of resemblance of grades by 10 %.

The evaluation of databases performed according to the second scenario, in which several teams build databases for companies, results in two conclusions. The company D's resemblance analysis results show that the evaluation grades of a single company will vary significantly (from 64 % to 95 %) if the shipowner's impact is missing (or it is removed). The databases will have uneven quality and usability. In contrast to this, company E's resemblance analysis (from 98.33 to 100 %) shows that the grades will be very uniform if there is the control and supervision by the shipowner. In that case, the databases will have very similar quality and usability.

All the conclusions of research according to the first scenario can be applied to the results obtained during the testing of evaluation methodology for ship's *Planned Maintenance System* database (Table 1), where the similarity of results can be noted. The resemblance of database evaluation grades within one company (databases 1 to 4) is between 95.00 % and 99.17 %, which is in accordance with the first scenario results. The resemblance of grades decreases to the range from 86.66 to 90.83 % when compared with a database developed for another shipowner (database 5), also in accordance with the first scenario results. The comparison provides identical results, which solves the problem of unexpected results of a small sample.

It has been found out that Ship's *Planned Maintenance System* database evaluation grades will have a great resemblance within one company (higher than 90 %, often over 95 %), if there is good shipowner's supervision of the database development process and a well organized and carried-out acceptance test. This fact is valid for all the databases of one shipowner, whereas the number of development teams has no relevance.

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Optimal Design of Ship's Hybrid Power System for Efficient Energy

Maja Krčum[a], Anita Gudelj[a], Vinko Tomas[b]

The International Maritime Organization regulations on the reduction of greenhouse gas emissions (GHGs) from ships require efficient dealing with this complex techno-economic and highly political problem through joint efforts of all major stakeholders from the shipbuilding industry and ship operations.

The key problems of any research in the field of renewable energy, including power generation, storage, transformation and distribution, and the issues associated with limited power generation for specific loads, are the same issues that are experienced in the implementation of electric distribution technologies onboard ships.

This paper analyses the effects of efficient shipping using the solar panel system and batteries to ensure continuous power supply, regardless of the weather conditions. The logistics chain of this control architecture is modelled by Colored Petri Nets. The economic analysis examines the annual costs of fuel consumption, the initial capital cost, total net cost and CO_2 emissions.

KEY WORDS

~ Renewable power
~ Power management system onboard ships
~ Energy efficiency
~ CO_2 emissions
~ Multi-objective optimization

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1. INTRODUCTION

The Kyoto Protocol of 1997, paragraph 2.2, entrusted the International Maritime Organization (IMO) (3rd IMO GHG Study, 2014) with the responsibility to regulate and reduce harmful emissions from ship (IMO, 2017). Maritime transportation emits approximately 1,000 million tons of CO_2 annually and accounts for about 2.5 % of the global greenhouse gas emissions (Kyoto Protocol, 2017). The emissions of harmful contents from vessels are anticipated to increase by 50 %-250 % by 2050, depending on the future developments in the fields of economy and energy. This is not in line with the international agreements to decrease global emissions by at least 50 % by 2050 to keep the global temperature increase under 2°C. The IMO regulated CO_2 emissions by adopting Annex VI to the MARPOL Convention. Guidelines for improving energy efficiency were also laid down with the intention to monitor and improve ships' performances and features with regard to various factors that may contribute to CO_2 emissions (see Figure 1). A "new" ship means a ship the building contract for which was concluded on or after 1 January 2013 or in the absence of a building contract, the keel of which was laid or which was in the similar stage of construction on or after 1 July 2013 or which was delivered on or after 1 July 2015.

Various studies and papers (Gudelj and Krčum, 2013; EEDI – IMO, 2012; RSSPS, 2017; Øverleir, 2015) indicate that environmental pollution can be significantly reduced and the low energy efficiency of traditional marine systems improved by the proper integration of renewable energy sources onboard vessels where electrical power is produced by the ship's power plant using a diesel / turbo generator.

For instance, the installation of photovoltaic (PV) systems in the power system helps reduce greenhouse gas emissions, improves energy efficiency and contributes to the stability of the ship's power system.

However, installing a PV system requires significant attention and consideration of certain aspects, such as: unlike land-based systems, onboard power systems are exposed to constant load changes (Krčum et al., 2010). The frequent presence of seawater on the deck, where photovoltaic panels are accommodated, has a significant impact on their effectiveness; at sea, a vessel is always under some load, which may not be the case with shore-based PV systems; while the angle of sunlight at a specific location on land is constantly the same, this is never the case at sea with ever changing waves, sailing routes and courses.

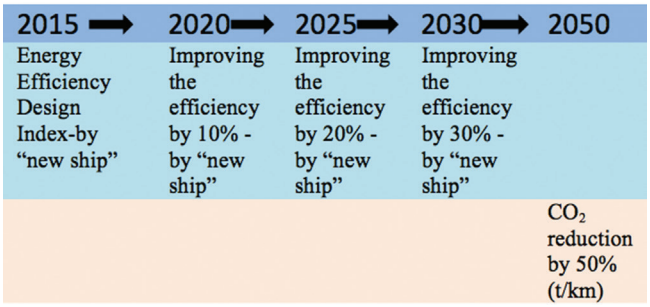

Figure 1.
IMO recommendations for reducing CO_2 emissions 2015-2050

This paper is a contribution to ships' power system energy management in general, and to PLOVPUT's working boat in particular. This vessel, which served as the basis for our research (Tech. doc. PLOVPUT) was under construction. It is a public service workboat, fully equipped to perform a variety of marine and hydro-submarine operations related to the maintenance of waterways in the Croatian Adriatic. These activities include the maintenance of existing and the construction and equipping of new aids to navigation, e.g. marking waterways with navigation buoys; supplying and maintaining onshore and offshore lighthouses; transportation and installation of construction materials onshore and under the sea, performing hydro-submarine operations; transportation of construction machinery.

The vessels' energy resources include:

- Three main-board voltage generators: diesel electric power generators 190 kVA, 3x400 V, 50 Hz, one diesel electric generator 80 kVA, 3x400 V, 50 Hz and an inverter/charger; and
- Secondary-board voltage transformer, batteries and rectifiers.

The diesel electric aggregate (DEA) meets energy consumption needs in all modes, depending on the balance of electricity. In the operating mode and normal mode of navigation, all required power is provided by one diesel electric aggregate (1x190 kVA). In departure mode, buoy handling mode and concrete plant operation mode, the required power is supplied by two DEA (2x190 kVA) in parallel operation. When staying in port, electricity supply is provided by one DEA due to reduced electricity consumption. In case of overload, the power management system shuts down shedable, i.e. less important consumers.

The authors of this study assume that the integration of renewable energy sources in the vessel's power system (Figure 2) may contribute to CO_2 emission reduction. The basis for this hypothesis were the results obtained by the simulation of a hybrid marine power system on HOGA software, developed on the basis of Colored Petri Nets (CPN) models that coordinate and manage the flow of information.

2. POWER MANAGEMENT IN THE PROPOSED SHIP'S POWER PLANT

Figure 2 shows the hybrid system consisting of PV panels, batteries, a charge regulator, AC diesel generators, converters/inverters, and load controls. The hybrid power distributed generation system provides four operating modes, depending on the prevailing environmental conditions, battery charge status and load variation. The controller switches from one mode to another, depending on instructions determining mode selection.

Mode 0: If solar energy is not available and the state of charge (*SOC*) of the batteries is very low, i.e. lower than the minimum recommended by the manufacturer (*SOCmin*), the batteries should not be used and the required energy should be provided by the AC generator.

Mode 1: If weather is cloudy and (*SOC*) is normal, the controller allows the batteries to provide sufficient power for the load. If the load exceeds the power of batteries, excess load will be handled by the AC generator. This mode is maintained while the state of charge (*SOC*) is above SOCmin or while power obtained from solar energy is above threshold power. Outside the above limits, the hybrid power system must switch either to Mode 0 or Mode 2.

Mode 2: If there is plenty of solar energy, photovoltaic (*PV*) system resources are connected to the vessel's grid and PV-generated energy must be preferentially used to power the loads. In the event of surplus energy (Pch), the controller puts the batteries into charging mode until they reach maximum charge value (*SOCmax*). If the power supplied by the PV system is insufficient for the load, the necessary power should be supplied by the batteries.

If the batteries cannot handle the entire load, the excess part of the load will be handled by the AC generator.

Mode 3: In this mode the load demand (*Pload*) is lower than the available solar energy (*Ppv*) and the batteries are fully charged (*SOC >=SOCmax*). This mode is used when there is sufficient PV power to meet the total demand and it is maintained until the load exceeds the available PV power. If the total load exceeds the available PV power, the system switches to Mode 1.

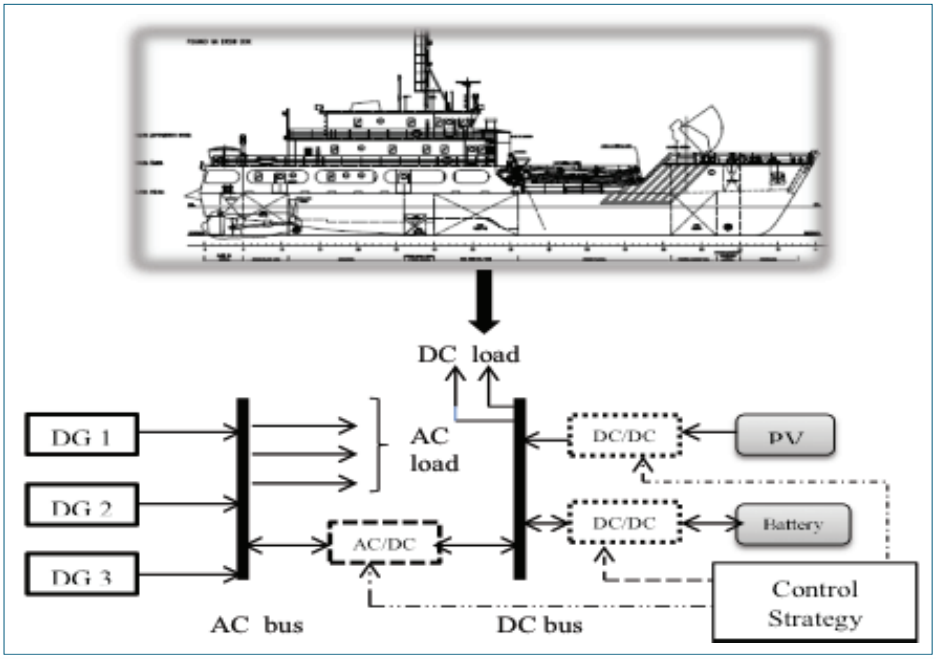

Figure 2.
Hybrid ship power system configuration.

For modes 1, 2 and 3, if the AC generator produces more power than required, and the power envisaged to be supplied by the AC generator is lower than the critical power limit (*Pcritical_gen*), surplus power can be used to charge the batteries up to SOC value, the so-called *SOCstp_gen* (batteries SOC set point for the AC generator). In order to present a supervising control of the hybrid energy system, the following sections discuss the use of Colored Petri Nets (CPNs). Since the hybrid renewable energy system consists of several sources and involves different states and events, the entire system is considered to be a discrete event system (DES). The discrete dynamics of power systems are particularly relevant for mode switching and selecting sources on DC and AC buses depending on the available renewable energy and load. CPNs allow us to define which actions occur in DES, which states preceded these actions and which states will be achieved after the actions have been performed. Colored Petri Nets is an outstanding tool for testing the simulated environment and avoiding the occurrence of potential forbidden states in the real world.

2.1. Colored Petri Nets (CPNs)

Petri net (PN) is a bipartite graph determined by four kinds of objects: *places, transitions, directed arcs and tokens* (Gudelj et al., 2012). In the PN model, places represent system states and transitions represent the assessment of transition of system states. Colored Petri Net (CPN) combines the best of classical PNs and high level programming languages (Jensen et al., 2007; Jensen, 1991). Data, data types and transition conditions are described by a functional programming language. The token, with attached data value (called *token color*), can encode a vast amount of information that determines transition firing. Places are associated with color sets. A color set specifies the data type a place can hold. A transition can be programmed using special constructs and functions. Additional constructs can be used to enable or disable transition firing. Input and output arcs can have expressions and functions related to them. For a transition to be enabled, input arcs expressions need to bind successfully with the tokens present in the input places and the transition guard. The tokens are placed in the respective output places.

A Colored Petri Net can be formally defined as a 9-tuple (Jensen, 1991).

$$CPN = (P,T,A,\Sigma,N,C,G,E,m_0) \quad (1)$$

where, P is a finite set of places, T is a finite set of transitions; A is a finite set of arcs. Σ is a finite set of types called color sets. This set contains all possible colors, operations, and functions used within a CPN.

$N:A \rightarrow (P\times T)U(T\times P)$ is a *node* function. C is a *color* function which maps places in P into color in Σ. G is a *guard* function

defined from *T* into guard expressions *g*. The output of the guard expression should evaluate to Boolean value true or false. *E:A→[expr]* is an *arc* expression function which maps each arc *aϵA* into expression *e*. m_0 is the initial marking of CPN. For more details and CPN theory, refer to (Jensen et al., 2007).

2.2. CPN Control System

Based on the proposed hybrid power system (see Introduction) and logistics issues related to the implementation of renewable sources facilitating efficient shipping, algorithms developed by the authors and C-PN rules, we designed a PN model of a control system managing energy flow and

coordinating operations of hybrid energy systems onboard ships (see Figure 3).

The PN controller was designed using CPN tools (Version 4.0.1 (CPNTools, 2017). Taking into account the specific network topology and net load, the model simply focuses on switching modes of operation and estimating the batteries' state of charge (SOC) once an hour. Battery SOC and net load are used as parameters for the ON/OFF control of PV and diesel generators. As stated above, CPN places consist of a set of markers called tokens, with their attached token color. The necessary color sets and variables are as shown in Figure 4. In the design control strategy, hourly intervals are considered, where all the involved variables are assumed to be constant throughout these intervals. Accordingly, the place *Next_hour* represents one hour which is allocated a single token. Initially this value is 0, and is updated on an hourly basis.

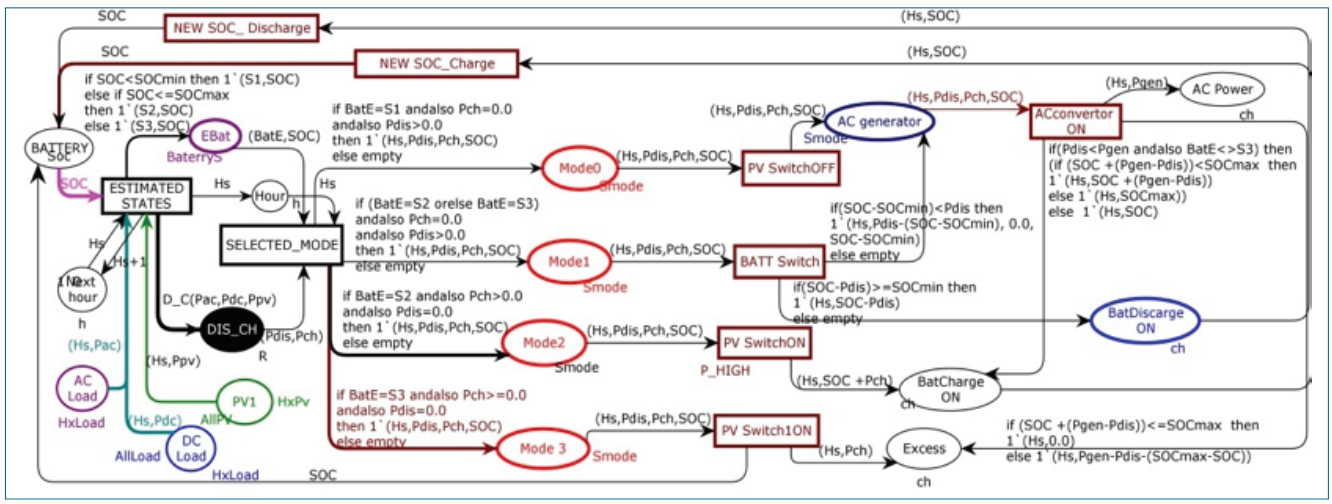

Figure 3.
CPN control design of the ship hybrid energy system.

```
▼Declarations
  ▼colset h=int;
  ▼colset I=int;
  ▼colset load=int;
  ▼colset REAL=real;
  ▼colset R=product REAL*REAL;
  ▼BATTERY
    ▼val SOCmin=6480.0;
    ▼val SOCmax=64800.0;
    ▼colset Soc=real;
    ▼colset batType= product h *Soc;
    ▼colset BatStates=with S1|S2|S3;
    ▼colset BaterryS=product BatStates*Soc;
  ▼PV
    ▼colset ppv=int;
    ▼colset HxPv=product h*ppv;
  ▼colset HxLoad=product h*load;
  ▼colset Smode=product h*REAL*REAL*Soc*BatStates;
  ▼colset ch=product h*REAL;
▼VARIABLE
  ▼var Hs:h;
  ▼var Pac:load;
  ▼var Pdc:load;
  ▼var Pload:load;
  ▼var Ppv:ppv;
  ▼var SOC:Soc;
  ▼var BatE:BatStates;
  ▼var Pch: REAL;
  ▼var Pdis:REAL;
  ▼var EE:REAL;
  ▼val Pinv_max=105000.0;
  ▼val Kinv=0.98;
  ▼val K_AC_DC=0.9;
  ▶val AllLoad
  ▶val AllPV
```

Figure 4.
Definition of color sets and variables.

The estimated state of batteries for each hour place is modelled by *Ebat*. Three states for the batteries are considered and they are defined by three token colors (S1, S2, S3) from the colors set *batStates* (see Figure 3). The first color (S1) indicates that the battery is empty (*SOC<SOCmin*), whereas the second color (S2) signifies that the battery is fully charged. The latter state is reached when the battery state of charge (SOC) becomes equal to or higher than the maximum value (*SOCmax*). The third color (S3) indicates that the battery is in an intermediate state, i.e. that its SOC is between minimum (*SOCmin*) and maximum value (*SOCmax*). The place DIS_CH checks the system energy balance and battery SOC at each time interval and shows whether the system is in *Charge* state or in *Discharge* state. Charging and discharging processes are coded by the function *Discharge_ Charge* (Figure 5) through a communication link with the load layer and PV resources.

```
fun Discharge_Charge(Pac,Pdc,Ppv)=
if (Ppv >Pdc)  then
        (if real(Ppv-Pdc)<(real(Pac)/0.98) then
                    1`(real(Pac)-real(Ppv-Pdc)*0.98,0.0)
          else if real(Ppv-Pdc)<=105000.0 then
                    1`(0.0,real(Ppv-Pdc)-real(Pac)/0.98)
            else if 105000.0<real(Ppv-Pdc) then
                  1`(real(Pac)-105000.0*0.98,real(Ppv-
                                              Pdc)-105000.0)
              else 1`(0.0,real(Ppv-Pdc)-real(Pac)/Kinv)
        )
 else
        1`(real(Pdc-Ppv)+real(Pac)*Kinv,0.0);
```

Figure 5.
Function declaration of the CHARGE and DISCHARGE processes.

Pac is power consumed by loads in the AC bus, while *Pdc* denotes the power consumed by loads in the DC bus. *Ppv* refers to power produced by PV renewable sources in the DC bus. *K_AC/DC* is the efficiency of the battery charger and *Kinv* is the efficiency inverter. *Pinv_max* describes maximum active power that can be produced by the inverter.

This function computes the values of surplus power (*Pch*) which is used to charge the batteries or the value of the load that has not been fed (*Pdis*) as a function of the AC load (*Pac*), the DC load (*Pcd*) and the energy produced by the PV sources *Ppv* (Dufo-Lopez et al. 2007). If the PV renewable sources produce more energy than required by AC/DC, surplus power *Pch* is calculated on the one-hour basis. If, on the contrary, the PV system is unable to cover DC energy demand (*Ppv<Pcd*) or the apparent power at the AC/DC inverter output (*Pac/Kinv*), the load that has not been fed (*Pdis*) is calculated. The energy deficit should be compensated either by batteries or the AC generator to cover the AC load or DC load.

The second part selects operating modes of the power station. Each mode is represented by a single place: *Mode0, Mode1, Mode2* and *Mode3*. Communication between operating modes is carried out by the transition SELECTED_MODE. The latter is triggered when it receives information from the first part, and the next node when the aforementioned mode is selected. Although transition SELECTED_MODE is enabled for all modes, it can drive only one mode for each hour. This situation is called a conflict (because the binding elements are enabled individually, but not synchronously), and it is said that the transition SELECTED_MODE is in conflict with itself. The switching between the modes is determined by evaluating the corresponding arc expression, associated to the output arcs from the places *Mode0, Mode1, Mode2, Mode3*, according to the rules described in Section. These transmit information to one of four transitions (PVswitchOFF, BatswitchON, PVswitchON, PVswitchON1). Together with the surrounding arc inscriptions, these transitions define how resources are reserved and released.

Table 1.
Conditions for selecting the appropriate operating mode.

Conditions		Selected mode
Charge/Discharge value	Battery States	
Pch=0.0 and Pdis>0.0	S1	Mode 0
Pch=0.0 and Pdis>0.0	S3 or S2	Mode 1
Pch>0.0 and Pdis=0.0	S2	Mode 2
Pch>=0.0 and Pdis=0.0	S3	Mode 3

Due to limited space, the process shown in CPN Tools is not described in the paper. Figures 6 and 7 illustrate the performance of our strategy. Figure 6 shows markings of each place *Mode0, Mode1, Mode2* and *Mode3*. The figure illustrates the decision made by the PN controller coordinating operating modes. According to the process, Figure 7 shows the power balance during the simulation and describes the evolution of the duty cycle for PV sources and batteries. The synchrony between consumption and photovoltaic generation can be considered to allow the direct use of energy. In this simulation, the weather was very sunny.

During the night, energy is supplied by batteries and the system is in mode 1. At 8 a.m. and 5 p.m. PV panels generate approximately 401Wh of power, which is insufficient. The batteries are used to compensate for the gap. At 9 a.m., when the power generated by the PV increases very rapidly and exceeds the load, the PN switches the system to mode 2. Surplus power is stored in batteries, which are recharged. At 2 p.m., when batteries are full and surplus PV power can no longer be injected into batteries, the PN switches the system to mode 3. In mode 3 the battery SOC is constant.

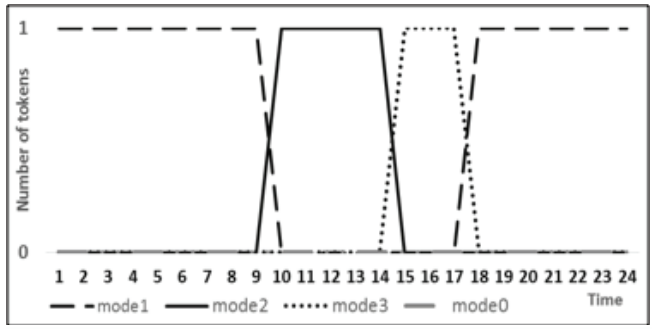

Figure 6.
Mode switches in function of time.

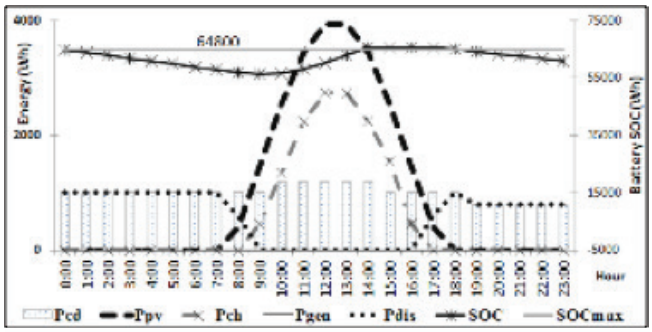

Figure 7.
Simulation results.

3. OPTIMIZATION METHODOLOGY

This research proposes a HOGA based-optimal design of PV-Diesel-Battery stand-alone hybrid energy system for a specific vessel. The system should be properly designed in terms of economic and environmental aspects that are affected by physical and operational constraints and strategies. HOGA software uses Genetic Algorithms (GA) that may produce adequate solutions when applied to highly complex problems (Dufo-Lopez, 2006; Dufo-Lopez and Bernal-Agustin, 2005; Dufo-Lopez et al. 2007; Gudelj and Krčum, 2013). They optimize system components (main genetic algorithm) and the control strategy (secondary genetic algorithm (HOGA, 2017). The program permits mono or multi objective optimization (Dufo-Lopez and Bernal-Agustin, 2005). In this research, the focus of the analysis was on the multi-objective design of the hybrid PV–diesel system with battery storage, intended to minimize both the Net Present Cost (NPC) of the system and the life cycle of CO_2 emissions (LCE), taking into account only emissions from fuel consumption. The NPC represents investment costs plus the discounted present values of all future costs during the system's lifetime. It can be defined as follows:

$$NPC = \sum_k \left(C_k + C_{REP}^k + C_{O\&M}^k \cdot \frac{1}{CFR\,(ir, R)} + C_F \right) \tag{2}$$

where C_k ($) represents capital costs of each component k (PV generator, battery, inverter, battery charge controller and diesel generator). C_{REP}^k ($) indicates the cost of replacement of each component k during the system's lifetime. $C_{O\&M}^k$ ($) are the annual operating and maintenance costs for component k throughout the system's lifetime. CRF is capital recovery factor (Yang et al., 2008; RSoSPS, 2017) which is defined as follows:

$$CFR\,(ir, R) = \frac{ir \cdot (1 + ir)^R}{(1 + ir)^R - 1} \tag{3}$$

where R is the useful lifetime of the project, ir is the real interest rate, which is a function of the nominal interest rate $ir_{nominal}$ and the annual inflation rate f_r, defined by following equation (Yang et al., 2008):

$$ir = \frac{ir_{nominal} - f_r}{1 + f_r} \tag{4}$$

C_F ($) are fuel consumption costs for 1 h of diesel generator operation (Belfkira et al, 2011):

$$C_F = Pr_F \cdot (A \cdot P_D + B \cdot P_{RD}) \tag{5}$$

where Pr_F is fuel price ($/l), A=0.246 l/kWh and B=0.0845 l/kWh fuel curve coefficients.

The model of PV-Diesel-Battery stand-alone hybrid energy system for a specific vessel is a multi-objective problem where two objects are to be minimized (the sum of the net present cost and life cycle CO_2 emissions) and is expressed as follows:

$$min\ F = min\ [\ NPC(x), LCE(x)\ ] \tag{6}$$

$$x = \{\ N_{PV}, a, N_{BAT}, b, N_G, c\ \} \tag{7}$$

where N_{PV}, N_{BAT}, *and* N_G are respectively the total number of PV panels, batteries and AC generators. a, b and c are the type of PV panel, the type of battery, the type of AC generator, respectively. Additional constraints to be imposed are:

$$P_{PV}(t) + P_{BAT}(t) + P_G(t) \geq P_{load}(t) \tag{8}$$

$$SOC_{min} \leq SOC(t) \leq SOC_{max} \tag{9}$$

$$\left.\begin{aligned} 0 \leq N_{PV} \leq N_{PVmax} \\ 0 \leq N_{BAT} \leq N_{BATmax} \end{aligned}\right\} \tag{10}$$

Constraint (8) ensures that for any given period t, the total power supply from the hybrid generation system is sufficient to supply total demand. The relation (9) determines the maximum depth of battery discharging and the minimum depth of battery charging. The relation (10) is the constraint referring to the number of PV modules and batteries.

The number of batteries to be connected in a series is not subject to optimization but is a straightforward calculation, whereas the number of parallel battery strings $N_{BAT,P}$, each consisting of $N_{BAT,S}$ batteries connected in series, is a design

variable that needs optimization (Trazouei and Trazouei, 2013). The total number of batteries is $N_{BAT} = N_{BAT,P} * N_{BAT,S}$.

The number of panels to be connected in series $N_{PV,S}$ depends on the selected DC bus voltage (bus V) and is not subject to optimization. The number of parallel strings $N_{PV,P}$ is the design variable that needs optimization. The total number of PV panels is $N_{PV} = N_{PV,P} * N_{PV,S}$.

Inputs required for system optimization include capital expenses, replacement, operating and maintenance costs of all components, as well as efficiency, components and project lifetime, component specifications, hourly load demand and hourly meteorological data over a one year period.

4. EXAMPLE OF APPLICATION

HOGA was used as a test tool for the optimization of the hybrid system analyzed in this research. As mentioned above, the PV-Diesel-Battery energy system on the special-purpose vessel serving along the eastern Adriatic coast is used as case study. The system has the DC voltage of 48V and AC voltage of 230V. The typical daily load profiles of the ship are shown in Figure 8.

The selection of appropriate solar panels requires data on solar radiation by month in the given area. An average monthly solar irradiation energy throughout the year for the eastern Adriatic Coast is between 1.62 (kWh/m^2) in December and 8.07 (kWh/m^2) in July. In this area, the value of average daily irradiation on horizontal surface is 4.76 (kWh/m^2/day). Therefore, the potential for the utilization of this type of energy is clearly rather high.

In optimizations, commercially available components are considered and prices are all unfeigned. Most low budget solar PV panels are designed for use in residential applications and will not survive being installed on a vessel or seawater exposure which will cause them to delaminate, corrode or deteriorate. KYOCERA Solar panels (Kyocera, 2017) have demonstrated successful and reliable performance in the marine environment over the years. This is the reason why three commercial models of multi-crystalline silicon KCM solar panels of 140/255/320 Wp, featuring 12/12/24 V nominal voltage, having the acquisition cost of 293/317/432 $/per panel and the annual O&M cost of 2.93/3.17/4.32 $/year, respectively, are considered. As the DC voltage of the system is 48 V, the application of four or two panels in series is possible, depending on the nominal voltage (48/nominal voltage). The number of parallel groups allowed ranges between 0 and 20. The estimated lifetime of PV arrays is 25 years and emissions are 600/600/800 kgCO_2, respectively, in the manufacturing.

Trojan's deep-cycle flooded batteries were chosen. Trojan's technology has proven to be suitable for use in marine applications (The Marine battery…, 2015). Three models of 12V batteries with the capacity of 97/106/225 Ah, having the acquisition cost of 150/195/211.6 $/battery, respectively, are considered. As the DC voltage of the system is 48 V, there are four batteries in series. The number of parallel groups allowed ranges between 1 and 15. The O&M cost amounts to 1.5/1.95/1.6 $/year.

The number of possible AC generators in parallel can range from 1 to 3. The lifetime of an AC generator is 10000 h, and its minimum AC generator output power is 30 %. CO_2 emission is 3.5 kg CO_2. The effective interest rate considered is 6 %. The fuel price is 0.8 €/l. The efficiencies are 80 % for the batteries, 90 % for the inverter and 90 % for the battery charger. The lifetime of the entire system is 25 years.

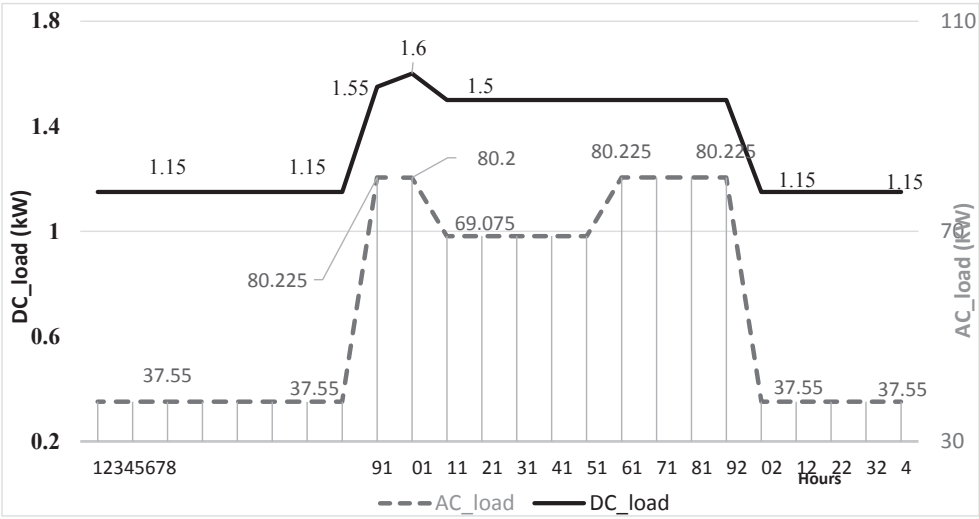

Figure 8.
Average hourly distribution of AC and DC loads.

5. OPTIMIZATION RESULTS

This section is an assessment of the realistic operating scenario for PLOVPUT's working boat. The behavior of the energy storage and production system was simulated using the simulator presented in the preceding section. Three load profiles were tested: profile #1: full AC/DC load was simulated; profile #2: 10 % of AC load and full DC load were simulated; profile #3: only DC load was simulated.

The goal of optimization is to find an optimal configuration of the system by simultaneously minimizing net present cost and CO_2 emissions in terms of the decision variables of the problem (Eq. 7). This task was achieved using HOGA, utilizing a multi-objective genetic algorithm.

The applied genetic algorithm GA can search for the configuration of PV panels, batteries and AC generators that minimizes the two objectives expressed in Equation (6). The genetic algorithm GA simulates the survival of the fittest among individuals over consecutive generations throughout the solution of a problem (Goldberg, 1989). Each generation consists of a population analogous to a set of chromosomes. In this paper, GA uses an integer representation of chromosomes. Each chromosome is a vector in the form $[N_{PV}\ a\ N_{BAT}\ b\ N_G\ c]$ that consists of six positions which, respectively, correspond to six decision variables: number of PV panels, the type of PV panel, the number of batteries, the type of battery, the number of AC generators and the type of AC generator (Eq. 7). The individuals in the population are then exposed to the process of evolution. The elitist mechanism is applied which keeps individuals with high degree of adaptability depending on their fitness. Crossover operator is applied to the group, and individuals are selected by crossover and mutation probability to generate new individuals. Thus, genes from good individuals propagate throughout the population and each subsequent generation achieves better fitness values.

The parameters for the Genetic Algorithm (GA) have been taken from Table 2.

Table 2.
Multi-objective GA Parameters.

Parameter	Values	Parameters	Values
Population Size	15	Selection function	Elitism
Population Type	vector	Crossover function	Single-point
Initial Population	random	Crossover rate	0.75
Max generation	20	Mutation function	Uniform
		Mutation rate	0.01

The obtained optimal configuration for profile #1 is unacceptable because it includes a large number of PV modules which cover an area of 120 m2.

The obtained optimal configuration for profiles #2 and #3 has the lowest system total cost and the lowest emissions. According to the results, the lowest NPC over 25 years is obtained when PV-diesel hybrid generation is combined with battery storage. In addition, this configuration is capable of meeting the load demand without any unmet load during simulation time. Hybrid solutions for renewable and AC generation can reduce costs in the long term, although the initial investment is much higher. The use of AC generator is substantially reduced, resulting in fuel economy and emission savings (see Table 2). Figure 9 and Figure 10 show optimal configurations for load profiles #2 and #3, total energy production for each component and hourly simulation throughout the year.

During the year, for load profile #2, AC generators produce about 77.7 % and renewable resources only 22.3 % of the overall energy. For profile #3, owing to lower load (DC load only), a viable solution is an AC generator operating only for a couple of hours each day. The AC generator produces only 0.01 % of the energy,

Table 3.
Multi-objective GA Parameters.

Load profile	Only Diesel				Optimal results				
	NPC ($)	AC operation (h/yr)	CO_2 (t/yr)	AC_CO_2 (t /yr)	NPC ($)	PV power (W)	Battery capac. (Ah)	AC Pgen_min (kVA)	AC operation (h/yr)
#1	-	-	622.56	595.52	3809600.0	450x255	270x225	57	5127
#2	272261	6852.4	56.32	54.12	699016.88	45x255	72 x 225	3	4818
#3	63034	4376.3	0.774	10.00	49809.00	28 x 320	24 x 225	3	2

while renewable resources produce the remaining 99.9 %. CO_2 emissions from fuel combustion are avoided, leaving only those relating to the life cycle of the facility (manufacturing, transport and scrapping). However, the AC generator remains an important source of energy meeting the AC load demand although its O&M cost is high.

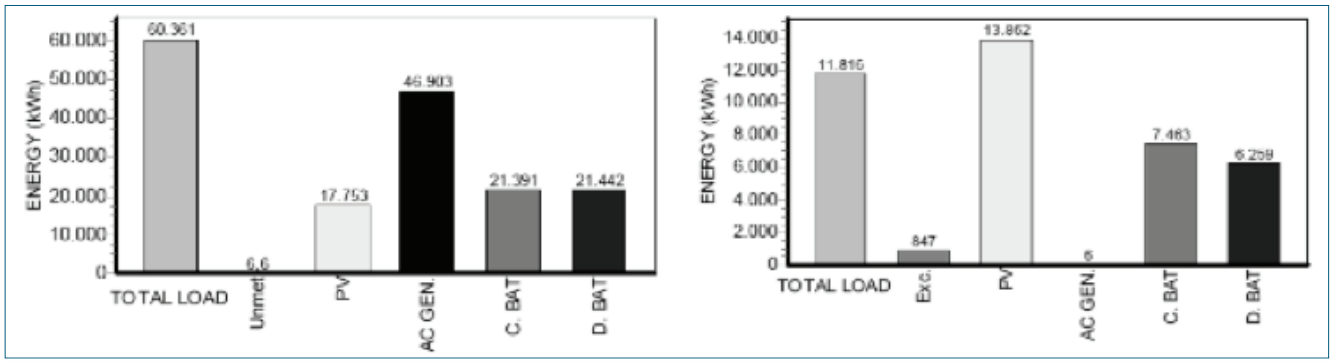

Figure 9.
Energy during one year, load profiles #2 and #3.

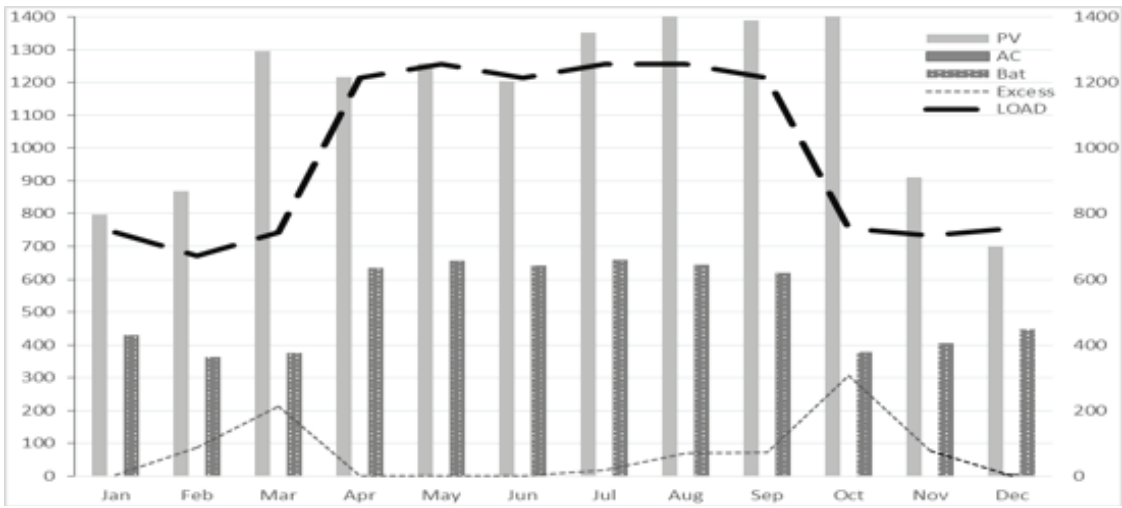

Figure 10.
Daily average energy to comply with the operational profiles and excess energy, profile #3.

6. CONCLUSION

The goal of this research was to prove that a specific vessel, a workboat built in 2016 and operated by Plovput, may generate renewable energy in compliance with the rules of the International Maritime Organization (IMO), which are becoming mandatory as of 2025. The use of photovoltaic (PV) solar systems to supply various onboard users with power (e.g. instruments, lights, winches, propulsion…) reduces fossil fuel consumption and consequently the harmful exhaust gas emissions. However, the efficient application of solar energy onboard ships depends on investment costs of any given solar system and the careful consideration of a number of factors such as required loads and the availability of solar energy. Using a simulation model that only considered PV systems which can actually be mounted on the deck of Plovput's vessel, the consumption loads in certain modes of vessel operation were monitored, and the information flow followed to manage the distribution of load power. The optimal design, allowing energy management, operational cost function minimization and the reduction of CO_2 emission, was implemented using the HOGA software.

This paper focuses on information management coordination and energy distribution that contribute to the study and represent a contribution to meeting IMO recommendations.

It is a part of the authors' ongoing study and can be used for further research that can be applied to similar vessels. The study can easily be extended to include considerations and other renewable energy sources suitable for onboard applications.

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Maritime Lighthouses in the Republic of Croatia – Safety of Navigation and/or Tourist Attraction

Tatjana Stanivuk[a], Ivan Juričević[b], Jelena Žanić Mikuličić[a]

The lighthouses are the most important navigation aids enabling safe navigation. Today, in the Republic of Croatia there are 46 maritime lighthouses in function. All the lighthouses are automated and controlled through the remote control system. In the Republic of Croatia, *Plovput* company is responsible for their maintenance. In recent years maritime lighthouses have increasingly been used for tourism. Still, their primary role has not been forgotten. The proof of this is the incorporation of the Automatic Identification System (AIS) in the lighthouses, raising the safety of navigation to a higher level. Interesting has been the market research in recent years, since there has been an increasing demand for lighthouses as tourist facilities. This is of great importance, as it provides additional financial resources for their maintenance. Unfortunately, the statistical data on renting and the availability of accommodation capacities indicates that there is space for improvement.

KEY WORDS
~ Maritime lighthouses
~ Safety of navigation
~ Statistical analysis
~ Tourist attraction

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1. INTRODUCTION

Man has always sought to mark maritime routes to make navigators safer. For this purpose, various marine signalling facilities were built. In the beginning, fire was lit (Pearson, 1995) and later, with the development of technology, lighthouses and other navigational aids such as coastal and harbour lights, signalling stations, light and signalling signs, signal buoys and other signs started to be established (Jeremić, 2014).

The lighthouses are the most important and safest sea navigation aids that enable safe day and night navigation in a particular marine area. They are built at the most prominent and/or the most distant points of the Croatian territorial sea. Today, in the Republic of Croatia there are 46 maritime lighthouses, of which 17 have lighthouse station and 29 are without human crew (Pomorski rječnik, 2017; Plovput, 2017).

All the lighthouses are automated and monitored through the remote monitoring system that provides permanent insight into the state of the equipment and devices on the most important 103 maritime signalling objects in order to ensure emergency intervention and to return the light to its function in navigation.

The lighthouses are mostly equipped with main and auxiliary lights. The main range is up to 30 miles. Some lighthouses are equipped with a radar beacon (racon), and /or fog system (fog detector and fog sirens) (Pomorski rječnik, 2017; Plovput, 2017).

In recent years, maritime lighthouses have increasingly been used for tourism, especially in the Republic of Croatia. However, the results of the collected and processed data shown in the Chapter 3 of this paper increasingly point to the importance of incorporating maritime lighthouses into the tourist offer.

2. MARITIME LIGHTHOUSES IN THE REPUBLIC OF CROATIA

In the alphabetic order, all maritime lighthouses in the Republic of Croatia are: Babac, Blitvenica, Crna punta, Glavat, Grebeni, Grujica, Host, Jadrija, Marlera, Mlaka, Mulo, Murvica, Oštri rat, Oštro Kraljevica, Palagruža, Peneda, Pločica, Pokonji dol, Pomorac, Porer, Prestenice, Prišnjak, Ražanj, Savudrija, Sestrica vela - Korčula, Sestrica vela -Tajer, Split breakwater, Stončica, Stražica, Struga, Sućuraj, Sušac, Susak, St. Andrija, St. Ivan at sea, St. Nikola, St. Petar, Tri Sestrice- Rivanj, Trstenik, Veli rat, Verudica, Vir, Vnetak, Vošćica, Zaglav, Zub (Plovput, 2017).

In accordance with the Maritime Law of the Republic of Croatia the primary role of the lighthouse is the safety of navigation and protection of human life. Its secondary role is to ensure the provision of services of public interest, among which are:

- Renovation and maintenance of waterways,
- Establishment and maintenance of navigation aids,
- Radio service of coastal radio stations.

These activities are performed by the company *Plovput*, while the administrative control is carried out by the Croatian Ministry of the Sea, Traffic and Infrastructure. Objects of maritime safety are facilities and/or technical systems that acoustically and visually, or through electromagnetic waves transmit, receive or exchange information of importance for the safety of persons and maritime objects (Kasum et al., 2013), protection of the marine environment or safety of people, maritime objects and ports that are located on the waterfront. Navigation safety facilities are installed in the inland waters and the territorial sea of the Republic of Croatia in order to ensure the safe conduct of maritime traffic.

It is important to emphasize that over the past 10 years, there have been no maritime accidents which resulted in casualties, and which were caused by unlit signalling lights. In the Republic of Croatia, there are at present 1,065 marine signalling facilities maintained by *Plovput*, of which 704 maritime signalling objects are owned by *Plovput*, i.e. the Republic of Croatia, according to the Maritime Code (OG 181/04, 76/07, 146/08, 61 / 11, 56/13 and 26/15) (Zakon o Plovputu, 1997).

2.1. Investments in Lighthouses for Safety and Tourism

By the automation of lights on the lighthouses, which *Plovput* carried out in the late 1990s, and according to the decision of the Managing Board, lighthouse human crews were withdrawn. The idea that then emerged was to hand over the abandoned lighthouses to wealthy foreigners. The project was called "Pharos", rated socially and economically unacceptable and was rejected. It is important to point out that reducing the number of lighthouse crew did not have any impact on the quality of the basic activities of *Plovput*, which is the safety of navigation.

In 2011, the realization of the "Stone Lights" project began, which was accepted by the public and the relevant Ministry (Šerić, 2017). The aforementioned project aimed at financial

Figure 1.
Split Gates.

investing in lighthouse buildings to represent a specific tourist service as such. In practice, this idea has proven to be profitable.

The absolute priority of *Plovput* is an investment in the basic activity, which implies that lighthouses are primarily used as navigation aids, and then inclusion in the tourist offer, which provides additional funding for the maintenance of those facilities (Perišić et al., 2010). During the previous years, *Plovput* allocated significant financial resources for renovation of the lighthouses. So, in 2008 through its programme of work it planned to spend approximately 4,000,000.00 HRK for the construction of lighthouse buildings, investments, and regular maintenance.

It is important to emphasise that the basic purpose of a lighthouse is to indicate to ships navigable waterways. In the past 2 or 3 years, *Plovput* invested in the safety of navigation by incorporating AIS (Automatic Identification System) receivers into the most important lighthouses (Categories 1), thus enabling the ship to identify it better through electronic devices.

In this way, the safety of navigation has been raised to a high level for several reasons. Besides the fact that the seafarers can control the position of the ship when seeing the reflection of light from a lighthouse, they also have the orientation in which direction they could ply. As it is well-known, there can always be unexpected failures in lighthouses (bulb, solar regulator, storm strike, etc.), and for these reasons *Plovput* has introduced AIS devices to duplicate the transmission signal to the ship. In this way, offshore accidents are reduced to a minimum.

3. LIGHTHOUSES IN THE CROATIAN TOURIST OFFER - CONCESSIONAIRES

There are 46 lighthouse objects in the Croatian part of the Adriatic. These objects hold a total of 10,398 m^2 of enclosed space, of which 83 % falls on residential buildings, while the other facilities are auxiliary ones. Thirteen lighthouse objects, almost a quarter, are in rent (see Table 1). For nine lighthouses, a long-term rent was agreed for 10 years, while the remaining four of them have a renting contract of 5 years.

There are numerous advantages of renting a lighthouse where there is a lighthouse keeper (Šerić, 2001) compared to those where there is none. Namely, lighthouses are of inestimable value and as such are protected as cultural monuments in the Republic of Croatia (Izvod iz registra kulturnih dobara, 2011).

The lighthouse keeper has his assignments including transmitting meteorological reports (Popović et al., 2014) via VHF (Coastal Radio Stations), main and auxiliary light control, seeing nearby lights, observation of the sea state (Pomorski rječnik, 2017). Taking into account all these technical duties of a lighthouse keeper, one can only imagine what malfunctions happen on the unmanned lighthouses. The light is automated and monitored by remote control, so navigation safety is not questionable, but all the other segments are missing. The advantage is to have a lighthouse keeper on the lighthouse, especially if this lighthouse also provides rental facilities (apartments). The lighthouse as such provides additional service, which contributes to considerable financial resources and facilitates the owner's maintenance.

Table 1.
Lighthouse objects in rent.

Ord. No	Maritime Lighthouse	Place	Year of rent
1.	Tri sestrice Rivanj	Zadar	2010
2.	Marlera	Pula	2010
3.	Pokonji dol	Hvar	2011
4.	Verudica	Pula	2011
5.	Cape Zub	Poreč	2011
6.	Vir	Zadar	2012
7.	Sućuraj	Sućuraj - Hvar	2012
8.	Host	Vis	2012
9.	Sestrica vela	Korčula	2013
10.	Grebeni	Dubrovnik	2014
11.	Crna Punta	Rijeka	2014
12.	Vošćica	Krk	2015
13.	Olipa	Dubrovnik	2015

Table 2.
Lighthouses in the Croatian tourist offer.

Ord. No.	Maritime Lighthouse	Place	Renting period	Apartments	Beds
1.	Savudrija	Pula	The whole year	5	20
2.	St Ivan at sea	Pula	Seasonal	2	8
3.	Porer	Pula	Seasonal	2	8
4.	Veli Rat	Zadar	The whole year	2	7
5.	Prišnjak		Seasonal	1	5
6.	Tajer		Seasonal	2	8
7.	St Petar	Makarska	Seasonal	1	4
8.	Sušac	Sušac	Seasonal	2	8
9.	Palagruža	Palagruža	Seasonal	2	8
10.	Struga		The whole year	4	15
11.	Pločica	Korčula	seasonal	2	16
12.	St Andrija	Dubrovnik	seasonal	1	6

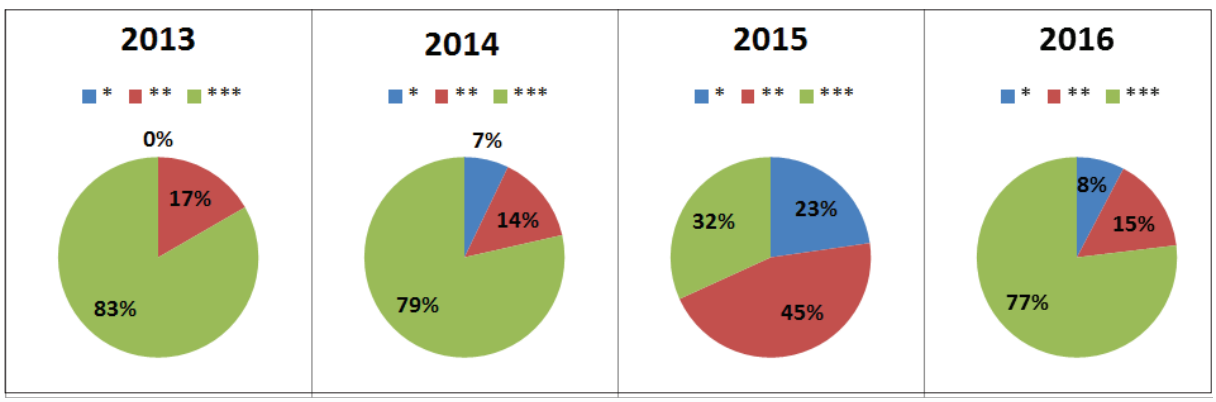


Figure 2.
Structure of the lighthouses according to the categories.

Categorization of lighthouses is similar to that of the apartments; blue colour indicates the lowest (1 star), red middle (2 stars), and green the highest categorization (3 stars).

From the aspect (see Figure 2) on the maritime lighthouse structure by categorization, it is apparent that since 2013 the categorization has not been improved, although significant funds have been invested in the previous periods. It can be concluded that the situation in which the lighthouses are currently managed does not allow it, although it is indispensable.

3.1 Availability of Accommodation Capacities – Results and Discussion

Of the total number of guests on the lighthouses, domestic tourists occupy 15 %; the rest falls on foreign tourists, mostly from Italy, then guests of the German-speaking area such as Austria, Germany, Switzerland, and tourists from Eastern Europe. Tables 3, 4, 5 and 6 indicate oscillations in renting, and by comparing those Tables it is not easy to conclude why the oscillations occur. Unfortunately, they are also good indicators of low availability and underutilization as well as the need to raise lighthouse categorisation and their promotion.

Table 3.
Results of tourist rent in 2013.

Ord. No.	Maritime Lighthouse	Place	No. of apartments /beds	Availability in a week period
1.	ML Savudrija	PP Pula	1/4	22
2.	ML St Ivan at sea	PP Pula	2/8	33
3.	ML Porer	PP Pula	2/8	17
4.	ML Veli rat	PP Zadar	2/7	35
5.	ML Prišnjak	PP Šibenik	1/4	20
6.	ML St Petar	PP Split	1/4	18
7.	ML Sušac	PP Korčula	2/8	8
8.	ML Palagruža	PP Korčula	2/8	16
9.	ML Struga	PP Korčula	4/14	29
10.	ML Pločica	PP Korčula	2/14	9
11.	ML St Andrija	PP Dubrovnik	1/6	26
12.	ML Grebeni	PP Dubrovnik	1/8	3
			TOTAL	*236*

Table 4.
Results of tourist rent in 2014.

Ord. No.	Maritime Lighthouse	Place	No. of apartments /beds	Availability in a week period
1.	ML Savudrija	PP Pula	1/4	24
2.	ML St Ivan at sea	PP Pula	2/8	14
3.	ML Porer	PP Pula	2/8	14
4.	ML Veli rat	PP Zadar	2/7	19
5.	ML Prišnjak	PP Šibenik	1/4	14
6.	ML St Petar	PP Split	1/4	16
7.	ML Sušac	PP Korčula	2/8	18
8.	ML Palagruža	PP Korčula	2/8	11
9.	ML Struga	PP Korčula	4/14	16
10.	ML Pločica	PP Korčula	2/14	13
11.	ML St Andrija	PP Dubrovnik	1/6	5
12.	ML Tajer		2/8	1
			TOTAL	*165*

Table 5.
Results of tourist rent in 2015.

Ord. No.	Maritime Lighthouse	Place	No. of Apartments/beds	Availability in a week period
1.	ML Savudrija	PP Pula	1/4	40
2.	ML St Ivan at sea	PP Pula	2/8	21
3.	ML Porer	PP Pula	2/8	27
4.	ML Veli rat	PP Zadar	2/7	35
5.	ML Prišnjak	PP Šibenik	1/4	18
6.	ML St Petar	PP Split	1/4	14
7.	ML Sušac	PP Korčula	2/8	8
8.	ML Palagruža	PP Korčula	2/8	30
9.	ML Struga	PP Korčula	4/14	21
10.	ML Pločica	PP Korčula	2/14	21
11.	ML St Andrija	PP Dubrovnik	1/6	6
12.	ML Tajer		2/8	6
			TOTAL	*259*

Table 6.
Results of tourist rent in 2016.

Ord.No.	Maritime Lighthouse	Place	No of apartments/beds	Availability in a week period
1.	ML Savudrija	PP Pula	1/4	42
2.	ML St Ivan at sea	PP Pula	2/8	21
3.	ML Porer	PP Pula	2/8	27
4.	ML Veli rat	PP Zadar	2/7	37
5.	ML Prišnjak	PP Šibenik	1/4	18
6.	ML St Petar	PP Split	1/4	14
7.	ML Sušac	PP Korčula	2/8	8
8.	ML Palagruža	PP Korčula	2/8	30
9.	ML Struga	PP Korčula	4/14	22
10.	ML Pločica	PP Korčula	2/14	21
11.	ML St Andrija	PP Dubrovnik	1/6	6
12.	ML Tajer		2/8	6
			TOTAL	*252*

From Figure 3 it is evident that the lighthouse ML Grebeni was rented only in 2013. After that, it is given in concession, and in 2014 *Plovput* categorises the lighthouse PS Tajer, which quickly becomes a recognisable tourist attraction.

The average price of the apartment depends on the rental period during the year (before and after the season or the main season). From the above tables (see Table 3, 4, 5, 6) it is apparent that there are 228 weekly rentals on average per year, which is 19 weeks or 8.3 % per lighthouse. If the average price of a weekly lighthouse rent is 700 €, the average income of the lighthouse is 13,300.00 €, which is 159,600.00 € on the annual level for all the lighthouses (Lighthouse pricelist, 2017).

On the basis of an analysis of income and expenditures, the profitability of this business can be estimated (see Figure 4).

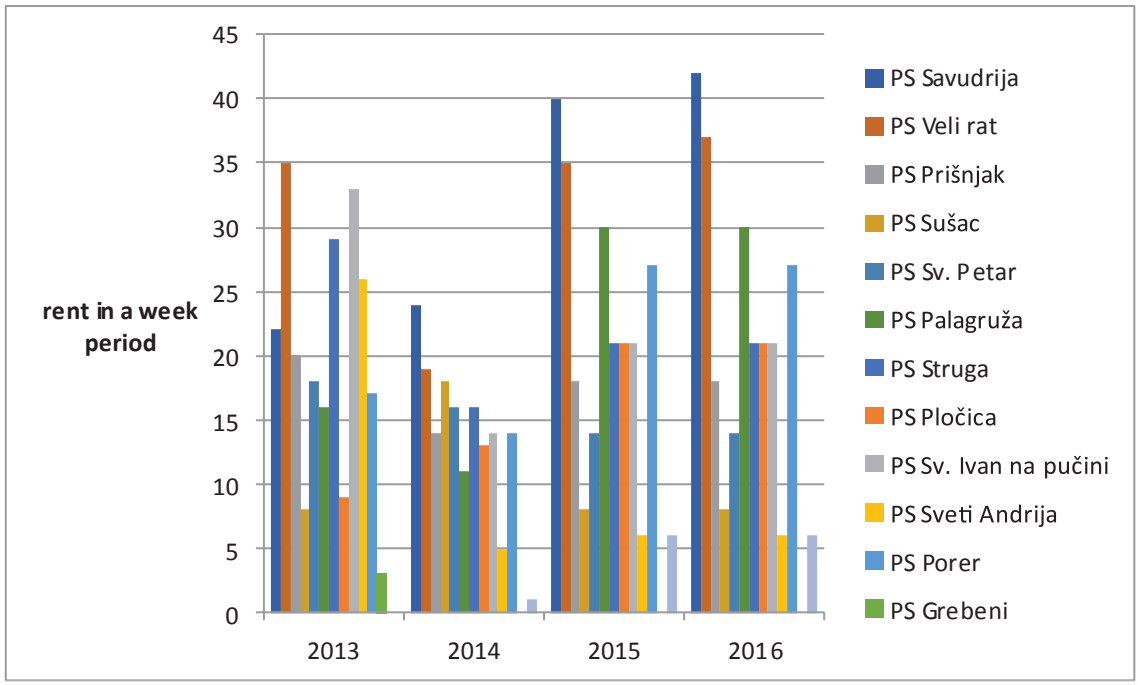
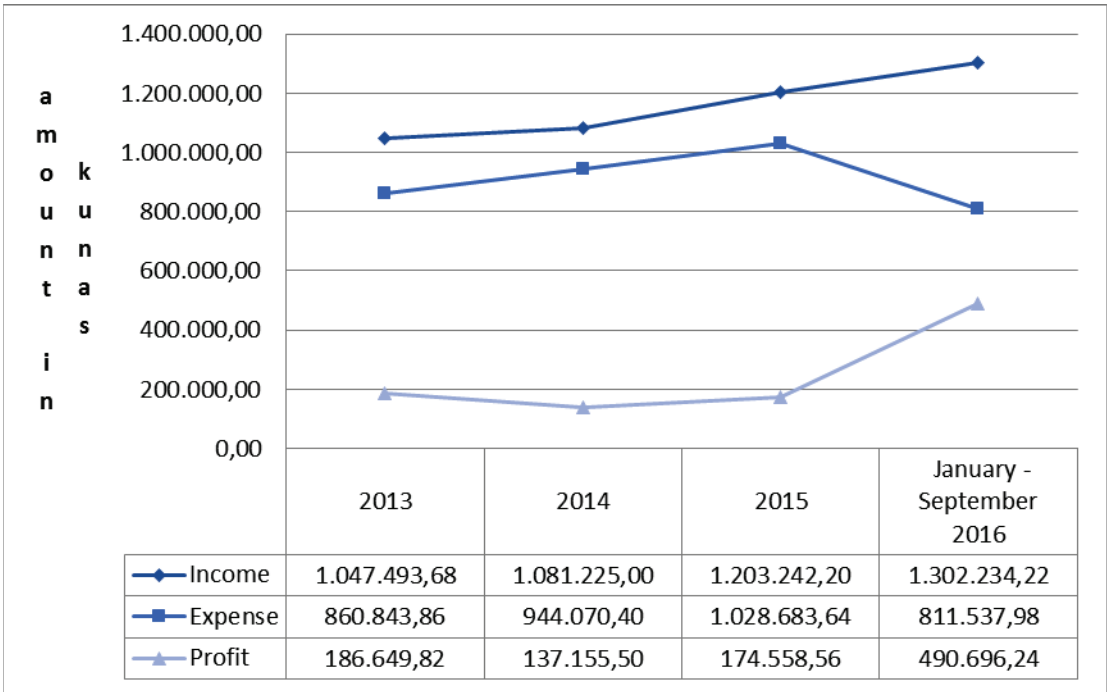


Figure 3.
Weekly rental of maritime lighthouses by years.



	2013	2014	2015	January - September 2016
Income	1.047.493,68	1.081.225,00	1.203.242,20	1.302.234,22
Expense	860.843,86	944.070,40	1.028.683,64	811.537,98
Profit	186.649,82	137.155,50	174.558,56	490.696,24

Figure 4.
Profitability from tourist rent of maritime lighthouses.

The results of the collected and processed data show that additional investment in lighthouse tourism is more than profitable. *Plovput* did not operate negatively in the tourism department in the past 4 years, but had a constant profit, which in 2016 resulted in 490,696.24 kn (65,426.17 €).

7. CONCLUSION

The maritime lighthouses in the Republic of Croatia as well as worldwide have the main purpose of signalling at sea, all in order to protect human lives and property at sea. It should be noted that in the Republic of Croatia there have been no marine accidents resulting in casualties, caused by the failure of maritime signalling (lighthouse).

As automation and technology are dominant nowadays, there is a question to be made about the adequate use of lighthouses which have enormous potential in tourist terms. Due to the lack of material resources, and perhaps the poor coordination of the Ministry (maritime affairs - tourism) and *Plovput*, the exploitation of this type of tourist facilities is not at an enviable level. On lighthouses that are rented by *Plovput*, new employment is required – not a lighthouse keeper, but a maid, chef, waiter, hair-dresser, so that the tourist offer itself would be of higher quality and more competitive. Tourist service is an additional service provided by *Plovput* and as such has no priority investment.

The advantages that have been shown of renting a lighthouse with regard to those which are not rented are enormous, and it is necessary to put all the lighthouses in the function of tourism as soon as possible. The lighthouses that are not in the function of tourism and do not have a lighthouse keeper are decaying, primarily because of the dampness and there is also the technical sustainability for which the lighthouse keeper cares. Safety in navigation is not questionable in these cases as the light is automated, and in case of the main light failure, the auxiliary one will be activated immediately.

The intervention by *Plovput* happens within 24 hours, of course with weather allowance. According to the latest data from *Plovput*, such cases are only in the range of 1-5 during the year and all are removed within 24 hours, which indicates 100 % efficiency. Thus, maritime signalling is at a high level in the Republic of Croatia, which cannot be said for the tourist part. Lighthouses are a new and recognisable tourist attraction that brings profit, and the data on the availability of accommodation capacities indicates their growth in the future.

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Issues in Dry Port Location and Implementation in Metropolitan Areas: The Case of Sydney, Australia

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The basic idea behind the concept of a dry port is a more efficient seaport access, movement of the seaport's interface inland with the shift of flows from road to rail. The application of the concept results in a reduction of road transport to/from the seaport together with the associated broad social and environmental benefits. This paper examines the complex factors influencing the timeframes and location of close inland intermodal terminals with dry port characteristics - metropolitan intermodal terminals, as they are usually referred to - and their implementation, with a case study of the Sydney metropolitan region and Port Botany, Australia. The issues surrounding suburban freight terminals are a sub-set of the wider social and environmental problems of the interactions of seaports with their hinterland. Port Botany and its close inland intermodal terminals are very distinctive: there are very few ports in the world with such a well-developed network of close inland intermodal terminals. Nevertheless, the Moorebank terminal was first mooted in 2003 but the latest plans anticipate operations commencing in 2018. The paper illustrates some problematic aspects of long timeframes for the development of significant freight infrastructure.

KEY WORDS
~ Dry port
~ Inland intermodal terminals
~ Metropolitan area
~ Location
~ Sydney

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1. INTRODUCTION

The increasing container volumes handled in seaports require adequate land to be available nearby for port-associated functions and an efficient inland multi-modal transport access. Some ports are physically constrained so that the ports and /or port terminal operators have become involved in developing dry ports (Roso, 2008; Ng and Gujar, 2009; Wilmsmeier et al., 2011). Whilst dry ports and their functions may be classified by distance from the port: close, midrange and distant (Roso et al., 2009), this paper focuses on the close dry ports – typically those located in large metropolitan areas, also referred to as suburban freight terminals. Services such as transshipment, storage, consolidation, depot, track and trace, maintenance of containers, and customs clearance are available at dry ports. This paper examines the complex factors influencing the location of close inland intermodal terminals with dry port characteristics - metropolitan intermodal terminals as they are usually referred to - and their implementation, with a case study of the Sydney metropolitan region and Port Botany, Australia.

The concept of a dry port should facilitate a more efficient port access, movement of the seaport's interface inland with the shift of flows from road to rail resulting in a reduction of road transport to/from the seaport together with associated broad social and environmental benefits (Henttu and Hilmola, 2011;

Hanaoka and Regmi, 2011; Roso, 2013). Various types of inland intermodal terminals that fit into the concept of dry ports have been developed and studied around the world, e.g. in China (Beresford et al., 2012), Japan (Yoshizawa, 2012), India (Ng and Gujar, 2009), the United States (Rodrigue et al, 2010; Roso et al., 2015), Asia (Hanaoka and Regmi, 2011), Russia (Korovyakovsky and Panova, 2011), Australia and New Zealand (Roso 2008 and 2013), and Europe (Flämig and Hesse, 2011; Henttu and Hilmola, 2011; Monios, 2011; Bask et al, 2014).

In the case of seaports in the metropolitan Sydney over the past five decades, we can wonder about: why, once the location for a new port was selected by the NSW Government to relieve the fragmented and site-constrained port facilities in Port Jackson, there was insufficient land available for a longer-term expansion of the new port; what inland terminals/dry ports were selected; what have been the issues surrounding the implementation of dry ports in Sydney; whether the implementation of these dry ports had the desired effects of switching containers from road to rail; what the contemporary issues in the implementation of dry ports are, especially in the planning of the Moorebank intermodal terminal that started in 2003 with the operations to commence in 2017.

The methodology adopted in the examination of the issues in the implementation of dry ports is as follows. To set the context for the case study of metropolitan Sydney, we compare the recommendations associated with resolving Port Botany's environmental and social problems against how successive governments have formulated palliative policies based on Butlin (1976), Rimmer and Black (1982), Black and Styhre (2016), other inquiries (for example, NSW Parliamentary Librarian, 1976; NSW Government, 1980 a,b, 2011; Infrastructure Partnership Australia, 2007). This historical research is supported by studies based on in-depth interviews with the key stakeholders on ports and dry ports (Roso, 2008; Roso, 2013; Roso et al. 2015). The interviews in these studies have been undertaken with different actors of the transport system, such as seaport managers, inland terminal managers, rail and road operators, as well as policy makers. In addition, secondary data sources, such as internal company reports and internet-based documents, were combined with the site visits in order to insure validity through triangulation (Golicic and Davis, 2012).

2. INTERMODAL TERMINALS – CONCEPT OF DRY PORTS

Intermodal transport refers to the freight supply chain using at least two different modes of transport for the movement of intermodal units (containers, semi-trailers or swap bodies) between origin and destination with one bill of lading, i.e. without handling freight itself during transshipment (Rutten, 1998). Reduced energy consumption, optimization of the usage of the main strengths of each mode, reduction of congestion on road networks, and low environmental impacts (Kreutzerberger et al., 2003) are considered to be the advantages of intermodal (road-rail) transport. Inland intermodal terminals should: contribute to intermodal transport, promote regional economic activity, and improve land use and local goods distribution. These features may also be applied to a dry port - an inland intermodal terminal that has direct rail connection to a seaport, and where customers can leave and/or collect their goods in intermodal loading units as if the transaction was directly with the seaport (Roso et al., 2009). As well as transshipment, which a conventional inland intermodal terminal provides, services such as storage, consolidation, depot, track and trace, maintenance of containers, and customs clearance are available at dry ports.

The quality of access to a dry port, and the quality of the road-rail interface, determines the dry port's performance (Bask et al., 2014). However, the quality of inland access depends on the behavior of a large variety of actors such as government planning agencies, regulatory authorities, terminal operators, freight forwarders, transport operators, and port authorities and this requires coordination between all the actors involved (de Langen and Chouly, 2004; Van Der Horst and De Langen, 2008). A scheduled and reliable high-capacity transport by road and rail to and from the seaport is a prerequisite. Bergqvist et al. (2010) identified the following factors affecting the development process and the time needed to establish intermodal road-rail terminals: profitability, financiers, political entrepreneur, location, large local shippers, and traffic authorities. The authors conclude that profitability combined with an enthusiastic and committed political entrepreneur are the most vital factors for the success and pace of the development process (ibid). Implementation of a close dry port in a seaport's immediate hinterland increases the seaport's terminal capacity and with it comes the potential to increase productivity because bigger container ships will be able to call at the seaport (Roso et al., 2009), provided they are not constrained by their draft.

With a dry port implementation, the seaport's congestion due to numerous trucks at the land interface is avoided because one train can substitute some 35 trucks in Europe (Roso et al., 2009). The benefits from distant dry ports derive from the modal shift from road to rail, resulting in reduced congestion at the seaport gates and their surroundings, as well as reduced external environmental effects along the route (Roso et al., 2009). A reduced number of trucks on the roads generate less congestion, fewer accidents, lower road maintenance costs, and less vehicle emissions. Although road carriers would lose market share in countries such as Australia, where long trailers are restricted to pass through city roads, a dry port is a good solution from their perspective as well. In addition to the general benefits to the environment and the quality of life by shifting flows from road to rail, the dry port concept mainly offers seaports a possibility to increase the throughput without physical expansion at the site

of the port; i.e. it is a movement of the seaport's "interface" inland (Roso et al., 2009) and, as such, extends spatially inland the gates of the seaport (Wilmsmeier et al., 2011).

As noted above, the success in the development of seaports and of inland terminals depends on the behavior of a large variety of actors such as government planning agencies, regulatory authorities, terminal operators, freight forwarders, transport operators and port authorities, and the coordination between all the actors involved. In practice, locating dry ports within an already developed metropolitan space is a tricky balance between evidence-based land-use and transport analysis and the politics at the local, metropolitan, state and national scales. However, the devil is in the detail when it comes to co-operative behavior and co-ordination with real-world examples. In order to understand suburban terminal location issues in metropolitan Sydney, we must first explain the historical context.

In the past decade, the dry port concept gained a lot of attention from researchers around the world who identified the success factors for dry ports related to their specific cases. Black et al. (2013) study on the implementation of a dry port in Asia

Table 1.
Success factors in the establishment and operations of dry ports.

Success factor	**Reference**
Discuss operational agreements in advance	Hanaoka and Regmi (2011)
Emission reductions	Roso and Rosa (2012), Hanaoka and Regmi (2011)
Government logistics policies/support	Hanaoka and Regmi (2011)
Public-private ownership or government	Hanaoka and Regmi (2011), Bergqvist et al (2010)
Railway connection	Roso et al. (2009), Roso and Lumsden (2010), Hanaoka and Regmi (2010)
Modal shift from road to rail	Roso et al. (2009), Hanaoka and Regmi (2011), Cullinane and Wilmsmeier (2011)
Stimulating economic development	Roso et al. (2009), Hanaoka and Regmi (2011)
Facilitating international trade	Hanaoka and Regmi (2011)
Development of supporting infrastructure	Hanaoka and Regmi (2011)
Streamlining of institutional and regulatory frameworks	Hanaoka and Regmi (2011)
Double-stack trains	Hanaoka and Regmi (2011)
Advanced IT systems & container tracking	Roso (2013), Hanaoka and Regmi (2011)
Market-driven development	Hanaoka and Regmi (2011)
Cooperation between the actors of the transport system	Roso (2013), Hanaoka and Regmi (2011)
Coordination among various government agencies	Hanaoka and Regmi (2011), Bergqvist et al. (2010)
Temporary warehousing facility	Rodrigue and Notteboom (2012), Cullinane and Wilmsmeier (2011)
Capacity problems in seaport reduced	Roso et al. (2009), Roso (2008), Rodrigue and Notteboom (2012), Cullinane and Wilmsmeier (2011)
Development of value added services	Bask et al. (2014),
Lower distribution cost	Rodrigue and Notteboom (2012), Roso et al. (2009), Cullinane and Wilmsmeier (2011)
Good intermediary location	Rodrigue and Notteboom (2012), Bergqvist et al. (2010)
Better usage of regional transport infrastructure	Rodrigue and Notteboom (2012)
Expanding or reinforcing hinterland	Cullinane and Wilmsmeier (2011), Roso (2013), Roso and Rosa (2012)
Marketing support by local economic agencies and state	Cullinane and Wilmsmeier (2011)
Lower land cost and taxes	Cullinane and Wilmsmeier (2011)

summarizes the factors that influence dry ports' implementation and operations and, consequently, their success (Table 1); the same has been adapted with new references.

3. PORT BOTANY – HISTORICAL DEVELOPMENT

A historical perspective is taken in order to understand the necessity of implementing suburban freight terminals in metropolitan Sydney. The port functions on Port Jackson (Sydney Harbour) had become increasingly constrained in the post-Second-World-War era. The trucks moving containers in and out of Mort Bay had to use the narrow residential streets of Balmain where protests from Residents' Action Groups (one of the first urban environmental lobby groups formed in Sydney) forced the Government into action. The NSW State Government wanted to maintain Sydney as Australia's premier port. A decision was made in 1969 to construct container facilities on Botany Bay. Its construction started in June 1971, the year before environmental impact assessment and the subsequent public inquiry became NSW Government policy. Brotherson (1975) explains the relevant history behind the need to relocate some port functions from Port Jackson to an entirely new port on the reclaimed land in Botany Bay. The new port involved the physical transformation of Botany Bay through dredging, construction of a high breakwater to counter storm surges in the bay, and reclamation of a large area (the plan called for 600 hectares of reclaimed land from the Bay) at a cost of about AUD 604 million in 2014 prices (Brotherson, 1975; Black and Styhre, 2016). A V-shaped entrance channel 19.2 meters deep was dredged in the mouth of Botany Bay to accommodate 200,000 dwt tankers ostensibly designed for petroleum imports and bulk cargoes. In 2016, the maximum draught was 12.7 meters.

From its inception, some major problems have arisen since the port site on Botany Bay was selected - not least the highly constrained site, container truck generation and the imperatives of finding metropolitan locations for intermodal freight terminal. Black and Styrhe (2016) describe the details of "six crises of the state". In this accommodation of change, conflict may intensify, or it may be resolved in one location only to reappear elsewhere, or it may be resolved to the satisfaction of most (if not all) groups (Rimmer and Black, 1982). In the case of Port Botany it was clearly a sub-optimal location – on a small site heavily constrained landward for any future expansion.

The problem of the site chosen for Port Botany, and the need for dry ports, was recognized as soon as the Government's plan was announced. A stellar group of Australian researchers promoted the preparation of reports on the Australian environmental situation, similar to those produced at that time by the US National Academy of Sciences. In 1970, the Council of the Australian Academies of Sciences, i.e. Social Sciences and Humanities, set up a Standing Committee on the Environment, a National Committee on the Environment, and established working groups and ad hoc committees that prepared reports on many environmental problems. A research proposal of looking at problems of the environmental change in some long-occupied urbanized part of Australia won support and it was decided to focus on Botany Bay. Further details on the Botany Bay Project can be found in Black and Styhre (2016). There were several cogent reasons for selecting this case study, including that the NSW Government Maritime Services Board had plans to establish a new port in Botany Bay. Discussions between the Academy of Science and the Minister for Environmental Control of the New South Wales Liberal Government secured the state government support. Discussions between representatives of the three Academies and the ministers of the recently elected Whitlam Federal Labor Government secured a promise of AUD 1,035 million research grant over five years (AUD 10,130 million in current prices).

Eighteen projects, each involving unpaid services and contracts, were approved, of which one study focused on the impact of Port Botany. The Botany Bay Project made specific suggestions about Port Botany around the general procedural issues, proposed construction, coal loader, container terminals, amelioration and compensation, total environment and administrative proposals. The report was successful in advocating the administrative and procedural change: the NSW Environmental Planning and Assessment Act became law in 1979, and Australia's commitment to ecologically sustainable development since the 1990s has ensured that the major projects, such as a new port, are evaluated from the economic, social and environmental perspectives; NSW Department of Treasury now plays a pivotal role in the appraisal of infrastructure proposals irrespective of whether generated by the public or the private sector of the economy; ports are operated in NSW as private entities subject to broader Commonwealth and State regulations. The greatest physical legacy of the Botany Bay Project was the removal of the proposed coal loader to Port Kembla, about 90 km south of Sydney, and the suspension of the later phases of the NSW Maritime Services Board plans – described as " a remarkable willingness to commit public funds to a grandiose but ill-conceived port design". However, there has been no appetite for the private sector to run the Botany-Marrickville goods railway line to and from the port although the privatization of parts of the extensive Sydney rail network remain on the political agenda of the incumbent NSW Liberal Party.

The richness of these data would allow a lengthy discussion on the relative power amongst the stakeholder groups and how this has shifted over time, but that is beyond the scope of this paper. A few examples will suffice. It is worth noting that resident's action groups in Balmain were largely responsible for forcing the government to relocate port functions from Sydney Harbor to other locations. Nevertheless, "The powers of the

Maritime Services Board, as harbor owners, port builders and port operators are, at one and the same time, extraordinarily wide and inappropriately narrow" (Butlin, 1976, p. 93). The powerful road lobby has been instrumental in thwarting successive government policy objectives of getting more freight onto rail. Finally, WestConnex – the largest road building program in Australia's history – is aimed at improving, among other things, access to Port Botany, but its implementation is hotly contested by sections of the community (Bacon and Dalley, 2015). Whilst successful in the advocacy of suburban container depots, the transport of containers by rail has been limited and the improvement of rail port access remains an unresolved problem to this day. What were the results of this advocacy in terms of the implementation of suburban container depots, intermodal terminals and dry ports? To answer that question we must establish some criteria for assessing success.

3.1. Port Botany's Inland Terminals Pre-2010

The impacts of Botany Bay report drew attention to the port's poor landward connections to the emerging industrial lands in the outer western suburbs of Sydney, limited rail access to the port, constraints imposed by its location (immediately to the port's north-west of Sydney International Airport that now has two parallel runways thrust into Botany Bay restricting any further expansion of wharf in that direction) and, significantly, community tolerance. All of these issues have haunted governments regarding the expansion of Port Botany up to this day. A number of intermodal terminals that were located within the Sydney metropolitan area nearly a decade ago are listed in Table 2. These are primarily located in close proximity to areas of concentrated industrial distribution. The total planned capacity is limited in some cases by the availability of freight train paths. The total estimated capacity of these terminals is 695,000 TEU. These intermodal terminals service the port or function as a transfer point for interstate cargoes. Sydney Ports Corporation (2008) recognized the need to expand the intermodal network within Sydney as a prerequisite for a greater use of rail in alignment with a NSW Government transport policy objective – in fact, the expected capacity for TEU containers has increased by over 5.5 times. The NSW Government Metropolitan Strategy outlined a proposed network of additional intermodal terminals in the central-west, south-west and west of metropolitan Sydney to meet the predicted demand (SPC, 20008).

Table 2.
Metropolitan Sydney intermodal terminals pre-2010.

Location	Operators	Siding length (meters)	Estimated capacity (TEU)
Camellia	Patrick PortLink	300	80,000
Chullora	Pacific National (inter-state)	680	300,000
Cooks River	Maritime Container Services	500	150,000
Villawood	Mannway	350	20,000
Minto	Macarthur Intermodal Shipping Terminal	390	45,000
Yannora	Patrick PortLink/QR National	500	50,000

The NSW Government proposed new facilities at Enfield, Moorebank and Eastern Creek. Sydney Ports developed a proposal for an Intermodal Logistics Centre at Enfield that provides an intermodal facility to cater for the demand generated in central-west Sydney. The private sector proposed an expansion of the Macarthur Intermodal Shipping Terminal at Minto and a joint venture arrangement between Kaplan Investment Funds, QR National, and Stocklands for a new intermodal facility at Moorebank (see Section 5). The inclusion of warehousing and freight support services within each site is a mitigation strategy to reduce the number of large truck movements within the local community surrounding the terminal facilities.

3.2. Port Botany's Inland Terminals Post-2010

Port Botany is Australia's second largest container port handling over 2 million TEU, approximately one third of the nation's maritime containers. Container volumes are expected to increase annually over the next decade and are projected to reach 7 million TEU by 2031 (Transport for New South Wales, 2016). The export and import of containers are rather balanced in the amount of TEU, with East Asia being the leading region for full container imports. The descriptive details of each terminal follow, but a broad overview of their TEU capacity is contained in Table 3.

Table 3.
Sydney suburban intermodal terminals.

Location	Operator	Capacity* TEU	Comments
Chullora	Pacific National	600,000	Announced in 2015 increasing from 300,000 to 600,000.
MIST	Qube	200,000	Capacity as stated on Qube website.
Cooks River	MCS	500,000	NSW Ports advice.
Yennora	Qube	200,000	Qube advice.
Villawood (Leightonfield)	Toll/DPW	180,000	Toll / DP World announcement.
Enfield	NSW Ports	500,000	Planning approval for 300,000.
Moorebank	Qube	1,550,000	Planned to commence operations in 2017. IMEX and interstate.

3.3. Enfield Intermodal Logistics Centre – Project of 2 Decades

Sydney Ports has developed an Intermodal Logistics Center at its 60 ha marshalling site at Enfield with the purpose of relieving the congested roads by moving more containers by rail to/from Botany. The existing freight line between Port Botany and Enfield / Chullora is a dedicated freight rail line. In 2010, the terminal finally progressed to the construction stage. The plans for the development of the former marshalling yard at Enfield started with planning approval in 1997 (Roso, 2008; Sydney Ports Corporation, 2008) and a statutory environmental assessment (Sinclair Knight Merz, 2005). Numerous obstacles hindered the realization of the plan although the site is located in an industrial and commercial area adjacent to a dedicated freight railway line. The terminal has a warehouse for the packing and unpacking of containers and short-term storage for unpacked cargo, as well as an empty container storage facility depot for later packing or transfer by rail. The terminal was planned for 500,000 TEU per year, but an independent review concluded and recommended that it was too large for the site and suggested a total of 300,000 TEU per year. In December 2015, the rail-based transport company Aurizon entered into the Heads of Agreement with NSW Ports to take on the role as the Intermodal Terminal Operator for the Enfield ILC. Aurizon have undertaken due diligence and operational planning, with a view to commence intermodal operations by the middle of 2016.

4. PORT BOTANY EXPANSION AND MOOREBANK INTERMODAL TERMINAL

The New South Wales Government has aspirations to make Port Botany the largest container port in Australia. Recently, Port Botany has undergone a major expansion of its container port facilities to cope with the growing volumes of trade. The expansion - one of the largest port projects ever to be undertaken in Australia in the past 30 years - entailed the design, construction, procurement and eventual awarding to Hutchison Port Holdings (HPH) of the 3rd stevedore contract (NSW Ports, 2015). The New South Wales Government would retain regulatory oversight of port matters, and the Australian Competition and Consumer Commission (ACCC) has established a price-monitoring regime to ensure transparency. Pilotage and the role of the Harbor Master, as well as the security and emergency response functions, remain with state-owned Sydney Ports. The successful private sector partner was NSW Ports, who obtained the concession for 99 years. The winning consortium - IFM Investors, AustralianSuper, QSuper and Abu Dhabi Investment Authority, made an upfront payment of AUD 5.07 billion – AUD 4.31 billion for Port Botany and AUD 760 million for Port Kembla (Infrastructure Australia, 2014, p. 22). In addition, the consortium pays an annual AUD 5 million to the State Government under the lease agreement. The proceeds will be allocated to the State Government's investment fund, Restart NSW, to help pay for large infrastructure projects (including the WestConnex roads project).

The Australian and NSW Governments identified the Moorebank precinct as part of this growth strategy as a key strategic location to increase intermodal capacity by adding capacity for an additional 2 million TEUs (NSW Government, 2013, p. 122). The Moorebank terminal was first proposed in 2003 while the South Sydney Freight Line, completed in 2013, was first proposed in 1985. The implication is that land-use planning, which has equally long time horizons, also needs to be clearly assessed and Governments need to be made aware of the long-term consequences for freight of their land-use planning decisions (ATRC, 2015).

Given the Commonwealth of Australia's agenda of improving the nation's economic efficiency of national ports

KPMG were commissioned by the Department of Finance and Deregulation to prepare a Detailed Business Case that contains advice, analysis and recommendations for consideration by the Commonwealth of Australia in its deliberations on a proposed intermodal terminal at Moorebank in Sydney, NSW (KPMG, Deloitte and Parsons Brinkerhoff, 2012). The deal is complicated. Essentially the Commonwealth is to fund about AUD 370 million of the development and, importantly, the rail connection between the terminal and the Southern Sydney Freight Line (Fullerton, 2015). Sydney Intermodal Terminal Alliance (SIMTA) - a consortium of Australia's import export logistics company Qube Holdings and Australia's largest rail freight operator Aurizon Holdings will deliver most of the capital investment (~ AUD 1.5 billion over the first 10 years), including the terminal infrastructure and warehousing, and contribute 83 ha of land to the development. Qube's investment will be around AUD 250 million over the first five years. Also, Qube will be working with alternative partners for development of the warehousing precinct – about AUD 800 million development probably over a ten-year horizon from now.

The Project site is centered on an approximately 220 ha area of Commonwealth-owned land in south-west Sydney currently occupied by the Department of Defense, School of Military Engineering and other minor Defense units. The Project proponent is Moorebank Intermodal Company (MIC) - a NSW Government Business Enterprise (GBE) set up to facilitate the development of an intermodal freight terminal. MIC entered into agreement with SIMTA under which SIMTA will build and operate the first stage of the terminal on 21 ha of SIMTA land in the precinct and a rail connection to the Southern Sydney Freight Line at the southern end of the precinct. Additionally, the project includes associated commercial infrastructure (warehousing), and road entry and exit points along Moorebank Avenue.

Development consent was required under both Commonwealth and State legislation: the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 and the NSW Environmental Planning and Assessment Act 1979. Parsons Brinkerhoff (2014) prepared the Moorebank Intermodal Terminal Environmental Impact Statement under NSW state procedures that went on public exhibition. On 3 June 2016, the NSW Planning Assessment Commission approved MIC's Stage 1 "State significant development" Concept Approval for an intermodal terminal on the MIC owned land at Moorebank. (To give an idea of the scale of this project, if superimposed over Sydney's CBD it would stretch from in the north Circular Quay to Chinatown in the south, and west to east across the city from Darling Harbor to William Street). During operations, MIC's main role will be to monitor SIMTA's compliance with its open access obligations. These obligations require the IMEX and interstate terminals to be operated on a non-discriminatory basis so that access will be granted to any transport operator providing freight transport services.

Initially, the 241 ha site will handle 250,000 import-export (IMEX) containers a year from about 2018, and ultimately up to 1.05 million IMEX containers a year. It will handle initially 250,000 interstate containers a year from around 2019, and ultimately up to 500,000 interstate containers a year. There will be up to 850,000 m2 of warehouses where containers can be unpacked before delivery to their final destination. Also, there is the possible future relocation of Moorebank Avenue external to the precinct (subject to future planning approval) that will remain open for public use. Substantial biodiversity offsets protected from development, including vegetation on the eastern bank of the Georges River, will be enhanced and preserved to comply with Commonwealth and State environmental planning legislation. According to ATRC (2015) Port Botany IMEX shuttle services to and from Moorebank will commence operation in 2017 at 250,000 TEU capacity and will have an ultimate capacity of 1.05 million containers per year in IMEX freight by 2028. Furthermore, Moorebank Intermodal, servicing the interstate market, is predicted to start-up in 2020 with steadily increasing volumes and an ultimate capacity of 500,000 interstate containers per year by 2028.

The project proponents claim ambitious goals: taking 3,000 trucks off the road; removing 40,000 tons of carbon a year from the air, and reducing the cost of importing and exporting by 20 to 25 per cent (Fullerton, 2015). The New South Wales Government fully recognizes the impacts such a terminal will have on the local road network and obtained money from the Federal Government under its Nation Building 2 program to undertake transport modeling and economic analyses to determine the optimal road upgrade package to meet the needs of the Moorebank facility. The impact on road investment, plus other issues, has been the essence of community objections to this proposal, including a gross underestimation of traffic generation. The implications of this underestimation of traffic are that the externalities associated with the terminals are also underestimated: road traffic accidents, vehicle emissions, and noise pollution. Furthermore, the report argues that the intermodal terminals will attract the co-location of low-density industries and the Liverpool Local Government will find it difficult to meet its employment targets under the State Metropolitan Planning Strategy. The Moorebank Intermodal Terminal – Traffic and Transport Impact Assessment, prepared by Parsons Brinkerhoff, analyzed New South Wales Roads and Maritime Services crash data for the years 2008-2013 for the section of Moorebank Avenue between the East Hills Railway Line and south of the intersection with the M5, and for the section of the M5 between the Hume Highway and Heathcote Road intersections (Moorebank Intermodal Company, 2016, pp. 22-23). The project proponents noted both roads were accident "black spots" and proposed treatments and their

potential individual impact on the type of accidents that occur (Moorebank Intermodal Company, 2016, Table 9.39). Further investigations by the NSW Roads and Maritime Services have led to a recommended package of works of about AUD 500 million (ibid).

The Liverpool Community Independent Team argued that there are more appropriate, more efficient and more economical solutions for the location of new intermodal terminals. One solution is to move the problem elsewhere – to Eastern Creek. The second solution is to move the problem out of metropolitan Sydney entirely - south to Port Kembla and this will exploit a rail corridor between Maldon and Dombarton - long on the planning books, but a project seen by governments as uneconomical. The Moorebank Intermodal Terminal is another case of the lack of the local community's tolerance of governments planning large infrastructure projects "in their backyards".

5. CONCLUSION

The New South Wales Government policy is to achieve a modal share on rail of 40 % of the total container volumes handled at the seaport through different initiatives by year 2031 (i.e. shift of containers from road to rail) to ease pressure on Sydney's already congested roads. Some of the success factors listed in the Table 1 are also noted in this case of Port Botany development. A well-functioning network of terminals is crucial to achieve this goal and in the case of Port Botany there is a clear cooperation between national and state governments on providing land for the terminals. The main success factors, given the multiplicity of agents involved, is to discuss operational agreements in advance within a market driven development framework that is supported by the Government logistics policies. There must be coordination among various government agencies and the willingness for cooperation between the actors of the transport system. Also, there must be a railway to the seaport to allow containers to be switched from road transport; all together is a sub-set of the wider economic, social and environmental problems of the interactions of seaports with their hinterland.

Port Botany and its close inland intermodal terminals are very distinctive because there are very few ports in the world with such a well-developed network of close inland intermodal terminals. Nevertheless, Moorebank terminal was first conceived as early as in the 2000, but it is scheduled to be operational in 2018. This shows problematic aspect of long timeframes for development of significant freight infrastructure. Even if 40 % of containers on rail share is reached by 2031 - which is unlikely because a communiqué issued in December 2016 by the Port Botany Rail Optimization Group (PBROG) reveals that a positive shift is taking place and rail mode share is tracking at 18.4 per cent for 2016/17 – up from 16.3 per cent in 2015/16 and 13.5 per cent in 2014/15 (Transport for NSW, 2016) - road transport will still more than double during this period.

This paper has examined the complex factors influencing the location of close inland intermodal terminals with dry port characteristics and their implementation with a case study of the Sydney metropolitan region and Port Botany, Australia. The basic idea behind the concept of a dry port is a more economically efficient port access, movement of the seaport's interface inland with the shift of flows from road to rail resulting in a reduction of road transport to/from the seaport together with the associated broad social and environmental benefits. The success in the development of seaports and of inland terminals depends on the behavior of a large variety of actors, such as government planning agencies, regulatory authorities, terminal operators, freight forwarders, transport operators, and port authorities, and coordination between all actors involved.

An important contribution of this paper has been to describe a case study of the planning and progressive implementation the Moorebank Intermodal Terminal. From this we can distil some generic factors that underpin its potential success. There has been clear cooperation between the national and state governments and the private sector on providing land for the terminal that will cover an area approximately the size of the Sydney CBD. The project is being delivered through a public sector-private sector partnership involving a New South Wales State Government Enterprise and SIMTA.

The Port Botany business development plan has included container terminal expansion and port privatization that have clear long-term targets for the future number of containers to be handled in future years, thus guaranteeing freight business for operators (supported by a New South Wales Government policy to achieve a modal share on rail of 28 per cent). There is government support through the construction of a spur line from the terminal to the South Sydney Freight Line and AUD 500 million road upgrades on the network surrounding the terminal.

On what sounds like an echo from the past, the national government has recently released a Smart Cities Plan and noted "urban development pressures around airports, seaports and intermodal facilities need to be carefully managed to prevent these important economic hubs and corridors from being constrained and to reduce their impacts on surrounding communities" (Commonwealth of Australia, 2016, pp. 16). Nevertheless, given the Federal Government's policy of making gateway ports (seaports and airports) the engines of economic productivity, it seems that port-hinterland research funding is essential to support the aspirations of the Smart Cities Plan.

There is an additional layer of complexity to assessing the success when addressing the general logistics or supply-chain management problem and research needs, i.e. the appropriate role of governments and other stakeholders in the planning of

seaports and dry ports in any urban system. This is essentially a question of political economy, and our case study of Sydney can only provide some guidance. The means of regulating urban system growth, mechanisms of resolving environmental conflicts and the relative power of political parties and different stakeholders and the community to influence planning and development decisions remain as research topics of relevance today when studying maritime ports.

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Impact of Technology on Safety as Viewed by Ship Operators

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Modern technology is being increasingly used on-board ships. It is a common opinion that its application has reduced seafarers' workload and improved safety of ships. However, human error induced by technology contributes significantly to risk in shipping. This paper analyses human and machine interaction and demonstrates which elements violate these connections. It is for this purpose that the survey has been conducted via an anonymous questionnaire among professional seafarers. The results indicate that non-standardisation of equipment, i.e. the differences in the settings and display interfaces between different manufacturers and poor design prolong time needed for familiarisation, and in combination with short period of handover can contribute to the occurrence of human error. Greater involvement of the ship operators in the procurement process of navigation equipment is essential, since it may lead to the selection of equipment that suits the end users.

KEY WORDS
~ Marine accidents
~ Human error
~ Human-machine interaction
~ Equipment standardisation
~ Type-specific training

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1. INTRODUCTION

In terms of tools and technology, ship's management has changed tremendously during the last few decades, by introducing larger ships at greater speed, increased number of passengers and volume of cargo, as well as the increased level of automation. Technological developments and improved safety standards were expected to affirm overall human capacity and diminish the occurrence of human error (Turan et al., 2016). However, the statistics on maritime accidents has indicated that the system is not resilient to human errors (Ćorović and Djurović, 2013). For example, analyses have shown that human error has been the cause of 67 % of accidents reported to European Marine Casualty Information Platform (EMCIP) in period from 2011 till 2014 (EMSA, 2015). Among other latent failures contributing to the occurrence of human error, lack of knowledge, inadequate tools and equipment, lack of skill, design, lack of information, as well as inadequately presented information have been recognised.

As another cause of accidents with a share of 24 % equipment failure is stated. Leading contributing factors for equipment failure are: maintenance, inadequate tools and equipment, design, regulatory activities, and work place conditions.

Managing ship safety is fed both by the knowledge about underlying accident factors and general ideas on the managing of companies. For better understanding of operators´ contribution to accidents we need to understand that they are placed at the centre of the work system, surrounded by series of elements with which she/he interacts, and each element interacts further with others (Carayon et al., 2015). Efficient usage of technology is one of the key factors for minimising risk, otherwise vessel and cargo loss or damage, along with adverse effects on human and environment can happen.

The aim of our study was to investigate which factors could contribute to dysfunctional interaction between operator

and technology. For that purpose an anonymous survey was conducted among the Masters and officers of the deck. The paper begins with an overview of ergonomic principles of the integrated bridge system (IBS) design, followed by the influence of technology on human element. The results of the survey and implications for safety follow.

2. ERGONOMIC PRINCIPLES ON-BOARD VESSELS

Ergonomics is based on a principle that efficient design supports human performance and that ergonomics, as a scientific discipline, is not restricted to the aesthetic qualities. Ergonomically well-designed operating system or part of the equipment takes advantage of humans' capabilities and attenuates the impact of human limitation. At the same time, it is necessary to insure that the equipment or the system is fully functional, i.e. designed for human use and meets operational requirements (IMO, 2001).

The principles of the bridge design, layout of navigation systems and navigational equipment and procedures are provided by the SOLAS Convention, Chapter V, Article 15 (IMO 2000a). Further guidance for human element considerations, regarding design, layout, and integration of personnel with equipment, systems and interfaces are set according to IACS recommendations (IACS, 2011, 2013). Product designers must integrate all information about operators, tasks, and environment to generate an acceptable design. Therefore, emphasis should be also on cultural and regional influences on personnel's behavioural patterns and expectations. This includes understanding that different cultural meanings with regard to colour exist (Madden et al., 2000). Awareness of the possible physical differences is necessary, so that the design, layout, and orientation of the working environment are adapted for the whole range and combinations of crew members. In case that these factors are not considered, the workplace design may increase the likelihood of human error. Detailed written procedures, additional training, operations and maintenance manuals cannot adequately compensate for human errors induced by inadequate design (IACS, 2011, 2013).

Fulfilling ergonomic requirements (IMO, 2000b) is especially important for integrated bridge system, because it is used as a control centre of the vessel. The IMO defines an integrated bridge system as: "*a combination of [technical] systems which are interconnected in order to allow centralised access to sensor information or command/control from workstations, with the aim of increasing safe and efficient ship's management by suitably qualified personnel*" (IMO, 1996).

The position of instruments and displays must be carefully planned because all the processes are monitored and controlled from one place. This makes the work easier, but also increases the required level of concentration needed for data analysis. The concept of work, regarding the duties of operator, includes manual control, monitoring, diagnostics of possible failures and repairs. Diagnostics and corrections of alarm system are of highest priority. Wrong system settings can often be the cause of "unnecessary" and "false" alarms. These alarms are recognised as ones that endanger the human-machine interaction the most. The instruction and maintenance manuals are very important for efficient interface running. Furthermore, it is very important to be aware of the limitations, which are typical for each system. Monitoring of instruments must be performed continuously and interference of the operator is required only in the case of a detected system failure. Considering its significance for routine and emergency operations, it is crucial to provide the operator with an operative and easily used human-machine interface (HMI).

Characteristics of effective HMI design:

- Depiction of process status and values as information, not numbers,
- Layout consistent with operator's model of the process,
- Key Performance Indicators as trends,
- No gratuitous information,
- Grey backgrounds, low contrast,
- Very limited use of colour (for alarming)

Characteristics of a poor Human Machine Interface design:

- Presentation of raw data as numbers (temperatures, pressures, etc.),
- No trends (representation of the complete process flow),
- Poor interface graphics,
- Bright colours, 3-D shadows (not suitable for night vision),
- colour coding of piping,
- Measurement units in large, bright text,
- Lots of crossing lines,
- Alarm-related colours for non-alarm related elements (Gruhn, 2011).

However, despite the existing requirements and guidelines, an inadequate design of HMI has been identified as one of the factors contributing to adverse situations on- board ships (EMSA, 2015).

To be adequate, the design of technology should correspond to 'work as done' rather than to 'work as imagined'. The challenges to designers come from practical needs which are rapidly changing. Furthermore, ship, as safety-critical system, represents a unique environment. Therefore, the involvement of the operators throughout design and development is necessary. Unfortunately, an insufficient collaboration between designers and operators has been recognised as one of the constraints in the design process (Shorrock and Williams, 2016).

3. THE INFLUENCE OF TECHNOLOGY ON THE OPERATORS

The role of technology on modern vessels is to make planning and problem resolving easier and to enhance safety. The technological advances have led to reduction of physical work, and contributed to decreased manning. However, technology design features can negatively impact two important factors for decision making: decision performance (situation awareness, threat avoidance, voyage plan monitoring) and decision processes (workload, stress, confidence, satisfaction, effort, vigilance and fatigue) (Dhami and Grabowski, 2011; Hetherington et al., 2006).

The increase in automation level changes the role of the seafarer. It detaches the operator from the control process, because the operator is not fully aware of all the relevant information needed for decision making in emergency situations. Furthermore, it is important to stress that the level of automation of working processes on modern vessel systems is high in demand in terms of human information processing. Increased cognitive demands can lead to fatigue and stress and consequently to detriment in performance (IMO, 2001). If the quantity of information is greater than the operator's capacity to process them, it can affect the time needed for decision making and cause a delay in safety-critical decision making.

There is also a risk of relying too much on technological systems instead of on traditional navigational skills. Consequently, seafarers might forget how to cope with dangerous situations if navigation support system is out of use for some reason. Furthermore, over-reliance on technology, lack of understanding of its limitations and overconfidence in the provided data can lead to a false sense of security and wrong perception or understanding of external environment (Schröder-Hinrichs et al., 2012).

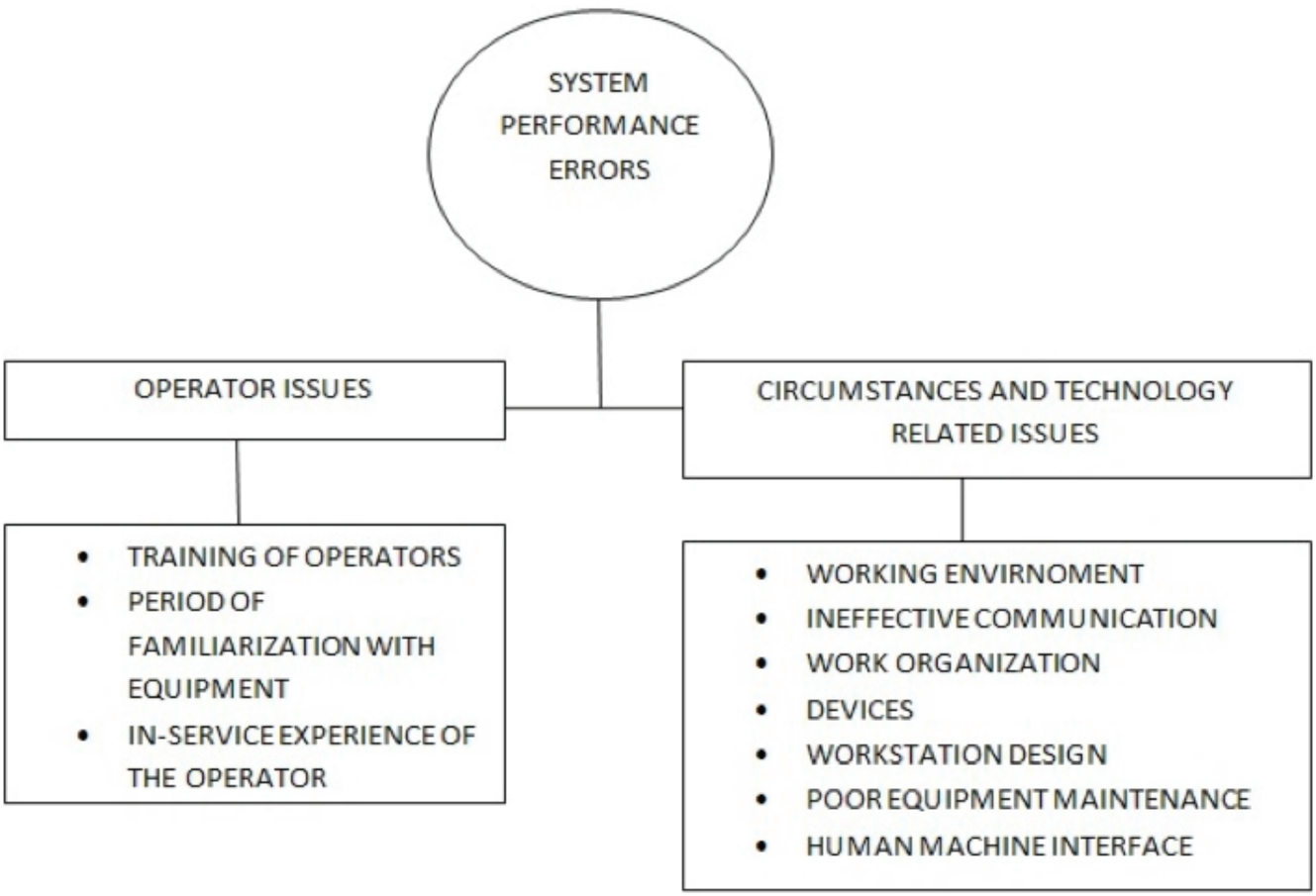

Figure 1.
Graphic representation of elements that might cause system performance error.

Combination of above mentioned factors might result in some type of system performance error (Figure 1).

Causes of system performance errors can be divided into operator issues and circumstances and technology related issues.

Operator issues are inadequate training, lack of time for familiarising with the equipment and the insufficient previous professional experience of the operator. After signing-on and taking over the duties, operators personal qualities and qualifications for work with the instruments come to expression, and those are directly associated with the period needed to get acquainted with them. Taking into consideration their qualities and required qualifications, a decision on employment is made by the Human Resources Department upon completion of testing and interviews. The training of seafarers on operating a specific system is of a great importance because it is unrealistic to expect that, following a short period of familiarising with the equipment on-board and with the experiences of their colleagues, they will be able to use systems competently. According to STCW Convention training is required for following navigational equipment: Radar/Arpa, Global Maritime Distress and Safety System (GMDSS) – generic training; – Electronic Chart Display Information System (ECDIS) –generic training and familiarisation training for the equipment fitted on-board. Additional training required is according to vessel type (tanker, passenger), which is also generic.

The period a seafarer needs in order to familiarise himself with the vessel, navigation systems and alarm systems on-board is of utmost importance to avoid human errors. In practice this period ranges from few hours to several days, depending on the time of port operations. Another possibility, more favourable for the new crew member and for the whole ship management system, is the willingness of the company to keep the previous operator on-board until the new member of the crew gets acquainted with the system. In practice, such cases are rare.

Circumstances and technology related errors arise from work environment, inadequate communication (between the members of the crew, between the Master and the pilot, vessel and vessel, and vessel and VTS), work organisation (adjusting the teamwork on modern systems), equipment maintenance procedures, and workspace design (navigating bridge). The additional problem is a lack of standardisation (Turan et al., 2016). Namely, although equipment and workspace design are stipulated by the IMO and IACS regulations, there is always a place for variations. Looking at operating consoles, differences are ranging from a "track ball and three buttons" to those who have a "full keyboard" for work. In order to adapt for work the operator needs a certain amount of time, particularly if he encounters it for the first time. A better scenario is if he has already encountered the equipment in the past, because in that case he needs less time for adjustment.

4. SURVEY RESULTS AND DISCUSSION

The authors have conducted an anonymous questionnaire survey among seafarers about their experiences with the navigational equipment and its impact on their daily work. The collected data were analysed with the help of analytics software package "Statistica" ver. 13.1., licensed by the Ministry of Science, Education, and Sports. Kruskal–Wallis H Test was used to determine if there are statistically significant differences between variables.

The survey was conducted among participants of the training courses, in accredited institutions, including only deck officers. A total of 55 respondents met the criteria: 8 Masters, 23 Chief Officers, 19 Second Officers, and 5 Third Officers. Out of 55 respondents, 4 % were between 23 and 26 years old, 31 % respondents were between 27 and 35 years old, 36 % of respondents were between 36 and 41 years old, 25 % were between 42 and 52 years old and 4 % respondents were older than 50. As regards education respondents reported that 10 of them has high school degree, 24 college, 20 university degree and 1 PhD. Reported navigating experience of respondents are of less than 3 years of in-service experience (5.5 %), 4 -7 years (20 %) 8-12 years (32.7 %) and more than 12 years of in-service experience (41.8 %). With regard to the number of ships they served on, 5 % of respondents have served on less than 3 ships, 16 % have served on 4-7 ships, 24 % of respondents have served on 8-12 ships whereas 55 % have had experience on more than 12 ships.

The questionnaire consisted of questions concerning the time of handover in their companies, the period needed to familiarise for taking over the watch, the procedure of shipping companies in providing equipment, number of navigational equipment (ECDIS, ARPA, AIS) they have had experience with, number of types of IBS they have had experience with, the maintenance procedures of the bridge equipment, quality of the instruction manuals of equipment they operated, whether they have ever been confused by the data on the system display, usefulness of navigation systems during watch and frequency of fatigue while performing their regular tasks on-board.

Seafarers' answers about time of handover in their companies (Figure 2), taking into account answers for required period of familiarisation to be fully acquainted with equipment, indicate that, in some cases, time of handover is not sufficient to become completely capable for executing their duties. Namely, 53 % of respondents have answered that the average time of handover lasts up to 10 hours while 62 % claim that they need more than one day to familiarise themselves with navigational equipment (Figure 3). This leads to conclusion that during certain period the vessel is underway without proper supervision. The period of handover is limited by time and resource constraints.

However, efficiency-thoroughness trade-offs can lead to accidents. Therefore it is important that sharp end operators communicate with management about this issue.

In order to obtain additional information Spearman rank order correlation was performed (Table1). As can be seen from the values of Spearman rank order correlation coefficients, positive relationships between in-service experience and the period of handover, number of ships sailed, and current rank are observed, as it could be anticipated. Similarly, there is a positive relationship between age and number of ships sailed, current position on-board, level of education and the period of handover. Seafarers with higher rank navigated more ships.

An analysis of the period of handover in dependence of different variables has shown that second officers report statistically significantly shorter time of handover of the Master and Chief Officer. This result is expected, considering their duties and responsibilities on-board.

An analysis of the relationship between length of familiarisation with the navigational equipment with different variables show that there are no statistically significant differences in the length of familiarisation with regard to the length of the sea service, level of education, current position on-board and with regard to the number of ships sailed. Therefore, based on data obtained in this study it could be concluded that operator´s general knowledge and experience are not that much important as quality and number of different types of equipment. However, a more comprehensive research is needed to increase reliability and validity of our findings, and to get a more accurate picture of these relationships.

The fact that only 55 % of respondents have answered that shipping company always uses the same manufacturer

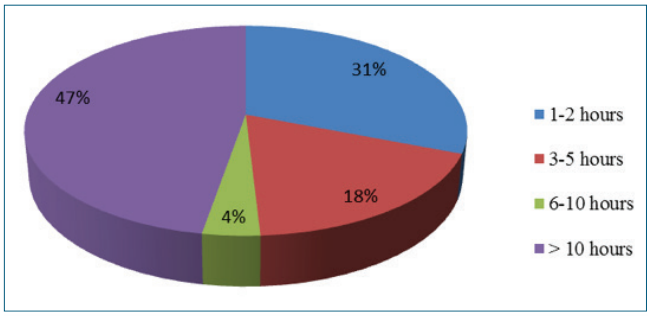

Figure 2.
Answers of respondents on average time of handover in their companies.

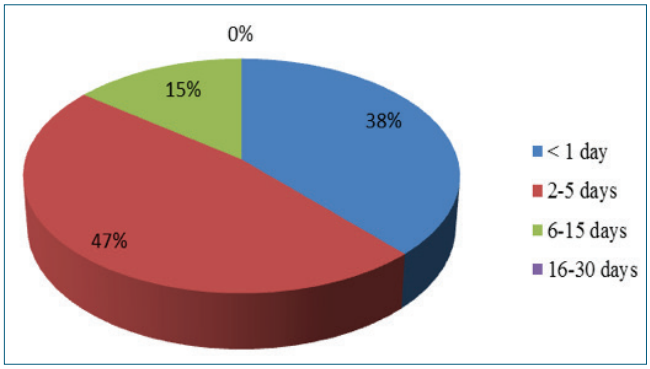

Figure 3.
Answers of respondents on required familiarisation period to be fully acquainted with navigational equipment for taking over the watch.

Table 1.
Relationship between different variables in research.

VARIABLE	Spearman Rank Order Correlations Coefficients							
	Handover	No.of ships sailed	Current rank	Education	Years of sea service	Age	„Confusion“	Fatigue
Familiarisation	0,20	0,00	-0,07	-0,08	0,05	0,18	-0,10	0,11
Handover		0,32	-0,72	-0,13	0,41	0,34	0,02	-0,12
No.of ships sailed			-0,47	-0,31	0,68	0,46	-0,16	-0,06
Current rank				0,18	-0,65	-0,51	0,01	0,14
Education					-0,31	-0,08	0,08	0,15
Years of sea service						0,66	-0,08	-0,18
Age							-0,09	-0,14
„Confusion“								-0,12

(Figure 4) indicates that unstandardized equipment could contribute to the prolongation of familiarisation period.

The share of seafarers which have had some type of experience with more than one type of navigational equipment (89 %) (Figure 5) also shows that problems due to lack of type-specific knowledge could be present.

Similarly, out of 76 % respondents who have had experience with modern IBS, 68 % have been familiarised with more than one type of IBS (Figure 6). These results show that the majority of shipping companies in providing navigational bridges and navigational equipment cooperates with different manufacturers and therefore different workspace and equipment on-board vessels are present. These differences pose an additional problem to seafarers when performing their tasks and could lead to unsafe acts. Therefore, standardisation of important equipment on-board vessels is recommended as a preventive measure. Furthermore, effective deliverance of type-specific training is crucial, taking into account factors which affect learning such as cultural differences, authority gradient and different understanding of technology by users.

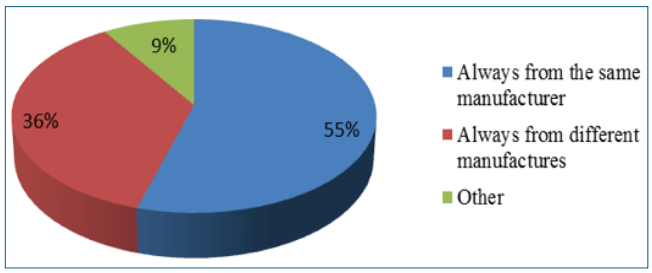

Figure 4.
Answers of respondents about the way companies provide ships with navigational equipment.

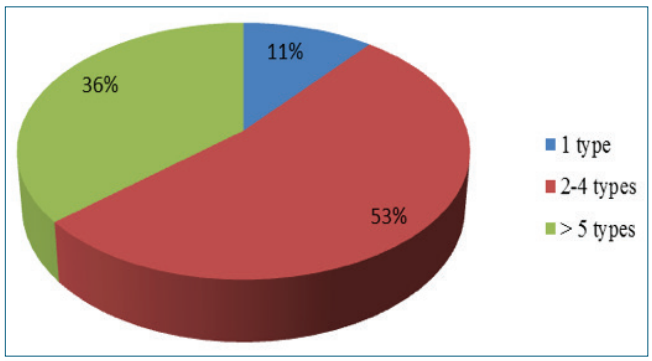

Figure 5.
Answers of respondents on number of navigational equipment (ECDIS, ARPA, AIS) they have had experience with.

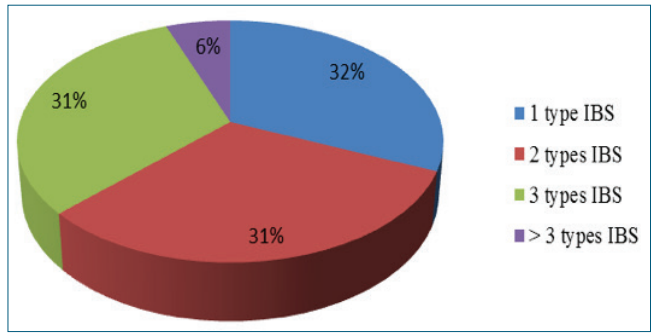

Figure 6.
Answers of respondents on number of types of IBS they have had experience with.

According to respondents' answers bridge equipment is maintained on regular basis only in 60 % cases (Figure 7). Considering its role in safe navigation and importance of functioning properly it is potentially a warning data.

The quality of instruction manuals is an important parameter for the evaluation of technology, especially considering the complexity of modern systems and shortage of time available for grasping it (Figure 8). According to the results, the majority

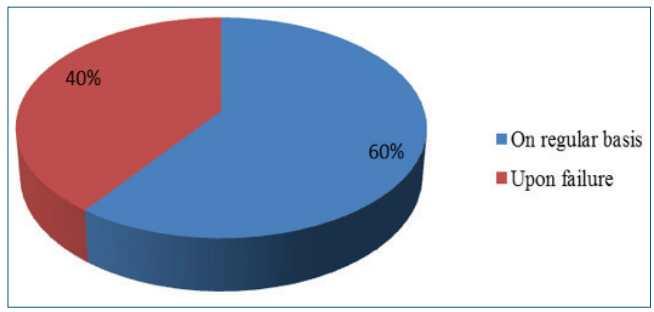

Figure 7.
Answers of respondents about the maintenance procedures of the bridge equipment.

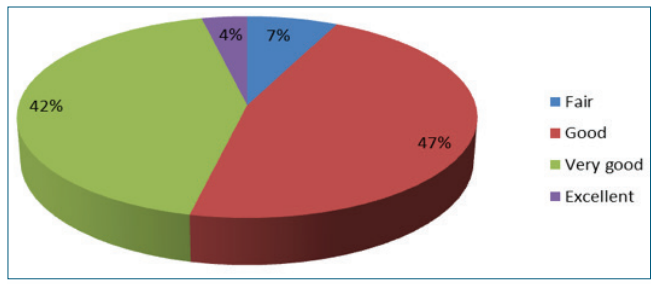

Figure 8.
Respondents' ratings of the instruction manuals of equipment they operated.

of operators finds the quality of instruction manuals satisfying. Option "very bad" was not selected by the respondents.

Technology acceptance variables, perceived ease of use and usefulness are also significant for safety. Therefore it is important to notice that 27 % respondents have been confused by data on display (Figure 9). The reasons for confusion were small display, too much data, poor graphical display, misunderstanding of alarms, and little time provided for the familiarisation with the system.

An analysis of evaluation of HMI with respect to different variables has shown that there is no statistically significant difference in the evaluation of HMI with regard to the age of the respondents, length of the sea service, level of education and current position on-board. This result indicates that technology characteristics, not operator capabilities, could be reason for confusion. This is in accordance with findings by Shorrock and Williams (2016) that collaboration between users and designers is essential and that it should be stimulated by all interested stakeholders. For example, reporting equipment deficiencies by operators should be encouraged.

The dominant rating of technology as useful (Figure 10) suggests that seafarers perceive usage of technology as improvement to decision performance and decision processes. However, the fact that 18 % of respondents have answered that they could not work without navigation system indicates overreliance which could have negative impact on safety. The available options "none" and "not very useful" were not selected by the respondents.

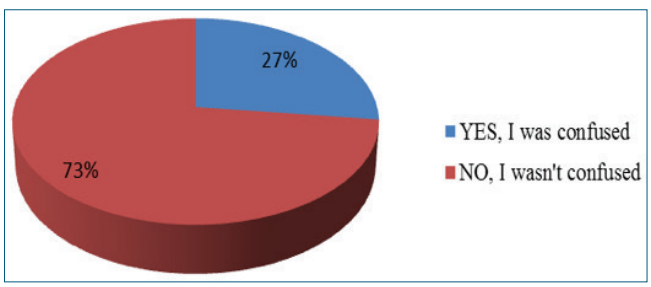

Figure 9.
Answers of respondents whether they have ever been confused by data on the system display.

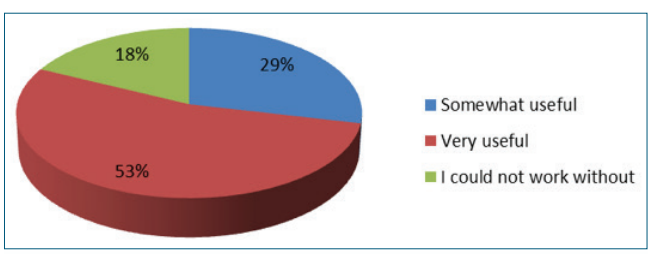

Figure 10.
Answers of respondents on the usefulness of navigation systems during watch.

For ship safety it is important to observe that 15 % of respondents always feel fatigued, and 78 % sometimes (Figure 11). According to our analysis (Table 1) fatigue is not connected with the other studied variables, meaning that crew members, regardless of rank and age can exhibit detriment while performing regular duties. There are many possible reasons including inadequate manning, work organisation, time constraints. One of the reasons could be that technological development is not reconciled with the physical capabilities and limitations of operators. The causes of fatigue should be further investigated.

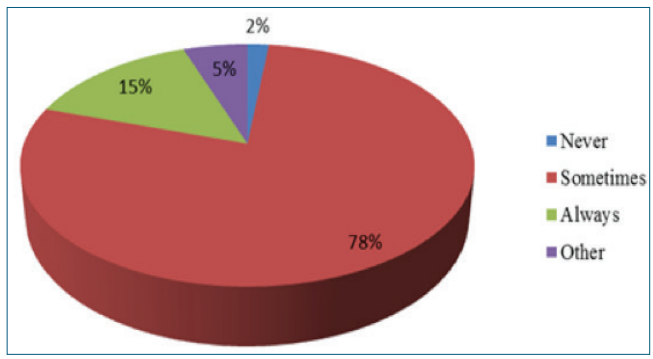

Figure 11.
Answers of respondents on frequency of fatigue while performing their regular tasks on board.

Finally, it should be noted that our results should be interpreted with caution due to the fact that they were obtained with a relatively small sample and should be checked on larger sample, including participants from different cultures. Additionally, there is a potential single source bias. Furthermore, the longitudinal research design is desirable to obtain a proper assessment of the situation. Taking the aforementioned limitations into consideration, this study may present a ground for further research.

5. CONCLUSION

Technological processes and level of automation on-board vessels, which have advanced during the last decade, have placed additional requirements for the smaller crew. Along with changes in work organisation, induced by a need for higher efficiency, technology could contribute to the occurrence of human error.

An analysis of marine accidents has revealed a sort of system performance error, and the following factors have been identified: education and experience of the operator, period of familiarisation with navigational equipment, and characteristics of man-machine interface.

A survey among seafarers, conducted by anonymous questionnaire method, indicates that almost half of respondents encountered a different type of equipment upon embarkation, on the ships of their companies. Also, 40 % of respondents stated that they had met three or more types of integrated navigation bridge during their careers. So many different types of equipment have resulted in almost one third of respondents being confused by the displayed data at some point. The important information is that 40 % of respondents state that navigational equipment is being poorly maintained. Of utmost importance is the fact that half of the respondents stated period of 2-5 days as needed time to adjust to the equipment, in order to be fully prepared to carry out their duties, while the period of handover is substantially shorter.

The results of our study show that present situation, as viewed by ship operators, offers a possibility for dysfunctional interaction between humans and technology. Experiences and attitudes expressed in the survey provide interesting ground for further examination of factors influencing usability of technology. Since quality of this interaction depends on a range of stakeholders (manufacturers, vessel owners, manning companies, regulatory bodies, crew), it is important to understand all issues that can lead to missteps in order to propose comprehensive preventive measures. Therefore, more extended studies on issues related to reducing potential adverse impact of the technology on ship operators are needed. They should include representatives of different stakeholders in order to reduce risk in shipping. If confirmed by further research, our results may have practical implications regarding necessity to involve ship operators in the process of the selection of equipment.

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Port Pricing in the North Port of Split: A Comparative Analysis

Luka Vukić, Ivan Peronja, Merica Slišković

Pricing in ports is an important element of port competitiveness when it comes to the establishment of logistics and transportation systems, determining cargo flows, and developing optimum and quality service. This paper aims to examine the need to modify the port tariff in the North Port of Split through comparison of the tariff system in the main Croatian cargo ports for specific vessel categories and types of cargo. The results were also compared with the port tariffs in the ports of Koper and Trieste to identify shortcomings and suggest potential modifications of individual service prices. The analysis revealed a discrepancy in the segment of port charges, towage and light dues (which account for almost 75 % of the total price), with the latter indicated as a crucial problem in all Croatian ports. Tariff adjustment would eventually improve port competitiveness, with the possibility of expansion to new markets, extension of the gravitational area, and acquisition of additional cargo for the North Port. The inclusion of "environmental charge", with envisaged discounts or additional charges for environmental protection and sustainable development, is essential for the port's strategic orientation and market positioning.

KEY WORDS
~ Competitiveness
~ Pricing
~ Port of Split
~ Sustainable development
~ Tariffs

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1. INTRODUCTION

At the moment, ninety percent of world trade is carried by sea, making ports an indispensable part of the world's economic system. The development of an integrated and sustainable transportation system is inconceivable without ports and the port industry. The high quality of port services, including the optimum price of such services, is an indicator of competitive advantage of ports on a specific transportation route. Among economic criteria, a port's pricing model and tariff policy are some of the dominant if not decisive items influencing ship operator's choice of transportation route and the most suitable port for cargo operations. Since cargo flows are changing rapidly, the objective of the port management and other participants, apart from investments into port infrastructure and services, is to establish a competitive, optimum and attractive pricing system ensuring the acquisition of new cargo.

This paper presents the port tariff systems in the main cargo ports in the Republic of Croatia (Rijeka, Ploče and Split), giving an overview of the complexity of the pricing system and market players involved, with the focus on the cargo Port of Split (North Port). These three ports account for almost 90 % of total freight in Croatia and are positioned as important transit ports for Eastern and Central European markets. Since the tariff system in Croatia differs from port to port, the differences need to be analyzed. An analysis of three observed vessels carrying different cargo into ports has been conducted to emphasize the competitive advantage of each port, with focus on the North Port, identify the shortcomings and suggest potential modifications of the tariff system. All entities operating in the port area are required to adjust their business plans and pricing models to increase cargo turnover in the North Port.

2. ROLE AND SIGNIFICANCE OF PORT PRICING

Seaports are an essential element of supply chains and distribution channels, especially those related to international

trade (Strandenes and Marlow, 2000). Ports are generators of trade (Valantasis-Kanellos and Song, 2015) and their integration into the global economic system is more important and significant than ever before (Dwarakish and Salim, 2015; Berköz and Tekba, 1999), considering that over 90 % of the world trade is carried by sea (IMO, 2017). Ports and the port industry are vital for the development of an integrated and sustainable transportation system, bearing in mind that ports are the centers of economic and industrial activities (Virlanuta et al., 2013) essential for the functioning of the transportation process and transportation services (Jugović, 2012). Pricing by ports and operators within the ports is historically determined (Meersman et al., 2003). Since the purpose of pricing is to stimulate the development and diversification of various services for all beneficiaries with both quality improvement and increased service performance efficiency, the prices and pricing systems are an important aspect of any economy (Virlanuta et al., 2013). When it comes to ports and the implementation of pricing into their strategic plans, pricing is a major factor (UNCTAD, 1995). Depending on market orientation, supply and demand ratio, the intensity and nature of competition, pricing is a contributing factor of company competitiveness (Virlanuta et al., 2013). Given the fact that ports are multi-output enterprises, with the main activity of commercial ports being defined as a chain of interlinked services (Meersman et al., 2010), these services are charged individually and by different parties (Acciaro, 2013). The cost incurred by a port entity needs to be covered through port charges (UNCTAD, 1975). Fees charged by the port authority are port tariffs for facilities and port dues (UNCTAD, 1995). Port services provided by other port entities or operators are the physical assets of the port facilities, such as pilotage, cargo handling etc. Commercial activities are most frequently performed by the private sector and often give rise to competition (UNCTAD, 1975). Pricing in ports is therefore strongly influenced by the structure of the maritime industry and the bargaining power of industry participants (Mchizwa, 2014).

A sizeable number of market players are involved in the creation of the port product value chain, defined as a chain of consecutive links (Suykens and Van de Voorde, 1998). Since the coordination of business activities is an important segment of the overall supply chain, the collaboration between various entities in the port business is essential for a more efficient economy. Various activities in the port, like infrastructure services are mainly provided by port authorities, with cargo handling and other services such as mooring, pilotage, etc. being provided by private enterprises (Dwarakish and Salim, 2015). Third parties like pilots, waste disposal facilities and bunkering companies, towage services, ship repairs and provisioning provide services indispensable for the operation of shipping companies (Meersman et al., 2014).

The demand for goods, requisite for economic growth, industrial production and international trade, is an indicator defined as demand for port calls, port transshipment and supplementary services, and in this sense pricing by and within ports is an important factor (Meersman et al., 2003). Ports play a significant role in the global supply chain as trade facilitators, where pricing is of interest to both academic and business entities (Acciaro, 2013).

Pricing by and within ports should correspond to the costs generated by ships (Meersman et al., 2003). With the growing global trend in the maritime sector and shipbuilding and changes in the demand for cargo and port services, digitalization and sustainability, port's competitiveness and market position can be ensured by the modernization of port services and port infrastructure. The acquisition of new cargo also depends on the quality of the tariff system and transportation service, having either stimulating or destimulating effect on cargo acquisition (Jurjević et al., 2016). Many factors influence the valuation and competitiveness of the transportation route, like geographical position, transportation corridors, transportation flows, transport infrastructure and superstructure, catchment area, competition, transport policy and tariff policy (Jurjević et al., 2016). Economic criteria (price of service) can be concluded to play an essential role in port competitiveness, as well as its attractiveness for cargo and the volume of port traffic. Economic criteria are, apart from qualitative criteria, the main factors of transportation route competitiveness and include port costs and land transportation costs (Poletan Jugović, 2006). These port costs are port charges and consist of: light dues, port dues, pilotage, mooring/unmooring, customs clearance, agency fee, waste disposal, license fee, bank guarantee, towage and miscellaneous (Dundović and Hess, 2005).

3. CURRENT PORT PRICING MODELS

The paper by Acciaro (2013) gives a review of the port pricing literature with various port pricing approaches proposed by authors of the documents. He concludes that the literature is structured around five main themes: strategic pricing, pricing and market conditions, pricing and infrastructure cost recovery, pricing and external costs and empirical studies. Each author has his own approach to the complexity of port pricing whether it is the congestion model of pricing, marginal cost pricing or the UNCTAD reports from 1975 and 1995 which considered pricing a strategic issue.

There are two basic port pricing models: economic and financial. The economic approach refers to port pricing based on marginal cost, considering the effect of users on the port, including benefits (UNCTAD, 1975). The marginal costs system is based on the principle that port users should meet the additional costs they impose on the port (Acciaro, 2013), and enjoys support due to its potential to increase economic welfare (Mchizwa, 2014). Meersman et al. (2003) state that port prices

should be based on short-run marginal costs indicating the precise difference in costs in case of acceptance and refusal of an additional user, while Haralambides et al. (2001) state that long-run marginal costs represent the most useful basis for efficient pricing. In his previous paper (Haralambides, 2000), according to a report by the Academic Expert Group (AEG), states that marginal cost pricing is not as straightforward in ports operating in the competitive environment, whereas full cost recovery, combined with the user pays principle, can form a working basis for fair and efficient pricing. The financial approach is based on accounting costs allowing the port to reclaim fixed and variable costs of providing the facilities and services, while also realizing an adequate return on investment. Simplified, the aim of the financial approach is to generate profit (UNCTAD, 1995). Bearing in mind that most authors state that the inclusion of marginal costs is a prerequisite for efficient port pricing, literature on this approach is rather scant (Haralambides et al., 2001).

The UNCTAD (1995) gives a review of strategic port pricing, a model that can be a very useful tool for achieving the objectives of a port's strategic plan, emphasizing that port charges are related to port objectives.

4. REFLECTION OF CPV APPROACH IN CROATIAN PORTS

The most common approaches to port pricing are provided in the UNCTAD (1975 and 1995) documents indicating pricing as a strategic issue, where the first was based on the economic approach focusing on costs, utilization and what traffic can bear, and the other on the three critical elements: cost, performance and value (CPV), with an emphasis on cost-based tariffs for maximizing port services, performance-based tariffs for maximizing throughput and reducing congestion, and value-based tariffs for generating sufficient revenue to cover port costs. All these elements are incorporated in the term strategic pricing, defined as "the use of pricing as a mechanism for achieving competitive advantage" (UNCTAD, 1995), and indicated as the fundamental part of the implementation of the strategic plan in the port business model. Strategic pricing is based on the principle that cargo and user elasticity in the demand for port services differ depending on prices.

The CPV model offers a wide variety of options for port management to draw up a port policy in the interest of both the port and its users. Furthermore, this approach offers a plethora of options for the allocation of port resources, like limiting pricing by imposing a minimum price or floor limit, where ports are prohibited from charging less than the incremental cost of serving the user and ceiling or maximum limit, forbidding them to charge more than the value received by the user, improving policy and decision flexibility to increase a port's productivity and competitiveness on the market (Meersman et al., 2003).

The CPV approach in the Port of Split is analyzed with the current tariff system in mind. The cost-based pricing is reflected in the recovery of the costs of the port authority and the utilization of facilities and services by users, and divided into fixed, variable and marginal costs depending on cost type (UNCTAD, 1995). An examination of the tariff system in the Port of Split leads us to conclude that the port authority applies cost-based pricing in all tariff system categories, but should strive to improve process efficiency, i.e. cost-based pricing should be reflected, as suggested by UNCTAD (1995), in pilotage, towage, berthing, cargo handling and all other charges, in the framework of both performance and value-based pricing.

Performance-based pricing stresses the importance of efficient and optimum utilization of port assets, taking into consideration both the time of facility usage and user waiting time. The concept is based on the decision to decrease or increase the tariff depending on whether facility utilization is below or above optimum level. The main performance-based pricing charges are berth hire and warehouse charges. Performance-based pricing focuses on increasing the productivity of port operators, anticipated to boost port efficiency and throughput (UNCTAD, 1995). Due to its unenviable market position, the Split Port Authority offers a variety of options in the context of performance-based pricing, like convenience in the extension of the amount of time cargo can be stored in transit warehouses and granting rebates to vessels which commence with cargo operations immediately after berthing, but likewise imposing additional charges or fines for delays. A detailed analysis of the above-mentioned issues should be conducted, since they are dependent upon different influences, like the quality of equipment and operational possibilities in the port, and market conditions.

The objective of value-based pricing is to generate sufficient revenue to cover all costs incurred during service and facility provision, while simultaneously estimating the port users' willingness to pay the requested price. The concept is based on the reaction of port users to price changes, and is known as price elasticity (UNCTAD, 1995). Tariff level changes have an impact on entrepreneurs mainly in the sense of logistical costs and final price of the product. The pricing system policy in the Port of Split needs to be stimulating to keep the existing customers, especially considering the availability of alternative transportation routes concentrated in the ports of Rijeka and Ploče. Bearing in mind the relatively limited market in the gravitational area of the Port of Split and consistent mobility and connectivity issues, mostly due to the condition of railway transportation, the characteristics of user demand should be taken into account when defining charges, in order to allocate benefits and achieve price elasticity. The value-based tariffs are mainly port charges on ships and cargoes (UNCTAD, 1995). These charges are differentiated depending on vessel and cargo types (container, dry bulk, etc.) as is the case in the Port of Split.

5. COMPARISON BETWEEN PORT PRICING IN CROATIA AND WORLDWIDE

Global trends in pricing in ports are very similar to those in Croatia. Basic charges for the use of port services prevail in most countries, varying only in the charge type and terminology. The state, along with port authority and other entities operating in the port area, depending on the port management model, can recommend, based on the principles of sustainable development, the application of a specific charge in its area of jurisdiction. This charge can refer to discounts or additional charges depending on environmental protection, especially air pollution level, the use of older or new technologies (type of fuel), construction of the vessel and other criteria. This "additional" charge aims to ensure competitiveness and stimulate investment into and modernization of port facilities and services, while simultaneously facilitating throughput in congested ports. Likewise, this charge is used by ports with the strategic purpose of being positioned on the market as an "eco-port" or "eco-friendly", with the special care and contribution to the environment, creating a brand and raising the awareness of environmental protection. The environmental component prevails in the calculation of surcharges or discounts on the basic price, and according to the literature and examples worldwide, is expected to become the leading indicator in the future, both for the port management and for shipping companies. The port of Gothenburg is an example of good practice, where environmental discounts are granted to vessels registered in accordance with the CSI (Clean Shipping Index) and ESI (Environmental Ship Index), namely a 10 % discount on port charges, depending on GT (gross tonnage), and a 20 % discount on port charges for vessels to LNG-powered vessels, depending on GT, if LNG is installed (Port of Gothenburg, 2017). The Port of Rotterdam likewise recognizes the importance of improving environmental performance, safety and quality, offering discounts for various scenarios, e.g. having a green award certificate, in the form of 6 % discount on port charges already paid, 10 % discount on port charges dependent upon GT-size already paid, discount on the ESI score of more than 31 points, agribulk discount depending on the number of vessel port calls, second call discount for seagoing vessels in deep-sea service, various transshipment and other discounts (Port of Rotterdam, 2017). The Port of Hamburg introduced a new fee rating system featuring an environmental component, categorically calculated and based on International Air Pollution Prevention (IAPP) certifications, i.e. environmental impact. In practice, vessels without IAPP certificate or with poor emission levels have to pay surcharges on the regular (basic) price, and are granted discounts when rated very clean based on the IAPP certificate (Port of Hamburg, 2017). In the framework of the ECHO program, the Port of Vancouver offers a discount for the protection of mammals (whales) and the prevention of potential threats in the form of acoustic disturbance (underwater noise), physical disturbance (ship collisions), environmental contaminant and others (Port of Vancouver, 2017). Furthermore, in 2017, the Russian Ministry of Transportation introduced special investment charges in national seaports dependent upon the vessel's GT with the aim of investment into construction and development of state-owned facilities in seaports, imposed on all cargo vessels calling in Russian seaports (Port today, 2017). Additional charges can also be imposed on safe passage, like in the Suez or Panama Canals, where vessels are obligated to meet the costs intended to compensate the investment into infrastructure and superstructure to the states having jurisdiction of the area.

As already mentioned in the previous section, these compulsory charges and the charges for the use of port services, are similar in the vast majority of ports, so we can talk about a unique or standardized model of charges, differentiated only by additional charges characteristic of a specific port or area, and business policy based on sustainable development. The initiatives of institutions like BIMCO and FONASBA (BIMCO, 2017) to standardize the format and contents of port charges support this statement and provide useful information both for the ship owners and ship agents.

All these additional charges represent different pricing system options used worldwide, and it can thus be observed that the Croatian pricing system is in line with global trends. The potential possibilities are enormous and manifested by the introduction of additional costs, potentially in the field of environmental protection and sustainability of coastal area, supported by sustainable development strategies at the national and transnational levels.

6. PORT PRICING IN THE NORTH PORT OF SPLIT

In the Republic of Croatia, port authorities are public non-profit institutions in 100 % ownership, in charge of the management of Croatian ports (Krčum et al., 2015). Port authorities are tasked with the management, construction and maintenance of the port area, the organization of port services and awarding concessions to port operators providing port services (Jugović, 2012).

Pricing in ports in the Republic of Croatia is a complex system, with maritime logistics and transportation chain being characterized by numerous participants, each striving to operate efficiency and sustainably on the market to raise their profitability and ensure growth. The port tariff system is created and harmonized with the involvement of all stakeholders, to ensure competitive advantage and increase a port's attractiveness for new cargo and markets.

A review of entities involved in the process of vessel arrival and departure in the Port of Split is shown in Figure 1. Indirectly, the figure gives a clear overview of involvement of numerous stakeholders in the transportation chain offering their service in a "user pays" system.

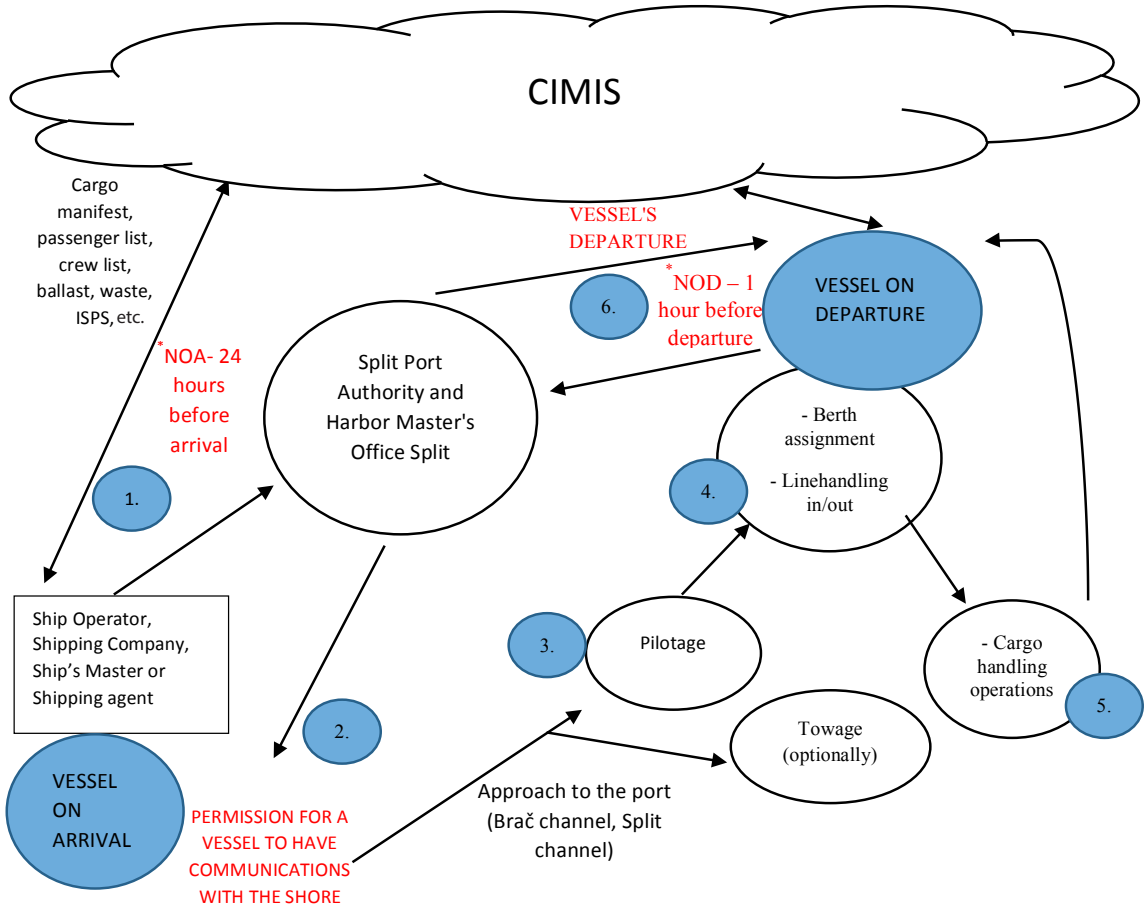

Figure 1.
Entities involved in the vessel arrival/departure procedures in the Port of Split.

All entities participating in this process, apart from the Harbor Master's Office as a constituent part of the Ministry of the Sea, Transport and Infrastructure, are service providers charging their services. It is important for the ship's operator to efficiently coordinate all the necessary procedures to reduce potential waiting time and additional costs. Any vessel planning a call to the Port of Split is obligated to submit the Notice of arrival (NOA) to the Port Authority and the Harbor Master's Office in Split at least 24 hours before arrival. Following the completion of the evaluation process, the Harbor Master's Office issues a permission for the vessel to communicate with the shore, enabling the vessel to continue with its primary operations depending on the nature of the transportation (passenger or cargo). Having obtained the permission, the vessel is obligated to use pilotage services to ensure its safe entrance into port and optionally towage services, at the Harbor Master's discretion. The Port Authority, within its jurisdiction, assigns berths to vessels, while other entities initiate the provision of their own services like line handling operations, cargo handling operation, waste management, etc. Following the completion of necessary operations in the port of call, on departure, the vessel is obligated to submit Notice of departure (NOD) to the Port Authority and the Harbor Master's Office which, after the completion of the evaluation process, issues the permit for the vessel's departure. It is important to emphasize that all the required documents (passenger list, crew list, waste, ballast water, etc.) have to be entered into the Croatian integrated information system (CIMIS) facilitating the administration process and database creation.

Since the tariff model in the Republic of Croatia is not unified, each port, governed by the port authority, is responsible for its tariff system and defining port prices relying on different indicators like the quantity of traffic or market condition, feedback from port users and operators, third party service providers, etc. The aim of the port authority, as a public non-profit institution, is to recover its investments, and collect all revenue from the use of facilities and services in the form of concessions and port

charges which is then reinvested into port infrastructure and superstructure as well as into the improvement of port services, modernization and maintenance of the port area to achieve competitive advantage in the Adriatic and its gravitational area of interest. So, the Croatian and Port of Split's tariff systems can be concluded to be based on four principles: competitiveness, cost recovery, required revenue and the "user pays" principle. The individual items are shown in Table 1.

Table 1.
Port service charges in the Port of Split.

ACTIVITY	SERVICE	SERVICE PROVIDER	SERVICE USER/PAYER	CHARGING UNIT
1. PORT SERVICES				
Launching	clearance at anchorage	Private company	Shipping line	- GT (gross tonnage)
Pilotage	assistance for vessels entering/leaving port	Private company (Pomorski peljar d.o.o.)	Shipping line	- basic tariffs based on GT (gross tonnage)
Towage	assistance to vessels entering/leaving port	Private company (Brodospas d.d.)	Shipping line – optional	- per service (hour), based on GT (gross tonnage)
Berthing services	services to tie/untie vessels at berth	Private company (Legio Quarta)	Shipping line	- GT (gross tonnage)
Port dues	demurrage	Split Port Authority	Shipping line	- by day (whole day) and vessel length (m)
	berthing fee			- vessel length (m)
	wharfage			- loaded/unloaded ton of cargo - embarked/disembarked passenger/vehicle
Port fees	services for port users (soft and liquid waste disposal, cargo loading and unloading, warehouse storage etc..)	Port concessionaires	Shipping line	- per service (various)
2. DUES AND TAXES				
Light dues	the use of navigation safety facilities in Croatia	Government (Plovput d.o.o.)	Shipping line	- unit measurement for all vessels is GT (gross tonnage)
Customs charges	clearance on arrival/ departure	Government	Shipping line	flat rate (different for vessels performing the commercial and non-commercial operations) per service
Various (Immigration permits, ISPS, ASBAC fee etc.)	each vessel calling to Croatian port	Government	Shipping line	per service (flat rate)
3.AGENCY CHARGES AND EXPENSES				
Agency costs	agency fee for user services	Shipping agents	Shipping line	per service (job)
Other expenses (car for authorities, bank charges, telecomm. / miscellaneous etc.)	various	Various	Shipping line	per service (flat rate)

The pricing system in the Port of Split, is based on Port Authority's charges in the form of port dues and charges imposed by concessionaires providing services to port users in the form of port fees. Port dues are divided into three segments: wharfage, demurrage, and berthing charges, and represent the revenue of the Split Port Authority. Wharfage dues are paid by vessels using the port for embarkation or disembarkation of passengers, vehicles, and cargo loading/unloading. The unit of measurement for wharfage dues calculation is loaded/unloaded ton of cargo (whole tones only) and embarked/disembarked passenger or vehicle. For cruisers, the unit of measurement is gross tonnage and charges depend on the number of passengers and crew. Demurrage is paid by ships staying in ports for any purpose other than embarkation or disembarkation of passengers, and/or loading/unloading of cargo. The units of measurement for demurrage dues are day (whole day only) and vessel length in meters (m). Berthing dues are paid by the owners of fishing ships, yachts, fishing and sports boats, other types of boats and floating objects (Split Port Authority, 2017).

Port fees are charged for services provided by port concessionaries operating in the port area. In publicly open ports like the Port of Split, concessionaires are obligated to publicly announce the fees for each particular activity or service. These fees include charges like fumigation, deratization, control and quality of goods, solid and liquid waste disposal, mooring and unmooring of vessels, yachts, fishing and sports boats, other types of boats and floating objects, water and electricity supply, cargo loading and unloading, warehouse storage and others.

To achieve and maintain the port's competitiveness, the port authority may modify its tariffs (port dues) and offer a wide variety of discounts for a number of ships' ports of call, like in the case of the Port of Split, in order to adapt its business to increasing market demand. Usually, they negotiate with longtime customers, and customers having long-term agreements and contracts (Jurjević et al., 2016). It is essential for the Split Port Authority to establish a favorable relationship and communication with the concessionaires having discretion in the creation of their own tariffs (fees). It is important for the port's progress, development and competitiveness, for all entities in the port area to harmonize their business strategies and invest in the port facilities and services to attract more vessels and cargo.

Vessels entering the Port of Split are obligated to pay "compulsory charges". These charges are imposed on every vessel regardless of the nature of mobility or type of cargo. The first is the light fee or fee for the use of navigation safety facilities, which is paid depending on gross tonnage (GT) or vessel type on the monthly or yearly basis, depending on the number of the vessel's ports of call. This charge is obligatory for every vessel entering the Republic of Croatia. Other charges are port charges as mentioned above, divided into quay dues, wharfage and berthage charged depending on the type of the vessel, pilotage, mooring/unmooring services, administration costs, agency fees and others. In some cases, mainly in the case of bad weather conditions at sea and depending on the agreement of the pilot and the ship's captain, the vessel may use the services of a towage company.

7. COMPARISON OF PORT TARIFFS IN THE MAIN CROATIAN CARGO PORTS

The analysis of the tariff systems in the main Croatian cargo ports of Rijeka, Ploče, and Split based on vessel type and type of cargo, is provided according to the model made by Jurjević et al. (2016), with some deviations. Here is the analysis of three vessels, carrying different cargo, indicating pricing policy methods and differences and emphasizing competitive advantage of each specific port with focus on the North Port (Port of Split). In order to improve port competitiveness and attract more cargo, shortcomings are identified and potential modifications of the tariff system proposed. Since these three ports account for almost 90 % of the total freight transportation in all Croatian ports (Ministry of the Sea, 2017), the analysis is necessary for the evaluation of the current state of pricing in ports, especially in the Port of Split.

The analysis is based on port charges for vessels performing commercial activities within the port area. Each service is charged in compliance with existing regulations, so that the total price is the sum of port tariffs for each individual vessel obligated to compensate the use of port activities and structures. All prices also contain a projection of overtime (additional) work required to perform the activities and are increased depending on requirements and conditions in the port (e.g. number and working hours of tugboats) and, for the purpose of this paper, based on publicly available tariffs and the experience of port agents in the determination of prices for each individual vessel. The comparison of the tariff systems used in main Croatian cargo ports is provided in Table 2. Individual tariffs, taken for the purpose of this analysis, are publicly announced for each particular activity or service and are not completely reliable in this form since they do not account for direct negotiations between service providers and customers mainly resulting in lower rates granted on the basis of long-term agreements and market conditions. Likewise, it has to be noted that vessel and cargo types have been chosen only to indicate the fluctuation of port charges, without taking into consideration the actual limitations in main Croatian ports with respect to vessel length and draft. In reality, the third vessel unloading 80.000MT of coal would be unable to enter the ports considered in this analysis, due to the draft of 15m, considering the limitation of vessel draft in the Port of Ploče to 13.8m, Split to 10.2m and Rijeka to 11.8m (Dundović et al., 2012). However, the obtained data are clearly indicative of the situation, as intended by this analysis, primarily in the port tariff system. The analysis

Table 2.
Port charges for general cargo vessel (1), bulk (grain) (2) and bulk (coal) carrier (3) in the ports of Split, Rijeka, and Ploče (€).

Cost-type	Port	SPLIT	%	RIJEKA	%	PLOČE	%
	Vessel						
launch boat	1	202.50	2,6	202.50	2,9	202.50	2,4
	2	202.50	0,6	202.50	0,8	202.50	0,5
	3	202.50	0,3	202.50	0,3	202.50	0,3
pilotage	1	352.50	4,5	352.50	5,0	352.50	4,2
	2	1,307.50	4,2	1,307.50	5,0	1,432.50	3,5
	3	2,762.50	4,1	2,762.50	4,4	2,887.50	3,6
towage	1	1,006.88	12,8	661.71	9,4	1,006.88	11,9
	2	5,219.50	16,6	3,440.84	13,3	3,814.25	9,2
	3	15,882.81	23,5	8,244.43	13,1	15,882.81	20,0
line handling	1	69.75	0,9	245.63	3,5	337.50	4,0
	2	261.00	0,8	1,415.25	5,5	1,334.50	3,2
	3	629.10	0,9	3,442.73	5,5	3,244.50	4,1
port charges	1	3,000.00	38,1	2,310.00	33,0	3,270.00	38,7
	2	13,500.00	42,9	8,640.00	33,3	23,490.00	56,9
	3	26,400.00	39,0	26,400.00	42,0	35,200.00	44,4
light dues (valid for 30 days)	1	1,497.12	19,0	1,497.12	21,4	1,497.12	17,7
	2	7,764.34	24,7	7,764.34	29,9	7,764.34	18,8
	3	16,612.46	24,5	16,612.46	26,4	16,612.46	20,9
customs charges	1	300.00	3,8	300.00	4,3	300.00	3,6
	2	350.00	1,1	350.00	1,3	350.00	0,9
	3	350.00	0,5	350.00	0,6	350.00	0,4
immigration permits, ISPS, ASBAC	1	195.00	2,5	195.00	2,8	195.00	2,3
	2	195.00	0,6	195.00	0,8	195.00	0,5
	3	195.00	0,3	195.00	0,3	195.00	0,3
agency fee	1	1,000.00	12,7	1,000.00	14,3	1,000.00	11,9
	2	2,200.00	7,0	2,200.00	8,5	2,200.00	5,3
	3	4,000.00	5,9	4,000.00	6,4	4,000.00	5,0
waste disposal	1	116.00	1,5	124.00	1,8	150.00	1,8
	2	116.00	0,4	124.00	0,5	150.00	0,4
	3	116.00	0,2	124.00	0,2	150.00	0,2
bank charges (0,6 %)	1	46.92	0,6	41.81	0,6	50.35	0,6
	2	187.51	0,6	154.65	0,6	246.41	0,6
	3	403.92	0,6	374.90	0,6	473.37	0,6
others	1	80.00	1,0	80.00	1,1	80.00	1,0
	2	135.00	0,4	135.00	0,5	135.00	0,3
	3	170.00	0,3	170.00	0,3	170.00	0,2
TOTAL (€)	1	7,866.67	100	7,010.27	100	8,441.85	100
	2	31,438.35	100	25,929.08	100	41,314.50	100
	3	67,724.29	100	63,858.52	100	79,368.14	100

was conducted for the following categories of vessels and types of cargo, for services in the ports of Split, Rijeka, and Ploče:

- general cargo vessel discharging 3,000 tons MT[1] of certain general cargo composition (coils). Vessel's features - GT[2]: 3,119; DWT[3]: 3.500; LOA[4] (m): 88.00; Dft[5] (m): 5.80
- bulk carrier discharging 27,000 tons (MT) of grain. Vessel's features - GT: 17,973; DWT: 28,000; LOA (m): 165.00; Dft (m): 10.00
- bulk carrier discharging 80,000 tons (MT) of coal. Vessel's features - GT: 47,717; DWT: 80,300; LOA (m): 229.00; Dft (m): 15.00.

The analysis of three categories of vessels carrying different cargo demonstrates a significant fluctuation of port charges in the main Croatian ports. According to the results of the analysis, the Port of Rijeka is in more favorable position and more competitive, offering lowest overall port charges for services in the port area for the general cargo carrier, grain bulk carrier and coal bulk carrier, judging by vessels chosen for this analysis. It is followed by the Port of Split (North Port) and the Port of Ploče as the port with the highest total price for each vessel. Whilst the discrepancy for the general cargo carrier is the lowest, notable difference can be found in the case of grain bulk vessel and coal bulk vessel. The collected data suggest that over 50 % of the total price of port charges for vessels considered in this analysis pertains to port charges and light dues, which are slightly lower in the Port of Rijeka. Larger differences can be found in almost every segment of overall port tariffs. Line handling charges are lowest in the Port of Split. The discrepancy between these charges evidently increases with vessel size, up to four and five times in magnitude among the ports considered. It has to be noted that the calculation of these charges isn't unique and standardized in Croatian ports. Prices for towage services, an optional service for vessels calling into Croatian ports, are slightly lower in Rijeka, charges for pilotage services are similar, as are other charges considered for the purpose of this analysis, like solid waste disposal charges or charge for the launch boat as a control for a vessel at anchorage.

In general, the differences between port tariff systems in Croatian ports depend on several factors. Firstly, the legacy from the past, the elements of port tariffs once created are retained regardless of the changes in fee level or changes to cargo structure and type. Secondly, the difference in the structure of cargo in ports results in the absence of certain categories of cargo and cargo with no relevance, including of corresponding specific fees, while other ports realize turnover from specific types of cargo, and impose specific or specially differentiated fees introduced in line with the business policy of individual port authorities (an effort to attract or stimulate certain types of traffic into a particular port).

Port authorities, apart from support at the highest, strategic levels in Croatia, should obviously consider elements other than port charges, imposed on vessels calling in ports of national interest. This applies not only to the prices of mooring and unmooring (also water and electricity supply, waste disposal, etc.) but especially to light dues, towage and pilotage charges. Light dues for cargo vessels rarely calling at Croatian ports (light dues vary from monthly to yearly with specific indexes multiplied by the vessel's GT) are obviously the most significant constituents of the overall price of port call where they account for a disproportionately large segment of total costs (in this paper more than 20 % of the final price), and should thus be taken into account in the future plans for the modernization and modification of the tariff system.

8. COMPARISON OF PORT TARIFFS IN CROATIAN PORTS AND THE PORTS OF KOPER AND TRIESTE

The comparison of results of this analysis presented in Table 3 provides an overview of the current state in the segment of port tariffs in the main Croatian ports and the ports of Koper and Trieste.

This comparison is conducted under the premise that the overall price charged at the port of call is the decisive element of competitiveness, neglecting the actual size of the port and its capacity to accept cargo. The results of the comparison are unfavorable for all Croatian ports, which have almost two to three times higher total costs. The difference is present in almost every segment of port tariffs, especially in the segment of light dues, with the ports of Koper and Trieste, apart from their geostrategic location, modernized port mechanization and facilities and road and railway connectivity, also having competitive advantage in the segment of the overall price of services in comparison with Croatian ports. Likewise, the overall price for the third vessel carrying coal, regardless of the modified and lower vessel specifications (vessel GT, taken into account in case of Croatian ports, is two times lower than in Koper and Trieste, and the volume of discharged cargo lower by one third), points to a large discrepancy between the observed ports and their tariffs, making the Koper and Trieste transportation route more competitive and favorable than Croatian ports. The presented results suggest that the current tariff models used in Croatian ports have to be modified to become more favorable for vessels and cargo owners, which will in turn result in increased cargo turnover and raise competitiveness in the Adriatic. If the mechanism of lower overall price is employed, the potential for exploiting new markets and changing traffic flows, given the same quality of service, is considerable and realistic.

1. *Metric ton*
2. *Gross tonnage*
3. *Deadweight tonnage*
4. *Length overall*
5. *Draft*

Table 3.
Comparison of port tariffs in main Croatian ports and the ports of Koper and Trieste for chosen vessels (€).
(Source: Author's own data; Jurjević et al., 2016; modified)

VESSEL	SPLIT	RIJEKA	PLOČE	KOPER	TRIESTE
1	7,866.67	7,010.27	8,441.85	5,051.00	4,336.00
2	31,438.35	25,929.08	41,314.50	15,897.00	14,550.00
3*	67,724.29	63,858.52	79,368.14	67,071.00	41,160.00

*comparison not relevant due to modification in the specifications of the third vessel

9. THE COMPETITIVENESS OF PORT TARIFFS IN THE NORTH PORT OF SPLIT AND POTENTIAL DEVELOPMENT GUIDELINES

With the current tariff system and pricing mechanism, the Port of Split and the Split Port Authority, the managing body of the port, are in subordinate position to their Rijeka counterparts. The pricing policy in the Port of Rijeka, imposing the lowest charges as demonstrated in this analysis, can be explained by the port's favorable geostrategic position in the north Adriatic and the vicinity of all the main corridors in the area, the Pan-European Corridor Vb, the Mediterranean Corridor, the Baltic-Adriatic Corridor, as well as of the national road and railway connections, especially with Zagreb, and railway connection to Serbia, serving as gateways to northern and eastern European markets. The port's management has also obviously recognized how these advantages can be used and further exploited with the proper pricing policy. The highest price in the Port of Ploče can be substantiated with the general characteristics of the port like the size of the port area, terminal capacity with cargo handling equipment, favorable maximum allowed draft, and other advantages like its geographical position often referred to as the southern gate of the Pan-European Corridor Vc and orientation on vessels carrying bulk. In addition, only the Port of Ploče could "possibly" accommodate the bulk carrier unloading coal, having the draft of 15m, considered in this analysis only for the purpose of calculation of port charges.

The Port of Split should focus on the acquisition of cargoes convenient considering its natural position, the current state of its infrastructure and superstructure, current and potential new markets, bearing in mind that the Port of Split (North Port) with accompanying basins realizes the total annual turnover of 3.2 million tons and is ranked second in Croatia (Ministry of the Sea, 2017). This result deserves respect and support from the competent institutions. Competitive advantage can only be realized if charges for vessels and cargo owner imposed by the port authority and its concessionaires are modified and made cost-effective both for the port and port users. The discrepancy is mainly seen in towage, port charges and the high share of light dues (these three charges combined account for almost 75 % of the total price), which is a crucial problem in all Croatian ports. Port tariff modifications are intended to create a policy which would attract more general and bulk cargo by offering lower rates for vessels, bearing in mind the steadily increasing container transportation over the last couple of years (Luka d.d., 2016). Incorporating rebates and discounts for vessels performing cargo activities immediately after berthing and granting benefits in the form of extended period of storage time in warehouses is hugely important. The modernization of existing road and railway connectivity is crucial for the port to be able to provide a reliable intermodal connection. The tendency to deepen the port basin to make it suitable for accommodating vessels with the draft of up to 12 meters, has to be supported by the decision to modify the port tariff to make it favorable for all participants in the transport chain.

An increase in the freight transportation volume in the Port of Split is recommended to be realized by complying with EU development strategies pertaining to environmental protection and sustainability. Considering its unfavorable market position and geographic location, outdated infrastructure, especially in the segment of railway connections and limited space for potential expansion, the port is recommended to be developed on the principles of sustainability and introduction of environmentally friendly technologies focusing on the reduction of air pollution, noise and other segments of external costs. The absence of increment in cargo turnover and unfavorable economic conditions in Croatia and its surroundings have to be overcome by strategic orientation on earning the status of an eco-friendly port, which is of outmost importance for the North Port of Split. Competitiveness could be improved by introducing stimulating tariffs for eco-friendly vessels, lower than the minimum price or floor limit, which would be compensated by the increased volume of overall vessel ports of call and activity. This environmental discount would be granted for the utilization of alternative fuels reducing air pollution (e.g. LNG, batteries), scrubbers for the reduction of harmful emissions, ballast water treatment technologies or noise reduction, and calculated on the total price of the port tariff. All profit generated from

increased turnover of 'green' vessels would be reinvested in the introduction of new technologies into the port, like control of emissions responsive to changes in the composition of air, noise levels and water quality, the implementation of "cold ironing", technology based on onshore power supply and shore hookups allowing vessels to connect to the local power supply network, investment in port mechanization using alternative fuels or the installation of liquefied natural gas (LNG) facilities to supply ships in the North Port. Special attention is recommended to be paid to air pollution and emissions, and the introduction of emissions related discount, as an incentive to use cleaner technologies, for vessels that perform better than required by the International Maritime Organization (IMO) emissions standard Environmental Ship Index (ESI), or to participation in environmental protection programs like the Green Award certificate program. This program rewards high safety and environmental standards in shipping, making ship operation more economically attractive, and is held in high regard in important European ports like Hamburg and Rotterdam (Green Award, 2009) which offer a considerable reduction on port charges for vessels holding the certificate. The introduction of this incentive and its program, intended to reduce the overall port tariff, should decrease costs for vessels, increase the number of vessels calling at the North Port of Split, strengthen the port's market position as an eco-friendly port and increase its competitiveness.

Simultaneously, tariffs for cruisers could increase. High external costs of cruising justify this approach (Slišković et al., 2017). This additional cost should fall at the expense of passengers. The current fee per passenger in transit on a cruiser is € 0.91, and the proposed fee should increase to e.g., € 1.91, with the difference of 1 € being included in the price of travel on a cruise liner. The average revenue would amount to approximately € 1200-1500 per cruiser, or close to € 300,000 annually for 237 cruisers calling in the Port of Split in 2017 (Split Port Authority, 2017). This revenue would compensate for eco-discounts granted to cargo vessels, with the above-mentioned revenue of approximately € 300,000 being equivalent to 10 freight vessels free of charge, 20 vessels with 50 % discount, 40 vessels with 25 % discount or 50 vessels with 20 % discount given the average tariff price of € 30,000. It would result in the arrival of 50 additional vessels, one per week, with the discount of 20 % on the total tariff price, with the potential for further increment in the number of vessels calling at the North Port of Split. In this way, the Port of Split wouldn't deny entry to cruisers, cruisers would not be burdened with additional expenses, the demand would remain the same knowing that the cruising passenger and vessel flows are created by cruise lines based on different factors on the market, taking into account passenger demand and attractiveness of the destination, and the Port of Split would strive to increase and improve freight transportation with proper development as indicated in the Transportation Development Strategy of the Republic of Croatia 2017- 2030 (2017).

The analysis presented in this paper and the analysis provided by Jurjević et al. (2016) indicate that there is a large discrepancy between light dues in Croatian ports and the ports of Koper and Trieste. In spite of the fact that cargo flows and selection of a specific port depend on a variety of market conditions, it is crucial for the Republic of Croatia to lower the light dues for cargo vessels engaging in commercial activities in the North Port, to increase overall competitiveness, especially in the segment of port tariffs, and attract additional cargo.

10. CONCLUSION

The amount of port charges can be considered to be an encumbrance for business activities in ports, decisive for the level of competitiveness of individual ports and the overall port system. Determining the optimum port tariff level in the North Port of Split is a sensitive issue, especially since it requires the establishment of an equilibrium between maintaining competitiveness and providing the necessary resources. The potential of the North Port is indisputable and recognized in the Transport Development Strategy of the Republic of Croatia. Consequently the modification of the port tariff imposed by all entities offering services in the port, especially in segments of the overall price burdening the vessel, and aiming to achieve cost-effectiveness, is essential both for the port and port users. This would result in an increase in cargo turnover and the number of vessels calling in port, with a special emphasis on the possibility of improving competitiveness by introducing environmental charges in the North Port of Split. The value for money stemming from the provision of services of reliable quality at reasonable expense is important for users. Furthermore, the modernization of existing infrastructure and labeling the port as eco-friendly due to the introduction of green technologies based on the principle of sustainability would increase the port's competitiveness and cargo turnover.

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Some Issues Referring to the Management of Beaches at the Local Level - Case Study of Croatia

Mirjana Kovačić, Astrid Zekić

The authors based the research on the main topic that a beach is more than a strip of land dedicated to tourists for their leisure activities. In order to achieve this, beaches have to be developed in regard to the surrounding landscape and the needs of the local community.

The main focus of the research is on local and guests' perspective of beaches, thus results highlight important issues in this relationship which may enable improvements in beach managing.

The purpose of this paper is to analyse the interdependence between sustainable beach managing and local/tourist needs and satisfaction.

The goal of this paper is to propose a model of sustainable beach managing that has a direct impact on development processes of the beach.

Research methodology includes an overview of recent projects and references and as a result it helps to understand why it is important that beaches should have sustainable managing. One of the important project goals is to differentiate different beaches and their main attractions as well as their adaptation to a particular target group and the emergence of new forms of specific thematic beaches.

KEY WORDS

~ Beach
~ Tourists
~ Local community
~ Sustainable beach managing

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1. INTRODUCTION

Beaches are one of the most important coastal resources and as such they require a holistic approach in managing. Today, beaches in Croatia are a resource whose development is more or less successfully managed by regional and local authorities.

When the first seaside resorts opened in the 18th century (Holloway, 2006) and when they started to expand in the 1840s, the growing interests in seaside resorts meant also an increase in research activities. First research papers were published in England where the culture of the seaside vacation was the most established one. Other well-known European destinations, such as the Mediterranean coast in France and Spain, also gradually attracted the researchers' interest. Researchers focused at first upon geographical and geomorphological changes at the side landscape (Cendrero and Fischer, 1997; Cicin Sain and Knecht, 1998; Defeo et al., 2009; Williams and Micaleff, 2009) and later the interest gradually extended to socio-economic aspect as well (Jovičić and Dragin 2008; Kovačić et al., 2013; Marković et al., 2010), including tourism which ranged from purely economical to sustainable and gradual to interdisciplinary researches, by combining different scientific fields (Kovačić et al., 2010; Ozhan, 1996).

However, beach managing is still an open question. It depends upon different variables. Some researchers (Botero and Hurtado, 2009; Jovičić and Dragin, 2008) think that the carrying capacity is one of the most common tools for beach managing, while some others (Botero and Hurtado, 2009) highlight beach user density as the most important variable. Finally, most researches assert that good managing includes beach evaluation.

This research provides a new point of view as it clarifies the relationship between the role of all stakeholders, the public administration, local communities, tour operators, spatial

planners, and the others aiming at sustainable beach managing, as well as the tourist satisfaction.

2. MATERIALS AND METHODS

Nowadays, the value of a beach cannot be measured only by its natural assets. Tourist's demands are on the increase and they except places where they can create their own experiences by activating their own networks and resources (Gnoth and Jaeger, 2007).

There are multiple beach evaluation methods that can be used to evaluate natural and cultural (Markelj et al. 2014; Micallef, 1996), as well as other socio-economic aspects of a beach and its environment (Kovačić et al., 2013; Simm et al., 1995; Williams and Micaleff, 2009).

However, the paper focuses on the method of beach thematization that can be best described via a project done at the national and regional level (Kovačić and Magaš, 2014). The purpose of the projects Adriatic Sea Stars has been to raise awareness of all stakeholders in the tourism sector in order to preserve the coastal area.

In many countries, local government has the power to adopt subordinate legislation that is related to beaches and beach managing. Nevertheless, most provisions regarding beach managing are contained in Coastal Zone Management Acts or some sectoral provisions. Legislation (WHO 2000), that relates to the quality of the sea for swimming, beach safety, recharge and protection of the coast, access to beaches and protection of crucial ecosystems, is of particular interest for beach managing.

It is a recognizable concept duty of care, that includes responsibility by either private operators or members of the public (Williams et al., 2009). It implies that good practice of beach managing is based on interdisciplinary knowledge of scientists, experts, and the local community.

Beach managing in Croatia can be perceived from the aspect of sea protection, ecological aspect and the aspect of authority that was, in accordance with the Maritime Domain and Seaports Acts (OG 158/03, 100/04, 141/06, 38/09, 123/11, 56/16) and the Concession Act (OG 69/17), given to the regional self-government (counties), and local authorities (cities/ municipalities). In this way, it is possible to apply concessions and concession approvals, and beach management has the function of retaining or improving a beach as a recreational resource and it has a very important function in beach managing.

Concessions for beaches in Croatia are given by regional self-government, and in some counties this responsibility has been assigned to the local government. Managing on a local level is carried out according to maritime domain management plans issued by cities/municipalities in the way that concession approvals are given or that communal companies manage it. Over the last few years, the aspiration and willingness of local government to assume responsibility for managing beaches through the concession institute in their administrative area is visible. In this way, local government has an additional motive, in accordance with the existing spatial plans, to directly manage the development of beach resources.

Croatian public administration mainly stipulates conditions for beach usage with an emphasis on the capacity, i.e. the maximum number of beach equipment and accompanying facilities (Jovičić, 2008; Marković et al., 2010). As the legal provisions in Croatia are very complex, their implementation at the local level is dependent on the knowledge of employees and their understanding of beaches as a resource of special importance. The lack of knowledge and evaluation of beaches sometimes leads to their overuse. This results in a dissatisfaction among the local people and different tourists' expectations. The conflict caused by a different understanding of beaches, wishes, motives and experiences have been the subject of the research whose results are given hereafter.

3. RESULTS

The realisation of the fundamental objective of this research was to recognise the economic and ecological impact of the increase in tourist traffic and tourists consumption. A special focus was on the growth of tourist satisfaction and greater opportunities for the employment of local people. A large study, which included an analysis of 1000 beaches in Croatia along the Adriatic coastline, was carried out during 2014. In 2015, the Primorsko-goranska County started working on a regional program of planning and managing beaches. The project leader of both projects was the Faculty of Tourism and Hospitality, Opatija, Croatia, as well as several interdisciplinary teams of scientists who also participated in the project.

The project included a series of activities from conducting surveys among stakeholders (concessionaires, locals and tourists) to workshops in cities and municipalities of the region. The survey questionnaire covered several groups of questions, the general ones and the specific ones addressed to concessionaires and tourism workers, and in particular questions for tourists and questions for the local population to find out how they perceive the issue. The most important results of the study are presented in this paper.

The analysis of the questionnaires indicated a series of open questions and issues, opposed interests, different desires and motives.

More than 80 % of respondents think that they know who manages beaches while 12 % of them say they do not know it. The others gave no answer to the posed question about who manages beaches. Those who do not seem to know who

manages beaches think that local government should manage them, independently or in cooperation with concessionaires, tourist board or agency in charge of maritime domain managing.

Stakeholder (concessionaires and locals), who were asked what they thought about the present model of beach managing, emphasised the absence of a beach managing model with clearly defined rights and obligations, a complex legal framework, overlapping of jurisdiction, a complex procedure of granting concession, frequent changes in spatial planning documentation, redundant administration, the lack of understanding of development initiatives, unsolved property and legal relations, out of date beach categorisation, uneducated local people, the impossibility of closing the beach to ensure a quality offer to tourists and their safety, and issues related to beach managing within camps. On the other hand, local people advocate open beaches in camps, and concessionaires and tourists think that camps must have a security check. Concessionaires are almost unanimous in assessing that local government should support those concessionaires who are willing to invest in beaches to raise the quality of service and offer. They have a positive opinion regarding beach thematisation. They have also pointed out the importance of beach categorisation with regard to the equipment and service quality. Concessionaires think that their association does not make enough effort to promote their interests.

The local population thinks that institutions (regional, local government and tourist board) do not pay enough attention to beach resources. They also point out issues regarding an adequate access to beaches, especially for people with disabilities, and the lack of parking areas. Furthermore, the locals think that some beaches are usurped by both the concessionaires and tourists, so that the locals have a reduced possibility to go swimming.

Moreover, the locals point out the problem concerning the breach of the concession agreement, i.e. the use of beaches in such a way that the obligations regarding investments are not respected and that besides the activities for which the concession was given, some other activities, not given by the concession, are carried out. Also, some other facilities are set up and the number of sun loungers and parasols is increased. The locals are in particular sensitive to the closure of beaches and think that it is justifiable only in special cases, when beaches are part of naturist camps, luxury hotels and resorts. Nevertheless, the entrance to these beaches has to be allowed by paying the entrance ticket.

The analysis of answers given by tourists indicate the lack of offer and order, overcrowded beaches, and the issue of beach pollution. Tourists showed partial satisfaction with the quality of beach services, and they emphasised the purity and beauty of the sea and beaches. The following answers have been given to the question whether some form of payment should be introduced to use well maintained beaches: most of them (29,3 %) is against the introduction of a fee to use well-maintained beaches. 13 % of them advocates eco-fee, 10,9 % are in favour of a parking charge and 8,7 % of respondents advocate the introduction of beach tickets. A significantly small number advocates a compulsory use of beach facilities (3,3 %) and the introduction of magnetic cards (1,1 %). There are also 33,7 % of them who advocate a combination of all these payment models. The key stakeholder as well as the locals, representatives of the tourist board, local government and other tourist workers attended workshops held in 19 coastal cities and municipalities of the region. The principle of cooperation and inclusion of copartners in the process of intensive communication, discussion and exchange of opinions, is a very important part of the process of solving key issues that have been identified during the implementation of the project.

4. DISCUSSION

An overview of the total number of beaches, their surface area and the ratio between maintained and non-maintained beaches was given on workshops. The beach typology was established according to the Study "Sustainable Beach Management in the Republic of Croatia –Guidelines and Priority Actions" written by the Centre for Regional Activities of the Priority Action Program (CRA/PPA) UNEP Mediterranean Action Plan, in which beaches are classified as: distant beaches, rural beaches, urban beaches, maintained resort beaches/hotel beaches. Furthermore, topics for beaches and their names were suggested. Carrying capacity by topics and stars was defined; a maximum tolerated carrying capacity for maintained urban beaches, naturally partially protected beaches, natural beaches without protection. Special attention was paid to the beach capacity in relation to the number of swimmers, and in accordance with the beach type.

Thanks to these projects and its results it is possible to propose a model as an efficient tool for communities beach managing. The fundamental determinant of a managing model at the local level includes participation of citizens in decision-making on issues of public goods and the partnership between local authorities, civil society organizations and the private sector.

The importance of beach managing due to their use as a tourist resource is based on the fact that vacation and swimming are one of the key motives for arrivals at Croatia's coastal destinations. Beaches in Croatia represent a significant economic resource that provides additional income for the locals. Thus, 74 % of the total tourism in Spain refers to beach tourism, in New South Wales beach tourism amounts to 57 % of the total profit from tourism, and in the USA the annual profit from beaches amounts to US $ 170 billion, while beach maintenance in Malta

(St. George Bay) increases the value of surrounding real estates for 13 % (Marković et al., 2010).

It is important to note that today beach managing is a component of an integral coastal area managing that is focused on the preservation and improvement of beach quality as a recreational and most importante resource.

Integral managing includes beach evaluation, classification systems and beach assessment that are focused on a holistic approach that takes into account a larger number of elements (e.g.: water quality, access, facilities, services, environment). A holistic approach in this respect should take into account wishes and interests of beach users, especially locals and tourists and all other partners at the destination. It is also important to reconcile eventual conflicts of interest, by reasonably respecting the users' preferences and wishes.

The research has shown that the current model of beach managing in Croatia, which derives from legislation, gives a very important role to regional and local authorities. The basis for the development of a sustainable model of beach managing has been found in issues noted during the implementation of regulations, primarily due to an inadequate intellectual capacity, conflict of various interests and pressures, as well as the results of conducted survey and conclusions made at the workshops.

The proposed model (Figure 1) is based on the holistic approach that includes defining the beach managing strategy at the regional level. Strategic goals include economic effects and benefits for the locals and tourists.

The basic starting point of the model is the regional physical planning and beach managing as well as the proposed thematisation.

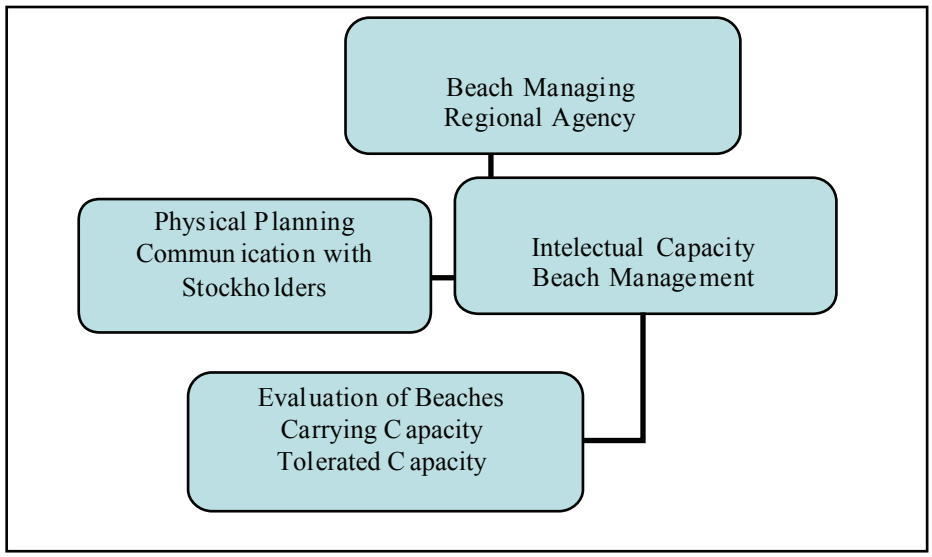

Figure 1.
Model of Beach managing.

The beach managing model assumes the establishing of a special agency for beach managing at the regional level. In that way, one can take care of the protection of beach resources (monitoring) and their economic use in one place with an appropriate intellectual capacity.

One of the essential elements of the Model is determining the effective carrying capacity based on the UNEP's evaluation of carrying capacity, which does not include the contact zone of the sea and mainland (tidal wave). The first step is to define the physical carrying capacity of a beach that is based on available beach area per swimmer, i.e. so called tolerated capacity.

The tolerated capacity defines the lowest and the highest level of the number of people on a beach. Smaller parts of the beach necessary to ensure the unobstructed flow of swimmers on the beach are excluded from the available beach area, which depends on the type of a beach (for example, resort beaches will require higher comfort levels and larger area per person, and thus they will have less available beach area). It should be emphasised that carrying acceptance is not a predetermined size but it depends on several elements, and among the the most important ones is the geographical microlocation of the beach.

The role of management is not only to understand and valorise beaches as a resource but to implement a basic knowledge of managing. A special management role is manifested in the maintenance of national quality standards

and water quality, and in co-operation with the environment and pollution team. In order to achieve this, it is necessary to improve communication with the locals, tourists, tour operators, and other stakeholders. At the same time, economic effects should be planned, which will be achieved by granting some beaches in concessions or issuing annual permits. Blackmore (Blackmore et al., 2002) point out that for the majority of beach users it is acceptable to pay some aditonal faccilities like eco tax and other. According to authors, the willingness to pay varies with social class, earnings, amount of beach use and between local, domestic and foreign user groups. Thus results are very indicative where beach management is concerned, since it implies managing the offer and demand of beach facilities.

Although the economic effects are important for the whole economy, it is even more important to understand the essence of unreasonable use of beach resources.

The proposed model is an open type model and it should be changed and adjusted in the interaction with the environmental changes affecting it.

5. CONCLUSION

Beaches are an integral part of the integral tourist product of a destination. It is a highly valuable resource from the natural, social and economic aspects, whereas beaches have a recreational potential as well. They make the tourist product more attractive and represent the reason why a certain number of tourists is likely to choose the destination.

The literature on beach management provides theoretical basis and good practice that can be implemented on future planning of sustainable beach managing in Croatia. The research intends to help to co-create a well-being for the local population and the tourism industry by providing tools for efficient model of sustainable beach managing in Croatia.

The proposed model is a result of the experience in managing the maritime affair, theoretical and empirical knowledge, and conducted researches and projects. The model is not a predetermined size, but is modifiable along with environmental changes and new circumstances, and it can contribute towards an understanding the importance of beaches as a resource that has to be specially taken care of.

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The Necessity of Adoption of New National Regulations to Prevent the Pollution of Croatian Coastal Sea by Sewage from Various Vessels

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This paper addresses international, Croatian and EU legislation on the prevention of sea water pollution by sewage from vessels. The paper also highlights the disadvantages of international legislation on the protection of coastal sea against pollution by vessel sewage. International legislation is enacted at the global level rather than for each individual coastal sea due to each sea having different exposure to pollution. Either the insufficiently comprehensive national legislation needs to be amended or, more suitably and effectively in the case of the Republic of Croatia, new rules regulating the prevention of coastal sea pollution at the national level and the prevention of negative influence on the marine eco-system, human health and economy established.

KEY WORDS
~ Vessel sewage
~ Sewage treatment plant
~ Pollution
~ Legislation

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1. INTRODUCTION

The pollution of the marine environment is one of the major ecological problems of our time. It has or is likely to have lethal consequences for the living conditions of the marine and underwater flora and fauna. Sea water can be polluted by pathogens, nutrients, chemicals, detergents, pesticides and heavy metals from sewage. The contamination of coastal water may change nutrient levels, abundance, biomass and diversity of organisms, the bioaccumulation of organic and inorganic compounds and the alteration of trophic interaction between species. The issue of sea water pollution and the impact of black water (sewage) on coastal sea have been the subject of research and publication by many authors, including A.M. Owili (2003) Ž. Koboević, Ž. Kurtela (2012). Authors S.E. Henrickson, T. Wong, P. Allen (2001) deal with a variety of human diseases caused by the release of faecal waters into sea. The problem of hypoxia and eutrophication was dealt with by authors V.H. Smith, G.D. Tilman, J.C. Nekola (1999), J.S. Gray, R. Sinu-sun, and Y.Y. Or (2002), S. Hanninen, J. Sassi (2009) and H.Shenping, F. Quangen, Z. Jinpeng (2010). Apart from increased sewage pollution from land sources, the sewage pollution from vessels is also on the rise. The number of cargo ships, cruise ships, yachts and pleasure boats is growing every year. The growing marine traffic increased pollution by sewage from vessels. Vessel sources of sewage include both commercial and recreational vessels. Most commercial vessels have sewage treatment systems designed to remove pollutants from sewage before releasing waste water into the sea. Instead of a sewage treatment system, smaller recreational vessels

have sewage collection tanks. Papers on the types of tanks for processing black water on ships have been published by M. Bupić and L. Milić (1998.), Dixon, J. Daly and H. Dorr (2002.), Ž. Koboević and Ž. Kurtela (2011). The issue of black water discharge from cruisers in Alaska was addressed by A.Mearns, C.J. Beegle-Krause and L. Loehr, (2005).

A number of international and national regulations have been adopted to prevent sea pollution.

Apart from international regulations on the prevention of marine pollution from vessels, many maritime countries have laid down their own stricter regulations (West, 2004).

2. RESULTS / REGULATIONS ON SEWAGE WASTE WATER FROM SHIPS

The issues of waste water discharge, storage and processing onboard, equipment and certificates required to be obtained by vessels are regulated by international and, in some maritime countries, national regulations.

2.1. International Legislation on the Prevention of Sea Pollution by Sewage from Ships

The discharge from and holding of sewage (black water) on ships, the equipment and certificates required onboard are all governed by international legislation and national regulations of individual maritime countries. Although not as a rule, highly developed countries frequently lay down national regulations that are more effective or impose more restraints on discharge of ship sewage, and have higher requirements with regard to the purity or quality of treated sewage before its discharge into sea.

The International Convention for the Prevention of Pollution from Ships, 1973/78 (MARPOL 73/78) brought by *International Maritime Organization* (IMO) is the most important international regulation regulating issues relating to the pollution of sea by vessels. The Convention has a number of Annexes. Annex IV contains provisions regulating the prevention and supervision of marine pollution by sewage waste waters from ships, including by: prohibiting or limiting discharge, certificate issuance and inspections, equipment and supervision of discharge, shore reception facilities. Annex IV to MARPOL is applicable to all ships on international voyages certified to carry more than 12 persons and that are 200 GT and more. Annex IV to MARPOL prohibits the discharge of sewage into sea, except when raw sewage is discharged at a distance greater than 12 nautical miles from the nearest land, or where the ship is discharging comminuted and disinfected sewage processed by an approved system, at a distance greater than 3 nautical miles from the nearest land, or where the ship is discharging sewage using an approved sewage treatment plant; the results of plant effectiveness are laid down in the ship's International Sewage Pollution Prevention Certificate and the effluent must not contain visible floating solids nor cause discoloration of the surrounding water. Discharge of this type is allowed at any location.

Apart from MARPOL, several other international regulations address the issue of pollution by vessel sewage, although not to the extent and with the precision of MARPOL. Those conventions are: *The United Nations Convention on Law of the Sea (1982); The Convention for Protection of the Mediterranean Sea against Pollution, adopted in Barcelona in 1976 / Action Plan 1995.; Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992; Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) 1992.*

2.2. Croatian Legislation on the Prevention of Marine Pollution by Sewage from Ships

Most Croatian regulations on marine pollution by ships are the result of the adoption of relevant international conventions under the International Maritime Organization, and the implementation of EU rules and regulations. The Republic of Croatia adopted the MARPOL Convention.

In the Republic of Croatia, the issue of protection of sea from sewage discharge has been addressed by a series of acts and regulations, such as: the Maritime Act[1], Environmental Protection Act[2], the Maritime Domain and Seaports Act[3], Regulation on the

1. *The Maritime Code, OG 181/04, art.64 p.2. "Ship captains and crew members, yacht or boat skippers or crew members are required to comply with international regulations and standards and Croatian regulations on the protection against sea and air pollution by seagoing vessels and pollution caused by the sinking of seagoing vessels in Croatian waters and territorial sea. Rather than proscribing protective measures against marine pollution, the Maritime Code provides for the adoption of more detailed regulations: (art. 64. p.6). "The detailed regulations on the protection of the marine environment from marine facilities and the conduct of pollution investigation shall be brought by the Minister"*
2. *Environmental Protection Act, OG 110/07, art.24. p.1: "The protection of the sea shall include measures of protection including the marine eco-system and the coastal area as an indivisible whole, the prevention of damage to the marine ecosystem, the prevention of sea pollution from the air, from the mainland, from vessels and other pollutants due to maritime traffic, including pollution caused by dumping from vessels or aircraft with the purpose of sinking or incineration at sea, and cross-border pollution, as well as pollution caused by major accidents and neutralization of their consequences."*
3. *Maritime Domain and Seaports Act, OG 158/03, art.90 prohibits the release of solid and liquid wastes, oily water, sewage and cargo residues from ships, as well as of all other substances polluting the waters and shores of maritime domain. Mobile, floating and stationary offshore facilities may discharge waste holds, oily water, sewage (black water) and cargo residues from ships in solid and liquid form, while other polluting substances may only be discharged at designated locations in or outside ports equipped with devices for the disposal of such substances. If the harbourmasters find that the unloading of storage tanks might cause pollution of the sea during navigation, the captain of a mobile, floating and stationary offshore facility will be ordered to empty them before leaving the port.*

Conditions and Manner of Maintaining Order in Ports and Other Parts of Internal Sea Waters and the Territorial Sea of the Republic of Croatia[4]. None of the above national acts are as detailed as Annex IV to MARPOL, and neither the measures against pollution by sewage water from ships nor measures against violators have been laid down in as much detail.

2.3. EU Legislation on the Prevention of Marine Pollution by Sewage from Ships

All EU member states ratified Annex IV to MARPOL, incorporating stipulations and limitations concerning the discharge of sewage from ships. The European Environment Agency (EEA) is the most important of all EU institutions and bodies for pollution monitoring and control.

The EU has issued a number of documents, initiatives, action plans and strategic instruments for the protection and preservation of the marine environment and especially of the Mediterranean.

There is no single and comprehensive legislation on marine environmental protection in the EU coming even close to the MARPOL convention. Different regulations on pollution prevention addressing various sources of pollution and environmental hazards (e.g. oil pollution, hazardous substances, eutrophication, habitat destruction, municipal waste issue) have been adopted.

The most important pieces of legislation relating to sewage from ships are:

Directive 2002/84/EC of the European Parliament and of the Council of 5 November 2002 amending the Directives on Maritime Safety and the Prevention of Pollution from Ships, instituting the Committee on Safe Seas and the Prevention of Pollution from Ships (COSS), intended to improve the implementation of EU legislation on safety at sea, prevention of pollution from ships and living and working conditions onboard, as well as to accelerate the updating of EU regulations on shipping and facilitate their amendment in the light of developments in international instruments.

Directive 2000/59/EC of the European Parliament and of the Council of 27 November 2000 on port reception facilities for ship-generated waste and cargo residues - Commission Declaration, adopted to ensure common ecological standards for private facilities (for liquid and crude waste from ships, or cargo residues) in all ports within the EU. The purpose of this directive is to reduce the quantity of waste (including sewage) discharged.

Directive 2007/71/EC of the European Parliament and the Council on port reception facilities for sewage from ships and cargo residues. It has been in force and effect as of 17 September 2009 and requires ships to advise the port of call on the condition of sewage waste waters onboard. The ships are required to pump out their sewage waters into port reception facilities if the ship cannot discharge sewage waters in compliance with MARPOL or if the ship's capacities are insufficient to keep the sewage waste waters onboard until the next port of call, including sewage collected prior to reaching the next port of call. The purpose of this directive is to reduce the discharge of sewage waters into sea, in particular illegal discharges within 3nm from shore. It does not apply to boats and yachts accommodating fewer than 12 passengers and fishing boats.

As far as correlations between international and EU legislation are concerned, it should be noted that the European Community is party to almost all international conventions and agreements dealing with marine environmental protection. The EC may improve the effectiveness of those conventions and agreements by adopting secondary acts (directives or regulations) required to be implemented or directly applied by member states. The adoption of international maritime policies is still within the scope of the International Maritime Organization.

The European Maritime Safety Agency (EMSA) was founded as a special supervisory body of the European Union primarily to monitor the efficiency of the implementation of rules on safety in shipping and prevention of pollution from ships, and the implementation and efficiency of individual measures within the EU. Although EMSA has no legislative function, it is important for the implementation and supervision of maritime policy of EU member states, as well as for monitoring the implementation of the relevant EU regulations into national legislations. (Barić-Punda, 2008).

2.3.1. The Shortcomings of Legislation in the European Union

The shortcomings of EU legislation on the prevention of sewage pollution from ships based on reviews and experience:

1. Non-existence of a single comprehensive regulation on marine environmental protection against sewage pollution from ships at EU level.[5]

4. *The provisions of the Regulations apply to all ships, yachts and boats entering Croatian ports and all ports entered by vessels (art.61. p.1.), irrespective of their flag of affiliation, except for war and state ships. In accordance with art.62, p.1, all ports open to the public and special purpose ports are required to compile and implement a Waste and Cargo Residue Receiving and Handling Plan as defined in art.3, p.7. The Ordinance on conditions to be met by ports (waste from vessels is all waste, including sewage and residues, resulting from the use of the ship and referred to in Annexes I, IV and V of MARPOL 73/78, except cargo residues). When entering a Croatian harbour, the master of a ship, other than a fishing vessel, must present to the harbourmasters and the body that manages the harbour full and accurate data on ship waste and cargo residues. (art.63, p.1). The master of a ship, yacht or boatmaster shall, before leaving the harbour, discharge all shipboard waste into the port's reception facilities. (art.64, p.1).*

5. *EU Directives are focused on individual problems, and lack comprehensive approach to sea pollution such as provided by the MARPOL Convention.*

2. Some maritime regions in the EU (e.g. Baltic Sea, Adriatic Sea and Black Sea) are more exposed and need additional attention and stricter legislation on sewage pollution prevention than is presently applicable at EU level and stipulated in Annex IV to MARPOL.

3. In the Baltic Sea the problem of nutrient input from land and ships is coming into focus of attention. Since pursuant to Annex IV to MARPOL no restrictions are imposed on nitrogen and phosphorus loads from sewage treatment plants, Baltic countries came forward to the international community and IMO with the initiative to adopt new measures and regulations to reduce nutrient input (nitrogen and phosphorus) from shipboard sewage, providing better protection of the ecosystem in the Baltic (IMO, 2009).

4. The Croatian coastline of the Adriatic Sea, as a destination for nautical and recreational tourism for water sports and swimming. The shallowness and semi-enclosed nature make the Adriatic Sea vulnerable to pollution. Untreated waste water from mainly land-based sources and ships further aggravate the situation (Communication from CEP, 2014). Sewage discharge from vessels in internal waters and bays is detrimental to tourists and the tourism sector. This hazard pertains more to vessels such as yachts, pleasure boats and fishing boats, which are exempted from the application of EU level legislation and Annex IV to MARPOL.

3. DISCUSSION / ISSUES CONCERNING SEWAGE POLLUTION FROM SHIPS NOT COVERED BY THE ADOPTED INTERNATIONAL LEGISLATIVE MEASURES

1. The limitations in the application of Annex IV to MARPOL depending on ship's gross tonnage are irrelevant, since the sewage onboard is produced by humans (crew and passengers) regardless of a ship's GRT (with the exception of several specialized ships for the transportation of livestock, where the livestock is cargo producing sewage). The sewage load onboard depends directly and exclusively on the number of persons onboard.

2. Ships not engaged in "international navigation" are exempt from the application of Annex IV to MARPOL. Such approach, where national administrations regulate the prevention of sewage pollution from ships flying their national flag and sailing exclusively in their territorial waters, is positive providing national administrations adopt national regulations stricter than MARPOL. As a further disclaimer, Article 11.2 of Annex IV stipulates that the discharge provisions of Annex IV do not apply while vessels remain in waters under state jurisdiction. Consequently if less stringent discharge standards are imposed by the state, ships can capitalize on the weaknesses of state jurisdictions (West, 2004).

3. Annex IV to MARPOL does not apply to ships carrying less than 12 persons, ships navigating in national waters, yachts and vessels carrying less than 12 persons. Annex IV to MARPOL only applies to yachts carrying more than 12 persons onboard. However, yachts are not subject to Port State Control inspections according to Paris Memorandum of Understanding (MOU) or any other similar regional agreements assessing the compliance of equipment, certificates and procedures with conventions such as SOLAS, MARPOL, STCW 78/95, COLREG, ILO 147, Loadline, Tonnage. Yachts to which Annex IV to MARPOL applies are required to have equipment proscribed therein, envisaged to be verified by initial or periodical inspections conducted by the national administration whose flag they fly, but since Port State Control can neither monitor them nor perform inspections it is rather questionable whether the said equipment is in good working order and how and to which extent it is used.

4. Boats (such as sailing boats and motor boats) are exempt due to their gross tonnage and number of persons they are certified to carry, although the length of up to 12 meters and sailing category leave room for some to navigate international waters. Yachts and boats built for voyages longer than one day are equipped with sewage holding tanks of limited capacities which must be emptied. These tanks are mostly emptied into sea, considerably closer to the shore than proscribed by MARPOL, (for untreated sewage 12 nm or more from nearest land) since MAPROL regulations do not apply to such vessels. On the other hand, the number and density of land-based reception facilities in marinas, wharfs and operational shores is still insufficient to accommodate yachts and boats.

5. The total number of persons onboard yachts and boats during the summer in countries with developed nautical tourism like Croatia, by far exceeds the total number of persons on all merchant ships in the same coastal area. Consequently, sewage from small vessels to which Annex IV to MARPOL does not apply causes significantly greater load and marine pollution than sewage from ships to which the Annex IV to MARPOL applies.

6. The requirements pertaining to the purity grade of discharges from sewage treatment plants refer only to parameters relating to fecal coliform bacteria loads, total suspended solids, biochemical oxygen demand, and pH, but there are still no limitations on nutrient loads such as phosphorus and nitrogen, which could have a significant impact on the eutrophication of closed and shallow seas. Although Annex IV to MARPOL addresses only fecal sewage (black waters), grey waters also have a negative effect on the sea since nutrient input may lead to eutrophication.

7. There are still some maritime regions which are more susceptible to pollution than other seas (e.g. the Baltic Sea, the Adriatic Sea, and the Black Sea) (Steckbauer et al., 2011). MARPOL defines certain maritime areas as "special areas" in

which, due to technical reasons relating to their oceanographic and ecological condition and maritime traffic, the adoption of special mandatory methods for the prevention of sea pollution is required (IMO, 2009). Under the Convention, these special areas are afforded higher level of protection than other maritime areas. Only the Baltic Sea is considered a special area under Annex IV to MARPOL (Article 13.2 of the revised Annex IV to MARPOL adopted by the MEPC.200(62) resolution, which entered into force on 1 January 2013). Unlike the Baltic Sea, the exposure of the Adriatic Sea to sewage discharge from ships is still insufficient to cause eutrophication. Nevertheless, sewage discharge from yachts and boats in "internal waters" and bays of the Croatian Adriatic coastline, as a nautical and recreational tourism, water sports and swimming destination, may have impact on the economy and human health. (Koboević and Kurtela, 2012).

4. DISCUSSION / SUGGESTIONS FOR IMPROVEMENTS IN THE PROTECTION OF THE SEA FROM SHIPBOARD SEWAGE POLLUTION IN THE REPUBLIC OF CROATIA

The internal waters and bays are more exposed to sewage pollution from ships, yachts and boats to which Annex IV to MARPOL does not apply. The risk of the very narrow coastline of the coastal sea becoming polluted by black wastewater from vessels mostly comes from smaller vessels in national navigation, yachts and boats to which international regulations do not apply (Annex IV to MARPOL). Therefore, the problem cannot be resolved by amending existing international regulations.

The issue of the discharge of black waste water, along with other waste from recreational vessels is recognized and listed in the *Strategy for Maritime Development and Integral Maritime Policy of the Republic of Croatia 2014-2020* from July 2014.[6]

The solution might be the amendment of existing national regulations which, in contrast to the previously adopted international regulations (Annex IV to MARPOL and EU Directive), would also apply to vessels which are not covered by such international legislation and specifically regulate the discharge of black waste waters from vessels in national traffic, such as fishing boats, ro-ro passenger ships (ferries), boats and yachts, as well as mega-yachts and boats in international traffic.

National legislation similar to that of some other developed countries like the USA[7] and Australia will have to be adopted.[8]

Bearing the above in mind, the adoption of a new ***regulation on the protection against marine pollution by black waters from ships, yachts and boats sailing in internal sea waters and in the territorial sea*** is proposed.

Explanation of the basis for the adoption of such regulations:

Although several Croatian regulations (the Maritime Code, the Maritime Domain and Seaports Act, Regulations on the Conditions and Manner of Maintaining Order in Ports and in Other Parts of Internal Sea Waters and the Territorial Sea of the Republic of Croatia) make mention of marine pollution by ships, vessels, yachts and boats, no measures ensuring protection against pollution are proscribed. Since regulations on the protection of the marine environment against pollution by black waters from yachts and boats in inland waters and territorial sea do not exist, pursuant to art.64, p.2 and art.64, p.6 of the Maritime Code, which reads "The detailed regulations on the protection of the marine environment against marine facilities and the conduct of pollution investigation must be brought by the Minister", there is basis for the adoption of a new *regulation on the protection against marine pollution by black waters from ships, yachts and boats sailing in internal sea waters and in the territorial sea*.

Explanation of the basic issues to be regulated by the regulation and the consequences of its adoption:

The proposed regulation might regulate the protection of the sea against pollution by black water from vessels in internal sea waters and territorial sea in compliance with Annex IV MARPOL Convention standards, and apply to all ships, yachts and boats, regardless of their flag of affiliation. The conditions under which yachts and boats would be permitted to discharge black water during navigation in the territorial sea and inland waters are proposed.

6. *"The Strategy for Maritime Development and Integral Maritime Policy of the Republic of Croatia 2014-2020", from July 2014, Chapter 3.2.: "The recent significant pressure on the marine environment and the deterioration of its quality come not only from classical shipping, but can also be attributed to the increased development of nautical tourism, which has negative effects, manifested especially in the quantities of waste and sewage water, necessitating the adoption of technical, technological and organizational measures for the establishment of an effective ship waste management system, and improvement of conditions for efficient ship and marine waste management."*

7. *One of the options would be the "No Discharge Zone", like in the USA. The discharge of sewage from ships would be absolutely prohibited in these zones regardless of the ship's category, gross tonnage and number of persons onboard. Sewage would be stored onboard until the ship is at sufficient distance from the nearest land (proscribed) or reaches land-based sewage receipt facilities, which should be built in all ports, marinas, operational shores etc. "No Discharge Zones" must be designated by national legislation.*

8. *An example of such regulation is the Australian regulation, which apart from Annex IV to MARPOL, contains a very detailed regulation pertaining to smaller vessels in national waters, national park areas and the narrowest coastal strip, where discharge of sewage is absolutely prohibited in the vicinity of the land or people, and allowed only at a set distance from land or in inland-based reception facilities for shipboard sewage. See AMSA (2012) and Australian Legislation (2008) - Transport Operations (Marine Pollution) Regulation.*

The adoption of the proposed regulation would facilitate better protection of the narrow coastal sea area against black water pollution and consequently of beaches and tourism as the most important economic sector in the Republic of Croatia. The regulation would contribute to sustainable development and the promotion of the highest standards of ecological protection of the sea.

The most important provisions of the proposed regulation on the prevention of pollution by black waters from vessels, yachts and boats sailing in internal sea waters and the territorial sea would be as follows:

1. The regulation is intended to proscribe protective measures against pollution by black water, which would apply to all ships, yachts and boats sailing or located in the internal sea waters and the territorial sea of the Republic of Croatia.
2. All ships, regardless of their flag of affiliation, should be prohibited from discharging black water into the sea, contrary to the provisions of Rule 11, item 1 and item 3 of Annex IV to the MARPOL Convention, while sailing or being located in the internal sea waters and in the territorial sea.

Explanation: This provision echoes the already accepted provision of Annex IV to the MARPOL Convention which applies to all *vessels in international navigation*, providing that the new regulation would extend the scope of application to all ships *in national navigation*.

3. All yachts and all boats, regardless of their flag of affiliation, should be prohibited from discharging black water into the sea, while sailing or being located in the internal sea waters and in the territorial sea, except when:
    - a yacht or boat discharges black water that has not been macerated and disinfected at a distance greater than 12 nautical miles from the nearest land, provided that during the discharging the yacht or boat sails at the speed of at least 4 knots;
    - a yacht or a boat discharges black water that has been macerated and disinfected at a distances greater than 3 nautical miles from the nearest land, provided that during the discharging the yacht or boat sails at the speed of at least 4 knots;
    - a yacht or boat is equipped with an approved sewage treatment plant that meets the requirements of Article 9.1.1. of Annex IV to the MARPOL Convention, for which documents were issued by the competent national authority. The effluent from this device must not contain visible floating particles and must not change the color of the surrounding water.

Explanation: limitations on black water discharge applicable to yachts and boats comply with the provisions of Annex IV to the MARPOL Convention, and thus equate ships, yachts and boats in this matter. Since the harmful effect of black water discharge from yachts and boats is no lesser than the harmful effect of black water from ships, there is no reason for the yachts and boats to be in a privileged position.

In addition, the United Nations Convention on the Law of the Sea (1982) recommends that States adopt national regulations for the prevention, reduction and monitoring of marine pollution from ships, which should not be less effective than the generally accepted international rules and standards adopted by the relevant international organization.

Explanation for the implementation of the proposed regulations and port reception facilities

The implementation of the *regulation on the protection against marine pollution by black waters from ships, yachts and boats sailing in internal sea waters and in the territorial sea,* will impel yachts and boats to discharge black water at the designated distance from the coast (minimum 3 nm), where it will affect neither human health, sea biodiversity nor the aesthetic appearance of the sea.

Alternatively, yachts and boats may empty their black water collection tanks into port reception facilities (pump-out stations).

Port reception facilities are already available in Croatian international harbors. Croatia has a comprehensive and modern legal and institutional framework for port reception facilities, compliant with the MARPOL Convention and EU Directive 2000/59, regulating port reception facilities and the collection of waste generated by ships at its ports. Port reception facility system refers to the installation of receiving devices and ship-generated waste management plants in ports.

The disposal of black water and garbage from ships is carried out by waste disposal utility companies with concluded concession contracts with port authorities. Local ports and port sports and recreational facilities (marinas) in Croatia are rarely equipped with stationary pump-out facilities. The service is provided by mobile units, i.e. dedicated trucks with a collecting sewage tank. The collected black waters from boats are discharged into the local sewage system.

The cost recovery system currently being applied in Croatia is the direct billing system, e.g. ships or their agents pay the waste collection and garbage collection services directly to service providers. Port authorities determine and publish tariffs for such services.

Given the results of the research on the general behavior of boat and yacht owners and/or operators regarding the discharge of black water into the sea and general human behavior, the impression is that the system of the direct billing of costs of black water disposal into receiving stations is not very stimulating for owners/boat operators and should therefore be changed. Research on responsible environmental behavior of boat and

yacht owners and/or operators in Maryland, USA, shows that although they are familiar with the regulations on the prohibition of the discharge of black waste waters along the coast (more than three miles from the coast), many owners/operators of boats and yachts discharge untreated black water into the sea near the shore. Many factors and/or circumstances (pressures) are involved in this behavior. The most common are: the inability to sail off the coast where dumping is permitted (three miles or so), lack of local reception facilities for black water, the inaccessibility of receiving stations, lack of adequate legal constraints, lack of knowledge of the hazards posed by black waters to public health and marine organisms, lack of responsible ecological awareness, etc. In addition, the volume of tanks for black water on smaller vessels is very limited, and given normal use, they quickly fill up and require frequent emptying. Moreover, in reply to the question: "What would induce you to use black wastewater treatment stations more frequently?" 61 % of ship owners opted for better working hours, 51 % for lower cost of reception facilities, 42 % for the availability of mobile stations for reception, 20 % for shorter standby time and shorter line at the receiving station, 42 % for better designed reception facilities which would encourage greater use. Survey results indicate that more than half of the respondents mentioned the costs of using black water reception facilities, which is understandable given the general human tendency not to pay for the things the payment of which can be evaded.

Therefore, the possibility of introduction of a vessel waste and black water collection billing system, which would provide for the inclusion of waste disposal costs in the price of the stay or berth per day for each vessel should be considered. Concessionaires who collect waste should be obliged to visit each boat once a day to collect black water and charge their services to the organization that collects the port fee (including the waste collection fee).

Another option would be for the entire Croatian coastal sea to be designated as a "No Discharge Zone". For such a measure to be efficient an appropriate number of land-based reception facilities throughout the "No Discharge Zone" is required.

5. CONCLUSION

The causes of inefficient sea protection and preservation are numerous and complex. Apart from economic, political and other differences between countries and the problem of limited finances, there are still low political priority and low public awareness of environmental issues in certain countries. The above discussion on international legislation regulating the prevention of marine pollution by sewage from ships indicates that the adopted measures do not adequately protect coastal seas from shipboard sewage pollution. Coastal sea is still at risk due to the number of operating smaller vessels to which international regulations do not apply. Consequently, better protection of coastal sea cannot be sought at the level of international regulations, but in the development and improvement of national legislation functioning as an addition and amendment to the adopted international regulations.

National regulations should address specific pollution problems which are not covered by international regulations or improve the efficiency of adopted measures which currently do not provide quality protection against shipboard sewage pollution. There are countries that have dealt with the similar problem of sewage pollution from ships. They have found solutions in the adoption of their national regulations or in an even more efficient combination of international and national regulations. Such positive experiences and solutions might simply be adjusted to the specific features of the Adriatic Sea and Croatian legislation.

There is no doubt that much better results in the area of protection of the coastal sea from shipboard sewage pollution could be achieved by the parallel application of international regulations pertaining to ships in international waters and national regulations pertaining to ships and smaller vessels in national waters.

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Investigation into Multicultural Readiness of Maritime Students: A Maritime English Lecturer's View

Adelija Čulić-Viskota

Maritime affairs imply multinational/-cultural/-lingual work environments, and maritime students' relative attitude should be investigated and the awareness raised. A research was undertaken with the 1st-year students of the Faculty of Maritime Studies (FMS) in Split, aiming at getting to know their cultural profile and their views of otherness. This is an essential starting point for the education of tolerant and knowledgeable seafarers, able to foresee possible problems arising in intercultural contacts, e.g. of a ship´s crew, and to deal with them if they should arise. Even before the introduction of multicultural elements into the university education of seafarers, some shipping companies had recognized the problem in an early stage and started undertaking individual initiatives to build respect and tolerance among crewmembers on board their ships originating from different national and cultural backgrounds. Since new nationalities are constantly entering the shipping industry scene, maritime students should be taught to: firstly, recognize the otherness and respect the different shapes it takes, and secondly, recognize the importance of the English language, not only as the occupational language in shipping and means of their professional communication, but also as their social life mediator in their working and living environment. A possible approach to this topic is proposed by an instructor of English for specific purposes in the maritime domain. It is through language that various attitudes presented by different nationalities in a variety of settings can best be illustrated.

KEY WORDS
~ Multicultural
~ Multilingual
~ Occupational language
~ ESP
~ Maritime English

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1. INTRODUCTION

Maritime affairs have always, of necessity, been an intersection of different nationalities and cultures due to the very nature of this business. Shipping has always meant international affairs, in the sense that trade, warship or explorations long ago forced seafarers to leave the familiar homeland waters and venture on journeys to distant foreign lands. Ever since, the need has been felt to armour seafarers with the knowledge of science to enable them to cope with the forces of nature and the relative response of their vessels, but also to take into consideration the human element, both on board ship and on shore. The ruling position of the English language in shipping has certainly facilitated maritime operations, but if proper care is not taken of crewmembers´ cultural backgrounds, the gap among them can be widened instead of bridged despite the common occupational language. Therefore, a number of studies have been conducted dealing with shipping as a multicultural setting, and the most represented crewmember nationalities. This paper aims at presenting the importance of raising frequently maritime students´ awareness of their future working environment, which is particularly important for the students originating from environments with low multicultural sensitivity, due to living in almost mono-cultural countries with an extremely low percentage of foreign citizens. It is, therefore, of the utmost importance to first measure the multicultural sensitivity of the

students enrolling for maritime studies, so as to clearly see what exactly the tasks of Maritime English lecturers should be. Due to the nature of their field of humanities and branch of linguistics, they should certainly take one of the leading roles and join in with their students to produce a wider range of materials intended for facilitating their students´ passage to real-life situations in multicultural environments.

2. SHIPPING AS A TRADITIONALLY TRANSITIVE ACTIVITY IN MULTICULTURAL SETTINGS, AND THE NEED FOR A COMMON WORKING LANGUAGE

Since the early settling of the Germanic tribes on the shores of the British Isles, the spoken language has begun its development to become the global modern English language as we know it today. Already the Old English of Beowulf represents a variety of literal terms for a *ship*, while following the poetic diction technique called *kenning* allusive compounds have been found, e.g. the term meaning literally *whale-road*, actually denoting the *sea*, while *wave-traverser/rider* was used to denote the *ship*. The mastery of the seas and ships was of greatest importance for the newcomers' incursions. Thus, the English words *ship* and *boat* are held to originate from this period. The Frisians, from what is now northern Holland and north-western Germany, were also among the invaders, and it is believed that the English words *sea, boat, storm, rain, snow, freeze, frost, mist*, all important or related to shipping, originate mainly from Old High German, Old Norse and Frisian[1]. Thus, ships and shipping already in those early days connected people of different backgrounds, their intercultural contacts resulting in changes, e.g. linguistic. Only much later on, during the times of great explorations will there be different nationalities mentioned as manning ships, such as the case of the Portuguese Magellan´s Spanish expedition with vessels manned by culturally diverse crew.[2] Other famous names from the seafaring history were well-known as internationalists, e.g. Thor Heyerdahl, Roald Amundsen[3].

However, British colonialism was definitely a major cause of propagation of the English language across the oceans from the British Isles around the globe, where it has established itself as an essential means of global communication in different human activities and businesses, maritime affairs included. With the times of colonisation of new territories by the leading European nations, there appeared a spread of the English language into colonialised areas, but also onto the activities involved in colonialisation itself, shipping certainly being part of it. According to Samuel Osborne, relating results of a survey on the British colonial past in *The Independent*[4] early in 2016, "*At its height in 1922, the British empire governed a fifth of the world's population and a quarter of the world's total land area*." The British were the leading colonial nation of the time and the English language influenced a number of minor languages, which resulted in a number of pidgins and creoles. Further developments in shipbuilding and navigation of the period facilitated and fostered the contacts. Still, the situation has changed over time. English has certainly become the global language without any real contenders, but the circumstances in shipping have in the meantime changed. The British are no longer the leading maritime nation they used to be, while the English language has seen the appearance of Maritime English as an independent jargon spoken and written by seafarers of origins different from the British. According to Alfiani (2010: iv), "*The declining number of seafarers from major ship-owner countries (EU, USA, Japan, etc.) has been one of the reasons which pushed the ship owners and employers to man their ships with crews from various nationalities*." Seafaring is not so attractive any more to the citizens of developed countries, but it continues to attract citizens of developing countries. Therefore, the need has arisen for a common occupational language that would ensure the safety of navigation.

2.1. Multicultural Awareness of Shipping Companies – Early Stage

A modern ship may be considered as the meeting point of representatives of different cultures gathered into a working team aiming at making profit for themselves and their employers. In this sense, a culturally diverse team has to live and work in a restricted space - their vessel, which certainly makes the scene more complicated. As it has already been stated, "*A fish only discovers its need for water when it is no longer in it. Our own culture is like water to a fish. It sustains us. We live and breathe through it.*"[5] This simply means that, when not supported by one´s own culture, a person feels like a fish out of water, i.e. not relaxed, insecure, deficient, frustrated. Thus, if not provided with multicultural awareness and readiness to understand and adapt to foreign cultures, one can hardly feel ready to work and accomplish the required tasks. On the other hand, there is a Hindu proverb expressing an apparently controversial thought: "*The three great mysteries: air to a bird, water to a fish, and human kind to itself.*" On a second thought though, it means exactly what Fons Trompenaars and Hampden-Turner stated, because we usually tend to take our environment for granted, seldom being aware of its importance to our functioning and self-realisation.

1. *According to Merriam Webster's online dictionary, available at: https://www.merriam-webster.com/dictionary (accessed February 15, 2017)*
2. *For more details, see Čulić-Viskota, A., 2015*
3. *Amundsen´s 1897-99 Antarctic exploration featured a vessel manned with a Belgian master and crewmembers of Norwegian, Polish, Romanian, American, French, and Swedish origins.*
4. *"5 of the worst atrocities carried out by the British Empire", an article authored by Samuel Osborne, appeared on the Independent of January 19, 2016*
5. *Fons Trompenaars and Charles Hampden-Turner. Riding the Waves of Culture. New York: McGraw-Hill Publishing, 1997*

After all, in old Greek there was a phrase introduced by Aristotle that a human being is *ζώον πολιτιχόν*[6] or, in a wider sense of the term, a social animal, i.e. a living being predisposed to live in a social group. Despite different interpretations of *πολιτικόν* in this Aristotle´s phrase, it could easily be understood as the characteristic of the human kind to cooperate within a group in a common enterprise, or to communicate within a community of a kind.

In the early 1990s modern shipping companies have realised the importance of the community of a ship's crew, as well as that of communication in both its linguistic and social aspects. The Japanese NYK shipping company management was among the first to make efforts to raise the level of cultural awareness or cultural literacy essential to intercultural communication. Having conducted a research among all their employees originating from different countries and cultures, they compiled *Guidelines on Understanding Intercultural Relationship* – a circular sent to ship masters to be provided in the messrooms and conspicuous places on board. In Part One of the *Guidelines*, intercultural relations are explained. First, it is stated as a fact that within a ship´s crew there are mutual influences at work – people recognise different ways of coping with problems. No culture is common to all people – cultural differences are natural and inevitable. Crewmembers are instructed to *learn* from representatives of different cultures and to seek similarities as a way of bridging the differences. Also, crewmembers are warned of the danger of falling into the trap of generalisations and stereotypes. They are instructed to be "*careful when expressing beliefs, slow in communicating them and to avoid unknown or culture-specific words / phrases*". Part Two of the *Guidelines*, titled "Practice Cultural Sensitivity", is introduced by the idea that each person is unique and there is a need for: a) respect of "*other*" (= different) attitudes and customs, and b) consideration of religion and culture as part of one´s personality. A conclusion is drawn that differences should be expected and consideration and respect should guide a person´s behaviour. The rest of the Guidelines is dedicated to individual cultures whose representatives man NYK vessels. Each chapter is divided into *Dos, Don´ts* and *Things to Remember When with* ... Among the concepts presented is *Mianxi*[7] in the Chinese culture, which is associated with the concept of *face* in the Western cultures, or *obraz*[8] in the Slavic ones, e.g. Croatian, Serbian, Bulgarian as exemplified by Stojanovich (1994: 48-9). All the examples refer to politeness in communication. It was introduced into the English linguistics by Goffman in 1959, later dealt with by Brown & Levinson in 1987[9]. The aim of developing such strategies of polite communication is to enable ourselves as speakers to save the face of the interlocutor and our own. It is important to avoid *face threatening acts* and to use *positive politeness* instead. The Guidelines have been revisited for the purpose of this paper after a 10-year period[10]. As more nations have emerged on the shipping scene in the meantime, the Guidelines have been extended with the characteristics of the Filipinos, Indians, Croats, Romanians, followed by "*General Perspectives on the Culture of Nations in Transitions / South East Europe: (Albania, Bosnia-Herzegovina, Bulgaria, Croatia, FYR Macedonia, Kosovo, Moldova, including Romania, Serbia-Montenegro, Slovenia)*". There are practical tips about each culture in the descriptive introduction. Still, the main point seems to be misunderstood, as can be seen from the extract below:

"*It is hoped that through this guideline readers will have the awareness in breaking the barriers, deterring misconception and misjudgement against certain cultures that may hinder a productive relationship on board a ship; and for a greater number of our people to feel greater satisfaction and enjoyment because of an enhanced good working relationship in any ship. Please post this circular to the mess halls and other conspicuous areas on board so that it will serve its purpose.*"

While it is certainly a good idea to post memos in visible places to be caught by the viewer's photographic memory, the expectation that it will substantially contribute to resolving possible breakdowns in intercultural communications is far from realistic. Raising awareness of problems is just the first step towards a less critical approach to other cultures, while only a much more comprehensive training including practical exercises could be expected to result in real changes in an individual´s attitude.

2.2. Multiculturalism as Represented in the Maritime University Studies at FMS

For the purpose of this paper, an investigation into the university courses incorporating multiculturalist topics in the

6. *According to some encyclopaedic interpretations (http://www.enciklopedija.hr/natuknica.aspx?id=67397 and http://www.encyclopedia.com/history/dictionaries-thesauruses-pictures-and-press-releases/media-history) Aristotle's definition of the human being as ζώον πολιτικόν clearly regards humans as properly belonging to a polis or community, but also indicates that humans are distinguished by communication since there can be no conception of a community without communication, and vice versa, as the Latin etymologies suggest.*
7. *Mianxi (pronounced mianzi in Mandarin Chinese), as a trait of Chinese culture, was first mentioned by an American missionary to China in the 19th ct. His name was Arthur Smith, and he spent 54 years in China. In the resulting book called "Chinese Characteristics", he pointed out that this was the key concept to understanding Chinese personality.*
8. *Croatian obraz, according to the Croatian Language Portal (Hrvatski jezični portal-HJP): conn. honour, honesty, pride. The item is followed by 10 different phrases, all having connotative meanings. (available at: http://hjp.znanje.hr/index.php?show=search_by_id&id=eFtmUBE%3D)*
9. *More about the concept of face and the communicative category of politeness in Čulić-Viskota A.(2002)*
10. *Guidelines for intercultural relations, issued by NYK shipping company, were first consulted in 2007 and mentioned in a conference paper presented at 2007 International Maritime English Conference in Rotterdam, Netherlands.*

curricula designed and implemented at the Faculty of Maritime Studies of the University of Split, has been undertaken.

The results have shown that multiculturalist topics are represented in the *Nautical* and *Marine Engineering* departments, with only one relative core course, *Psycho-sociology*, at the undergraduate level for nautical students, and *Work Organisation and Management on Board* for marine engineering students. The students of *Marine Electrical Engineering and Information Technologies* are offered the elective course *Work Organisation and Management on Board* in the 3rd semester, and the core *Safety at sea* in the 6th semester. *Maritime management* students have two core courses in the 2nd semester, *Management in Shipping and Ports*, and 3rd semester, *Communicology*, with an additional possibility of elective *Socio-psychology* in the 6th semester, as they are obviously expected to deal with people originating from different cultures, whether they work on board or on shore. The best educated students in this respect should result from *Marine Yacht and Marina Management* studies, as they are offered the core *Communicology* and elective *Socio-psychology* in the undergraduate, and two compulsory courses, *Human Resource Management* and *Psycho-sociology*, related to multiculturalist topics in the graduate studies.

In the compulsory course in *Psycho-sociology*, a lecture is dedicated to the *acceptance / inclusion of others: identity and multiculturalism on board*. Still, it is only a 1.5-hour lecture, without discussion or exercises to follow. This can only give students an idea of the topic without a more serious possibility of examining or deepening it. In the elective course *Work organisation and management on board* for the students of *Marine engineering*, one of the topics dealt with is *Management in the conditions of cultural differences*. Students of *Marine electrical engineering and information technologies*, except for the possibility of the elective course in *Work organisation and management on board*, have no multiculturalist topics included in any of the core courses, although the course in *Safety at sea* (45 hours of lectures and 15 hours of exercises) could certainly provide students with more than technical knowledge about the behaviour in emergencies. A number of International Maritime Organization Casualty Reports point out poor communications between different cultures as factors leading to accidents. More lecture themes related to multiculturalism can be found in the course on *Communicology*, and these are referred to as *Intercultural and non-verbal communication*, as well as *Organisational communication*. Finally, the course in *Human resource management* incorporates ideas about *neuro-linguistic programming*, which can also be related to multiculturalism, but no other topics within this course have been detected to relate to it.

2.3. Multiculturalism as Part of Maritime English Courses, and the Related Teaching Materials

The idea of multiculturalism should, more than in any other courses, be part of Maritime English courses at maritime universities. An investigation has been conducted into some teaching materials for Maritime English courses at this point, with the objective to find out how much multiculturalism there is. The results are not encouraging. For example, ships' crews in the teaching materials considered mainly consist of crewmembers of European origin: English, Scottish, German, Finnish, Polish or Latvian. No other nationalities are mentioned which currently represent a greater part of ships' crews. The materials should therefore be reviewed periodically, and alterations to suit current practices should be made if the materials are to remain in use over a lengthy period of time due to their being high-quality teaching materials from other aspects. Secondly, students' level of the English language knowledge at enrolling in university studies has been observed to be increasing rapidly due to their exposure to English through written and spoken communication. Therefore, due to the existence of modern e-learning Maritime English teaching materials such as those resulting from the MarEng Project as well as the already iconic IMLP, the students at maritime universities can very well acquire the basic terminology through independent e-learning, while the Maritime English lecturer should assist them, among other things, in the acquisition of intercultural communication skills. The terminological aspect of Maritime English is a kind of knowledge that is easily obtainable, understandable and easy to remember. Most of the time a Maritime English lecturer has for the terminology-related part of the syllabus should be dedicated to the disambiguation of terms. The topics like multi-/intercultural ones are currently those which should be more closely and extensively dealt with. More time should be dedicated to the topics on which safety provided by appropriate communication is based. Communication can be expected to be appropriate only when the participants are able to tolerate, understand, and accept one another, and this goal cannot be reached by insisting on the operational language only, but on the language in use, i.e. what the participants in a communication act can do with the language, which again is highly dependent on the cultures from which they originate. Therefore, the Maritime English lecturer should certainly be an English lecturer, but also an *intercultural broker*[11], who will help to educate *culturally literate*[12] seafarers.

11. *The term is used and explained extensively by Bocanegra-Valle, A. (2015) Intercultural Learners, Intercultural Brokers and ESP Classrooms: The Case of a Shipping Business Course*
12. *The term cultural literacy was coined by E.D. Hirsch (1987), and reappeared in Hirsch, Kett, & Trefil's (2002).*

3. CULTURAL PROFILE OF THE 1ST-SEMESTER STUDENTS AT FMS, AND THEIR VIEWS OF OTHERNESS

In order to be able to incorporate multiculturalism topics into Maritime English courses for the students at the Faculty of Maritime Studies in Split, a need was felt to discover their worldviews and attitudes towards otherness and inclusion, and to specify what the points of departure and destination should be, i.e. how long our voyage to understand and accept otherness and its inclusion would be, and what the teaching material should concentrate on.

3.1. Research Methodology: Use of Appropriate Multiculturalism Questionnaire

First, the decision had to be made on an appropriate questionnaire to be used for the purpose. There are already numerous questionnaires available worldwide, which had been devised for different purposes by different specialists in various fields, mostly psychologists. Thus, the decision was reached to use the *Multiculturality Experience Questionnaire* devised by Narvaez (2009)[13]. Still, it was devised for different target audiences and was not entirely appropriate for the Croatian students of maritime studies due to its containing a number of items not relevant for this purpose, e.g. those referring to the state of affairs specific for the USA, including the country-specific minority groups. So, the Narvaez *Multiculturality Experience Questionnaire* (MEQ) was adapted with the permission obtained from the author by retaining the first 15 items and leaving out the remaining 2 strictly USA-specific ones. The original scales by which the students´ answers were analysed have also been retained.

The investigation was carried out with the 1st-semester students in order to better familiarise the Maritime English lecturers with the kind of prevailing student mindset, i.e. their mental attitudes or predispositions that predetermine their responses to and interpretations of persons and situations. The questionnaire had to be inclusive enough to allow drawing conclusions but, at the same time, of appropriate complexity and length that would not discourage the 1st-semester students from participating in the research.

According to Narvaez´s idea, even in the adapted questionnaire, i.e. without the two additional items, there are two different subscales:

1. *The Multicultural Experience subscale* to which the items numbered 1, 3 – 5, 7, 12, 13, 14, and 15 refer;
2. *The Multicultural Desire subscale* to which the items numbered 2, 6, 8, 9, 10, and 11 refer.

The Multicultural Experience subscale helps in getting acquainted with the students´ current experiential assets, while the refers to the person's willingness or desire to increase their multicultural experiences and may be considered as an indicator of their open-mindedness.

3.2. Results and Discussion

The total number of 225 students from the 5 departments of the FMS participated in the survey by anonymously answering and filling in a 15-item-questionnaire.

The following is the analysis of each of the 15 items of the questionnaire, as answered by the 225 students.

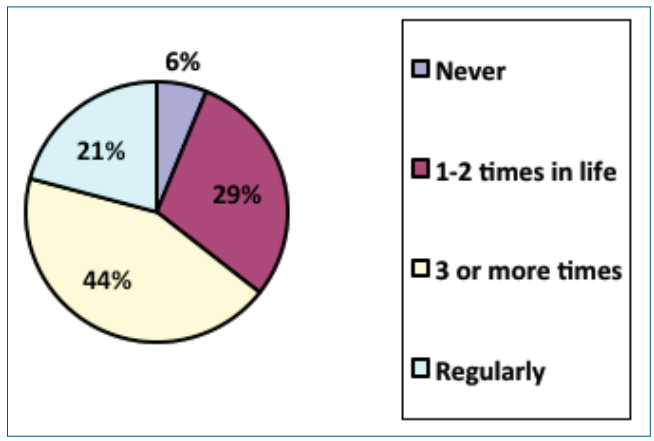

Figure 1.
Results of answers to Item 1: How often do you travel out of your country?

Figure 1 shows that 65 % of the students, who travel regularly or have travelled three or more times out of their own country, can be considered appropriate for the job of a seafarer, who will probably spend most of their working time abroad, in different countries and foreign cultures. However, 6% of the students have never been out of their own country by the age of 18. This can be an indicator of their possibly not having a clear idea of what is expected of them in their future job.

Figure 2 shows that 97 % of the students want to travel outside of their country, which is an essential attitude for their future job. However, the remaining 3 % of the students are not at all keen on leaving their country for their job, which is certainly not an attitude in favour of the seafaring profession.

13. *Darcia Narvaez, Ph.D., University of Notre Dame, IN., USA and her collaborators devised the questionnaire in 2009. With permission grant, the questionnaire was adapted for the purposes of this study.*

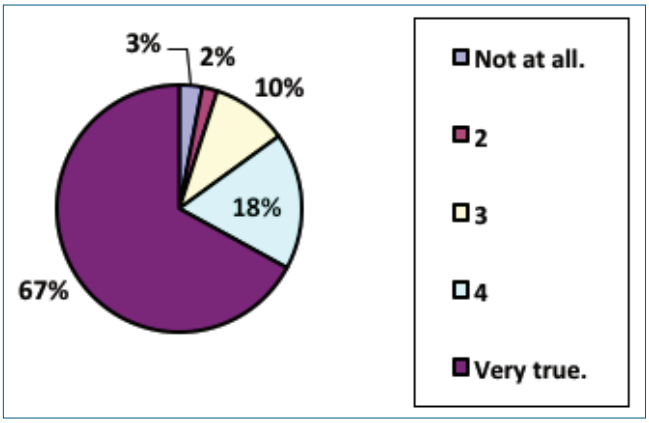

Figure 2.
Results of answers to Item 2: I want to travel outside of my country.

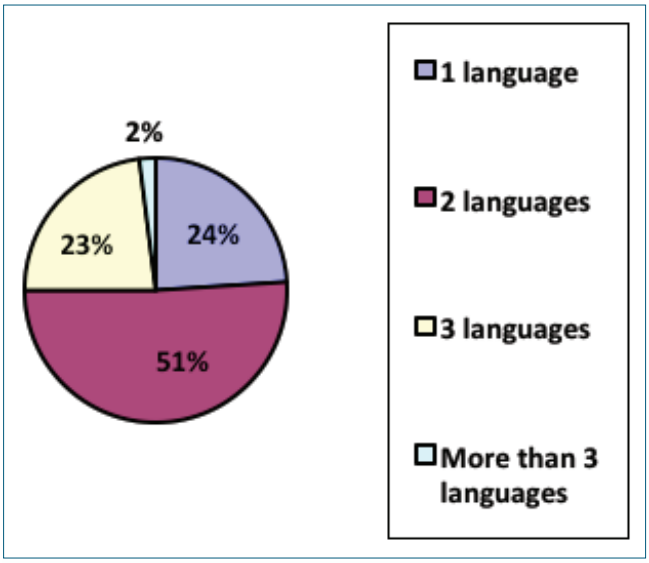

Figure 3.
Results of answers to Item 3: How many languages do you speak well?

Figure 3 shows an encouraging result of the students' knowledge of languages. Although English is the operational or vocational language in maritime affairs, there are different situations in onboard activities, e.g. during pilotage, when the activities are facilitated by the knowledge of the local language.[14] Thus, 76 % of the students speak well at least two or more languages. However, the percentage of students who have stated that they speak well only one language (i.e. mother tongue), is considered too high.

14. *For more about Master-Pilot-Tug communication characteristics and problems, see: Čulić-Viskota, A. (2014); (2015).*

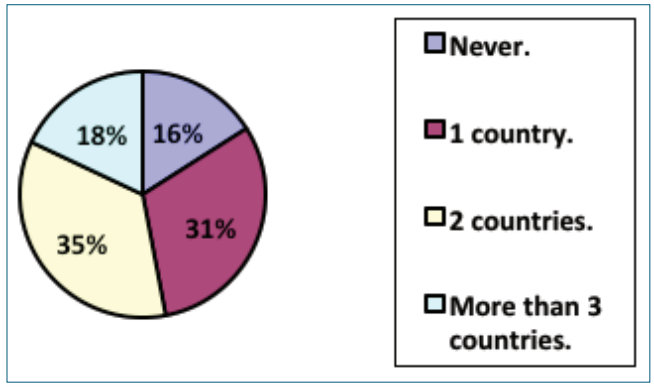

Figure 4.
Results of answers to Item 4: I correspond currently with people from other countries.

According to Figure 84 % of the students correspond with people from other countries, which can develop not only their knowledge of the language used for correspondence, but also of the elements of knowledge of other cultures. This fact can be used in the classroom work and these students can be given the opportunity to present the elements of their communication that they consider of possible interest to their colleagues, and the latter can indirectly get in contact with different cultures in this way.

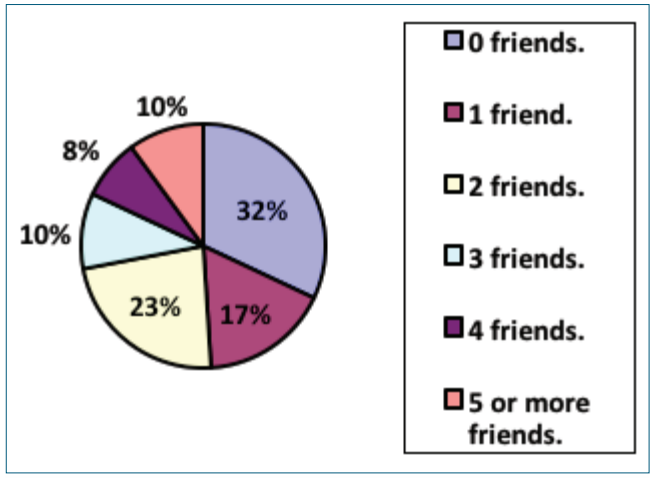

Figure 5.
Results of answers to Item 5: I have friends from cultural / racial / ethnic backgrounds different from my own.

Figure 5 shows that 68 % of the students have at least one or more friends with cultural / racial / ethnic backgrounds different from their own, and it is an encouraging fact as regards the development of their readiness to accept otherness in different forms it may take, or at least an initial predisposition

to the development and growth in this regard. The ship's crew is based on hierarchy, but they have to live as a family, in a limited space and with respect for one another.

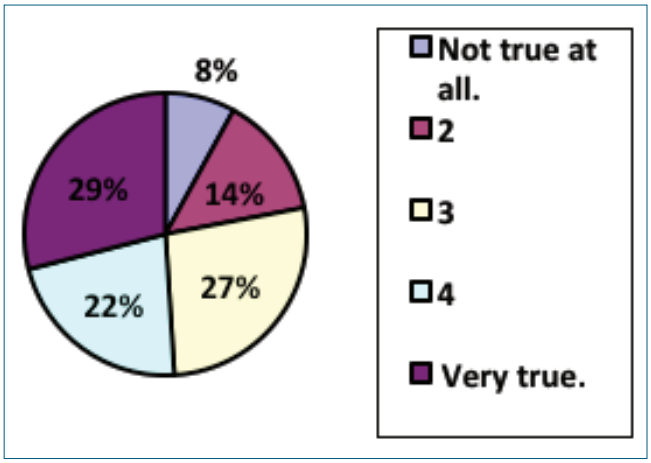

Figure 6.
Results of answers to Item 6: I want to have friends from different cultural/racial/ethnic backgrounds.

Figure 6 shows that 92 % of the students want to establish friendly relations to persons of different cultural / racial / ethnical backgrounds. This indicates their open-mindedness essential in their future jobs. However, 8 % of the students expressed overt disinterest or reluctance to do so, which makes them a group of particular interest for the lecturer, whose aim should be to try to make them contemplate on the nature of friendship and possibilities of making friends with persons of cultural or other backgrounds different from their own.

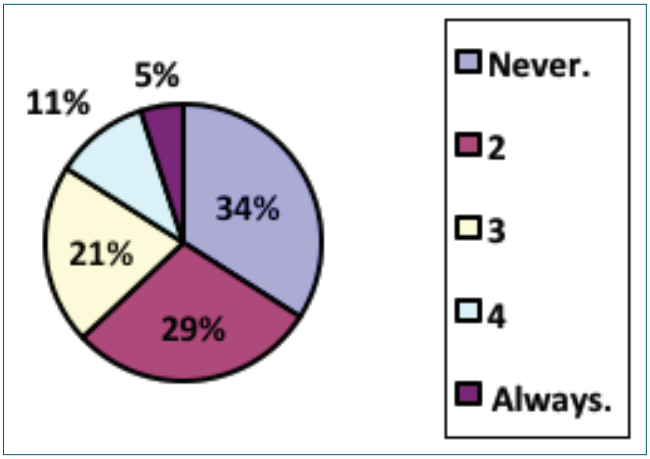

Figure 7.
Results of answers to Item 7: I study/work with people from cultural / racial / ethnical backgrounds different from mine.

Figure 7 reflects the true image of a largely mono-cultural society like the Croatian, i.e. 63 % of the students never or hardly ever find themselves involved in any kind of activity with persons from different backgrounds, which is certainly a disadvantage considering the requirements of their future jobs in the maritime domain.

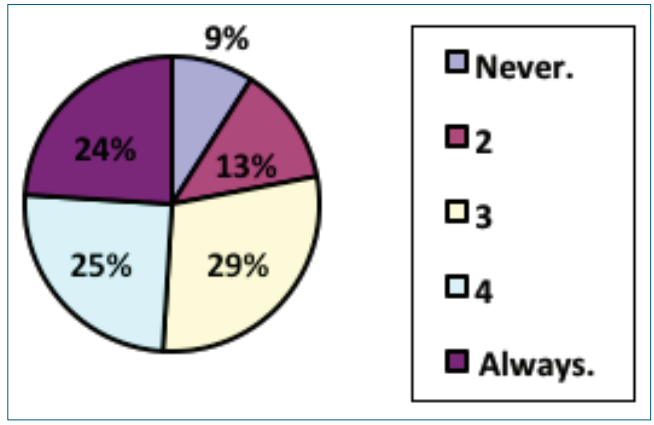

Figure 8.
Results of answers to Item 8: I go out of my way to hear/ read/ understand viewpoints other than my own.

Figure 8 shows that 9 % of the students never go out of their way to understand viewpoints different from their own, while 13 % of them hardly ever do so. Still, taking into consideration that 63 % of the students never or have hardly ever found themselves in a multicultural setting (see Figure 7), the considerably lower number of respondents not showing open-mindedness at the beginning of their studies is already an optimistic start for the lecturer.

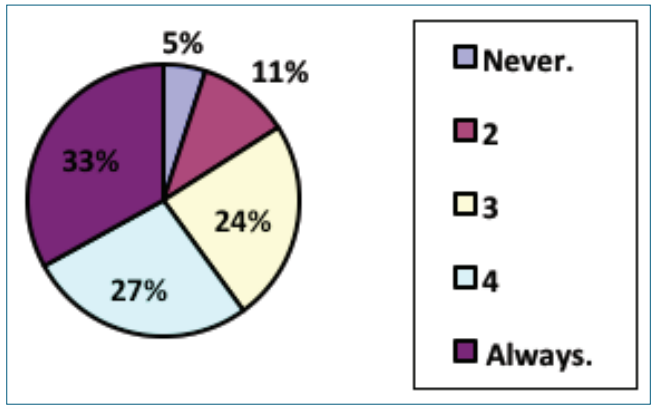

Figure 9.
Results of answers to Item 9: I try to get to know people who are different from me.

Figure 9 shows that a still lower number of respondents, 5 %, have expressed refusal or reluctance to meet persons from other cultures. It is possible that a lack or an insufficient exposure to multicultural settings and situations are the main reasons for this apparent lack of interest or willingness expressed.

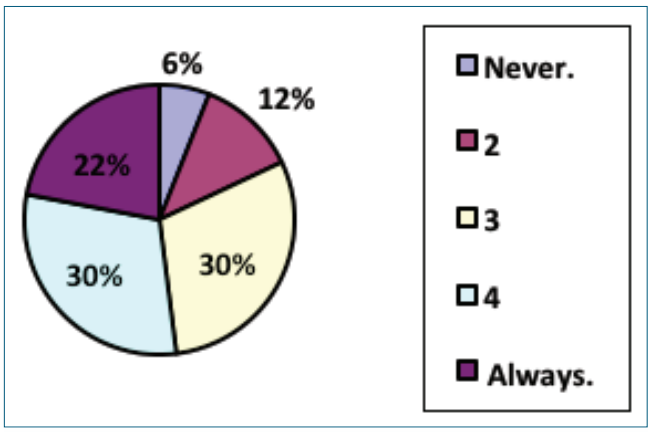

Figure 10.
Results of answers to Item 10: I push myself to explore my prejudices and biases.

Figure 10 shows that still 18 % of the students never (6 %), or hardly ever (12 %) try to recognise and analyse their own prejudices and biases. This certainly makes an important part of one's culture, i.e. of those 90 % of the cultural iceberg that is not visible without a deeper immersing oneself below the surface of the conscious part of our personalities.

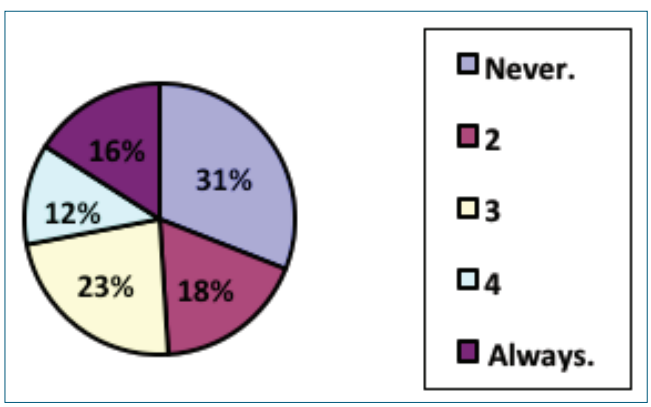

Figure 11.
Results of answers to Item 11: Discussing issues of discrimination, racism and oppression makes me uncomfortable.

Figure 11 shows that 51 % of the students who answered 3, 4, or 5, feel uncomfortable discussing 'difficult' topics such as discrimination, or oppression of any kind. Persons who intend to work in a multinational / cultural setting should be prepared to at least contemplate about such topics, which are certainly not the most pleasant ones, but university level students should already start thinking and discussing topics of interest to different social groups so as to raise their awareness of the possibilities of each individual to contribute to the empowerment of different discriminated groups.

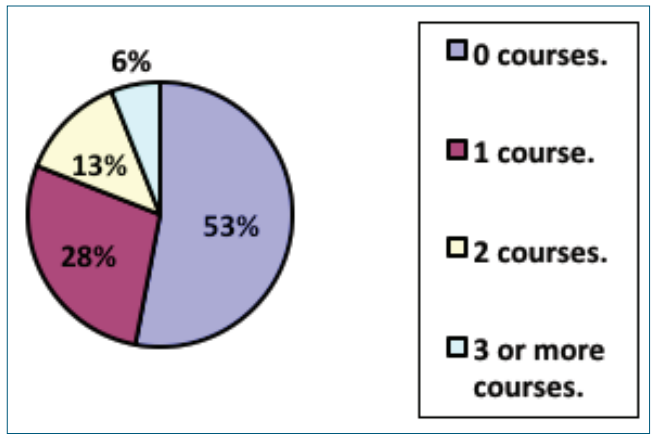

Figure 12.
Results of answers to Item 12: I have had courses/part of courses in intercultural communication.

Figure 12 shows that 53 % of the students have never been exposed to any form of intentional institutional education on intercultural communication. This indicates an urgent need to include elements of cultural diversity and interaction into elementary and secondary education. This would be of particular importance for largely mono-cultural societies such as Croatian.

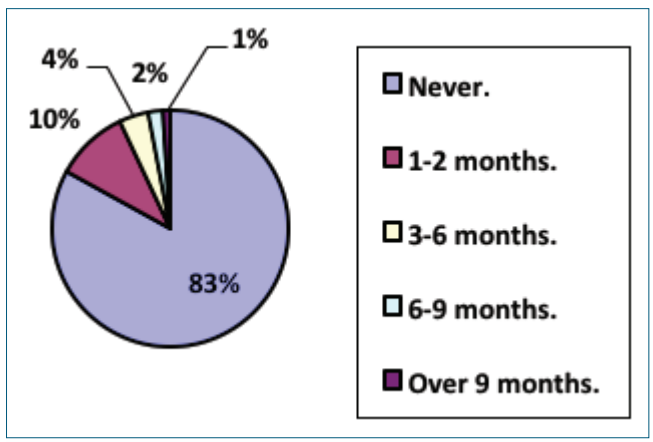

Figure 13.
Results of answers to Item 13: I have lived in a contrasting community (with a very different culture from my own).

Figure 13 further supports the thesis expressed in the analysis of the statistics presented in Figure 12. Namely, 83 % of the students have never lived in any kind of contrasting community. This indicates that their sensibility for otherness and diversity should be very low and requiring a gradual development to meet the requirements of their future jobs.

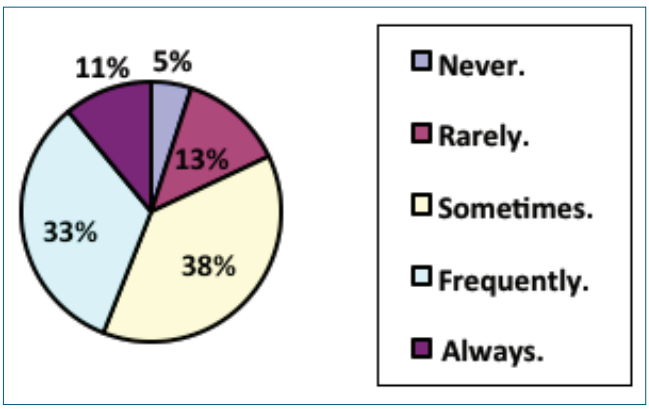

Figure 14.
Results of answers to Item 14: I pay attention to news about the world beyond my own country.

Figure 14 shows that 18 % of the students never (5 %), or rarely (13 %) pay attention to the news about the world beyond their own country. Also, 38 % of the students do it only sometimes, i.e. not on a regular basis, which again is an indicator of a rather low interest for otherness. Here again, a Maritime English lecturer can take the responsibility of bringing news about current events in the world to be discussed in class.

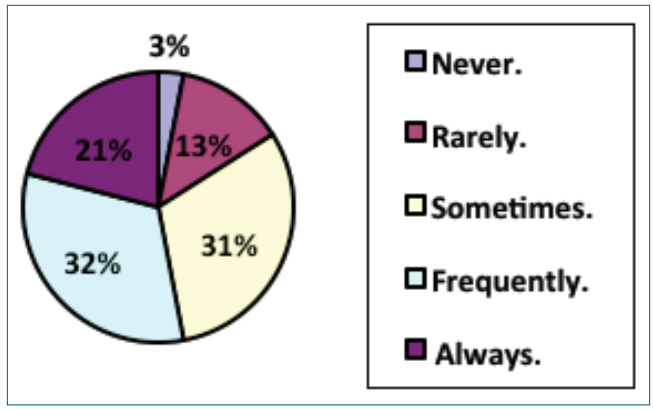

Figure 15.
Results of answers to Item 15: I enjoy media and art from different cultures.

Figure 15 shows that more than 84 % of the students (answering *Sometimes, Frequently,* and *Always*) are interested in getting in touch with the media and arts from different cultures, the frequency from sometimes to regularly ranging almost evenly. Still, there are 16 % of the students who never (3 %), or rarely (13 %) enjoy media or arts from cultures different from their own These are the ones to whom special attention should be paid in order to motivate them to explore other cultures and look for similarities in expressions or even diversities, which can also be attractive to foreigners.

Below, the ratio of positive (P) to negative (N) results of the survey is presented in Table 1 - *Multicultural experience subscale,* and in Table 2 - *Multicultural desire subscale*.

Table 1.
Multicultural experience subscale, according to survey results.

	Multicultural experience subscale: average positive 71.22 %								
N	6 %	24 %	16 %	32 %	37 %	53 %	83 %	5 %	3 %
P	94 %	76 %	84 %	68 %	63 %	47 %	17 %	95 %	97 %

Table 2.
Multicultural desire subscale, according to the survey results.

	Multicultural desire subscale: average positive 87.66 %					
N	3 %	8 %	9 %	5 %	18 %	31 %
P	97 %	92 %	91 %	95 %	82 %	69 %

From the results presented in Tables 1 and 2, the only negative percentages on the *Multicultural experience* subscale refer: 1) to the answers to Item 12 because 53 % of the students have not had any courses or parts of courses related to intercultural communication, and 2) to the answers to Item 13 because 83 % of the students have never lived in a culturally contrasting community. In all the other seven items, the students' answers were predominantly positive, resulting in an average positive percentage of 71.22 %. As regards the *Multicultural desire* subscale, which has resulted from the students' answers to six items, a highly positive score over all the questions can be observed, average positive percentage of 87.66 %, thus allowing optimistic expectations from all the students in their future studying intercultural relations and later participating in such relations.

3.3. Weakness of the Research Performed and Future Investigation Planned

With all the inevitability of the research performed in order to obtain some indicators as to the suitability of the current 1st-year students - prospective seafarers or maritime affairs participants in the diversity of its sectors, the research has obvious weaknesses. This survey was carried out among the current 1st-year students, and the output results will only be available in 3 years' time, i.e. on their completing the undergraduate studies, to test their progress in multicultural sensitivity, which could indicate the need for a more systematic approach to this important issue. Therefore, on every occasion, with topic and time allowance, emphasis should be put on the multicultural aspect of a situation and on the elements indicating culture-specific behaviour, not only in the social sciences courses included in the curriculum, but also in Maritime English courses. Only then will there be a solid enough ground to investigate into the possible gain.

4. CONCLUSION

The investigation into the 225 FMS maritime students' multicultural experiences and desire has shown that the majority of students coming from a largely mono-cultural society, such as Croatian, are nevertheless ready to face the multicultural setting, such as a ship's crew, and also try to a certain extent to prepare themselves for the experience by opening their minds to customs and attitudes different from their own, by making friends with their peers from different cultures, by travelling to foreign countries, and by experiencing different cultures through social media. These are encouraging facts because any person aiming at working in a multicultural setting should be prepared for intercultural communication, which presupposes openness to the different by understanding, respecting, and inclusion.

In this sense, it is the task of a Maritime English lecturer to assist the students in developing their intercultural competence, not only because the English language is the communication medium in the maritime field, but also because through learning about the differences in using language functions in English as compared to their own mother tongue, the students should avoid future breakdowns in communication. This is as important for their business communication as it is important for their successful taking part in everyday personal communication in intercultural encounters with the rest of the crew.

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Information Model for Global Shipbuilding in the Period of 2016 – 2020

Vinko Vidučić

This study explores the worldwide demand for the newly-built ships from 2014 to 2017 and produces forecasts for the demands concerning the years 2018 and 2020, on the basis of mental and verbal insights into the global shipping market, theoretical aspects of the issue, and the selected variables (South Korea, China, Japan, Europe and the Rest of the World) of the information model for the global shipbuilding. The value of the variables for the year 2016 has been achieved by taking into account the synergetic effect of the percentage obtained per order books across the world, gross tonnage in 0,000 GT and the value of vessels in billion US$ for each selected variable. In the next stage these values have been quantified based on the mental and verbal insights into the scientific aspects of the global shipping market variables of the information model for the global shipbuilding in the years of 2018 and 2020. In this way, for the first time, the growth matrix has produced the values of the selected variables, i.e. the direct growth rates of the information model for the global shipbuilding for the period 2018-2020. The research has involved a combination of scientific methods, among which the most relevant are analysis and synthesis, induction and deduction, descriptive, comparative, statistical and mathematical methods, method of model drawing (growth matrix), and methods of proving and refuting.

KEY WORDS
~ Shipbuilding
~ Ship
~ Cost
~ Production
~ Growth
~ Shipyard
~ Orders
~ Economy
~ Crisis

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1. INTRODUCTION

There are presently more than 250 large shipyards in the world. Most of them operate in the East Asian countries, i.e. South Korea, China, and Japan. The importance of this industry is clearly reflected through job creation across various business sectors and the interrelation of their economic activities. One of the causes of the current economy growth in these countries is the efficiency of their shipbuilding industries.

The development of world economy under global conditions has resulted in an increased demand for the seaborne shipping capacity. This has led to the growing number of newbuilding orders. This, naturally, affects the price of newly-built vessels. Opposite trends occur in the times of economic crisis, when the demand for newbuilding decreases along with the price of these products.

In terms of technology, shipbuilding represents an intensive activity. It requires the application of cutting-edge technological achievements and encourages the innovative production processes that reduce costs and affect competitiveness in a significant manner.

This issue has been in the focus of numerous studies, but this is the first time that it has been approached through an information model. This study uses the growth matrix to calculate the values of the selected variables of the information model for global shipbuilding and their direct growth rates for the period

2016 – 2020. In addition to the matrix and modelling, the study has also involved a combination of relevant scientific methods, including statistical and mathematical methods, induction and deduction, descriptive and comparative analysis and synthesis.

It is important to note that the quantification of the variables has been performed by taking into consideration the synergy of total gross tonnage and financial value of the newly-built ships, with reference to the countries and areas where the most important large shipyards are located.

2. MARITIME SHIPBUILDING MARKET

A shipbuilding process starts by designing a vessel. This implies a great deal of maps and drafts for making individual sections, as well as the design of the vessel as a whole. Designers and builders have to define and elaborate production processes, the flow of material supply, and so on. All these activities take considerable time resulting in multi-year deadlines. The latter stretches over a long period of time also due to the fact that respectable shipyards tend to keep their order books filled for a number of years ahead. In addition to deadlines, price, quality, and references, a shipper typically selects a particular shipyard taking into account the ways of financing the project (Hrvatska enciklopedija, 2017).

Shipbuilding heavily affects the growth of the related industries that create intermediate products to be fitted goods into the newbuilding. These industries include ferrous and non-ferrous metallurgy, engine building, wood industry, paint and lacquer industry, electrical engineering, etc. (Šimičić, 1972).

Through these multiplier effects, a single job in the shipbuilding industry creates three to five jobs in associated industries. Modern shipyards focus on their core business, outsourcing most of other production activities. Nevertheless, shipyards – and not the subcontractors – take the ultimate responsibility for the deadlines, product quality, and for meeting all other liabilities stipulated by the contract between the shipper and the shipbuilder (Kersan-Škabić, 2009).

The value of the shipbuilding contract depends on the warranty costs, deadline, quality of the delivered product, risk of increase in material prices (especially iron), cost of insuring the newbuilding in progress, currency of payment and the related risks, price of energy, labour, and so on (Ivanković et al., 2009).

A shipyard has to ensure necessary assets for all processes during building a vessel, while the client pays smaller amounts in advance or in instalments during the construction period, with the largest amount paid after the delivery. Warranties for financing the newly-built ships are normally provided to shippers by their commercial banks, whereas the shipyard obtains warranties from commercial banks and, under specific conditions, from the state (Hrvatska brodogradnja, 2015). In the present time of globalisation, this may affect the competitiveness of a shipyard in the global market, often resulting in dumping and disloyal competition, which is non-compliant with the postulates of the World Trade Organization (WTO). Japanese and South Korean shipyards are typical examples of the state-subsidy practice that has enabled them to become frontrunners in the global shipbuilding market (Author's calculations, 2017).

Coastal areas of the USA and developed countries of Europe have become inadequate for large-scale shipbuilding processes due to stringent environmental standards. It is well known that shipbuilding activities harmfully affect the environment. They require huge coastal areas, thus representing a non-economical option in the above mentioned countries, where the real-estate prices along the shorelines are rather high. This is why these areas are typically focused on more profitable industries, including housing, tourism, banking, and service activities in general (SEA Europe, 2017). Modern shipbuilding is an industry demanding a sophisticated know-how and high-skilled workforce. This requirement can be met only by highly developed and some of the developing economies (Razvoj, 2017).

3. WORLD ORDER BOOK OF NEWBUILDINGS

Today's largest shipyards are located in the Far East, in South Korea, China, and Japan. The leading shipyards take huge tracts of land in the vicinity of industrial zones outside city limits. Nine largest South Korean shipyards are situated in the same region. One of the reasons for the shipbuilding downsizing in the developed countries of the West is related to the environmental issues and the concept of sustainable development (Statista[b], 2016).

Figure 1 shows that in the first half of 2016 the world order book was in decline, compared to the same period the year before. Around 106 million compensated gross tons (CGT) or 5809 vessels were ordered. Their total value was approximately 290 billion US$. The share of European shipyards amounted to 13 % or 38.8 billion US$ of the ordered newbuildings, i.e. 8 % CGT. These figures indicate that European shipyards produce more complex vessels, i.e. vessels with higher added value per tonnage (CGT) (Hrvatska brodogradnja, 2014).

The 2015 frontrunners in the number of contracts were the shipyards in China and Japan. However, in compensated gross tons (CGT), the leading shipyards were those in South Korea. In 2014, South Korean shipbuilding industry produced 33 % of the global bulk carrier tonnage and 13 % of the global container ship tonnage. In 2015, the output increased to 29 % of all types of vessels. That year, the world order book contained a total of 1598 bulk carriers with around 130 million tdw, 978 tankers with about 93.6 million tdw, 436 container ships with around 42.5 million tdw, 201 LPG tankers with about 6.7 million tdw, and 159 LNG tankers with approximately 13.1 million tdw. (Hrvatska brodogradnja, 2015).

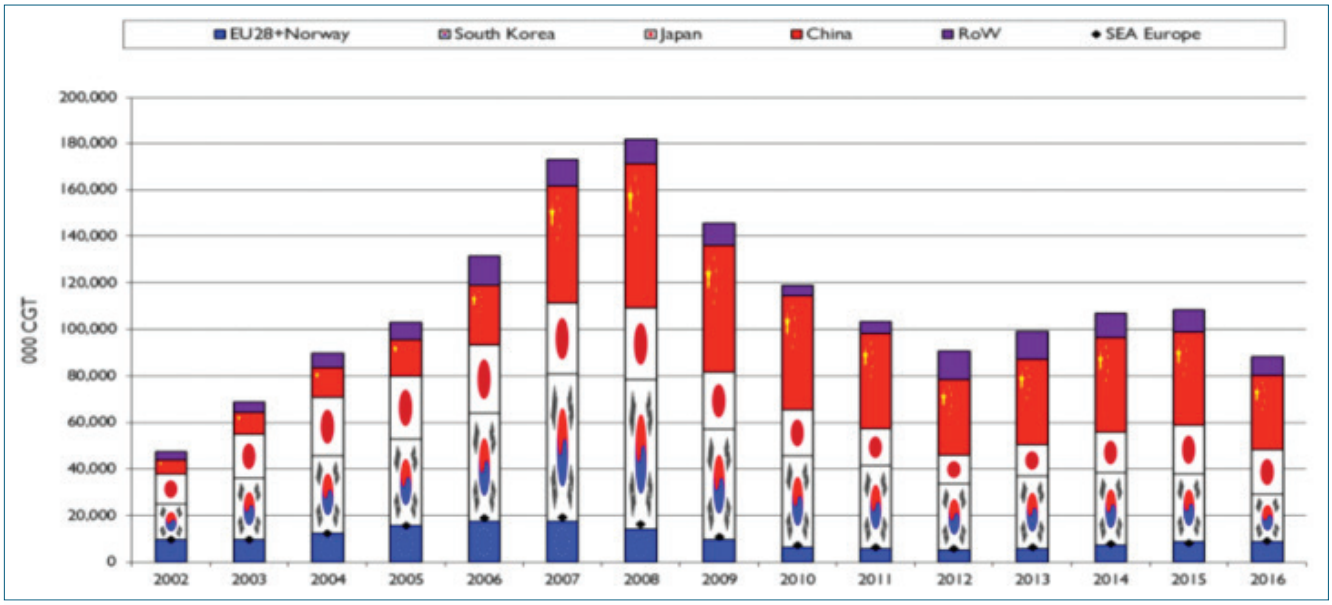

Figure 1.
World's book of orders by shipbuilding regions in the period 2002- 2016 (Razvoj, 2017).

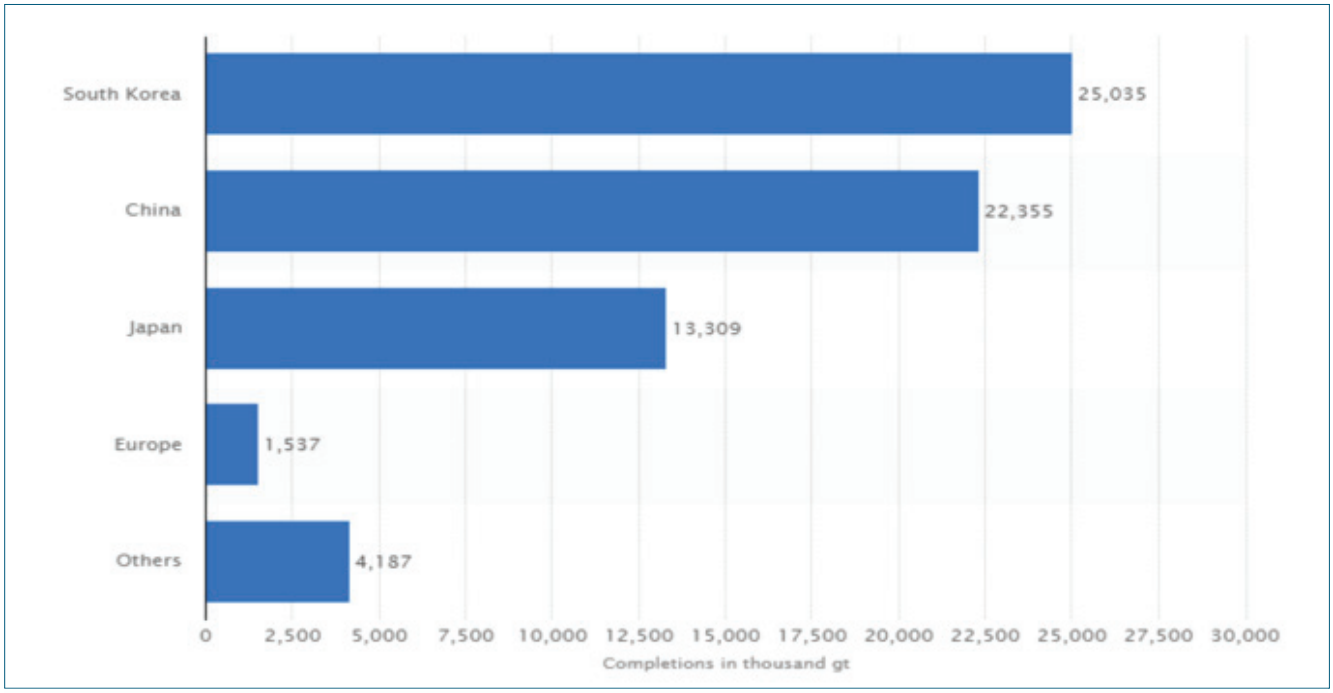

Figure 2.
Major shipbuilding countries in December 2016 (in thousand GT) (Statista[a], 2016).

Figure 2 shows that, at the present time, the leading shipbuilding countries include South Korea, China and Japan. The year of 2016 experienced a slight decline in the book of world orders when compared to 2015. During the period 2014-2016 Japan's shipbuilding industry produced a larger number of vessels than South Korea. In terms of compensated gross tons (CGT), China ranked best in world order book with 31.7 M CGT, followed by South Korea (20.4 M CGT), Japan (19.2 M CGT) and the EU 28+Norway (8.6 M CGT). As for types of ships, tankers represent the principal item in the world order book (20 % CGT), followed by bulk carriers (18.9 %) and container ships (17.8 %). The shares of passenger ships and offshore vessels were 8.2 % and 12.8 %, respectively (SEA Europe, 2017).

Figure 3 shows that South Korea and China had the largest order books in 2017. The market share of Europe increased to 19 %, mainly due to construction of passenger vessels, cruise ships and off-shore vessels (SEA Europe, 2017).

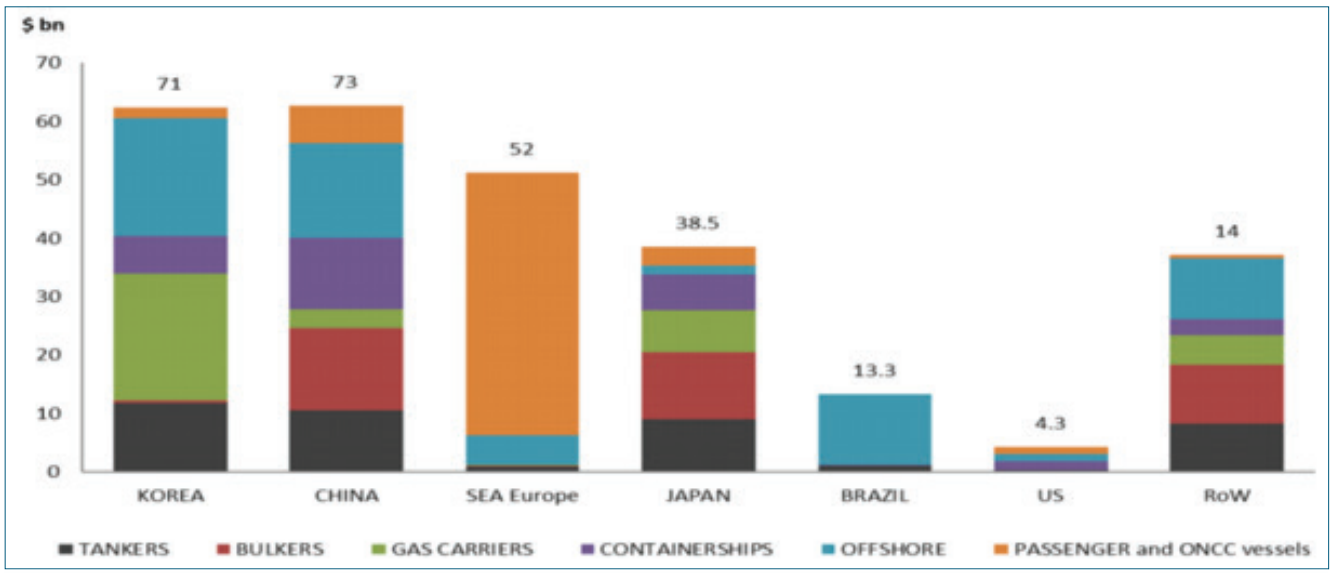

Figure 3.
Value of shipbuilding orders by areas (in billion US$) in February 2017 (Razvoj, 2017).

March 2017 experienced the lowest level of shipbuilding orders since 2008, amounting to just 513 newly-built vessels. Compared to the same period in 2016, new-build orders were reduced by 70 %. However, the demand for passenger vessels and cruise ships increased, together with the record growth in LNG tonnage (304 %). In terms of CGT, the 2017 world order book had 36 % of tankers, 22 % passenger ships, 13 % bulk carriers, 7 % container ships and 4 % offshore vessels. Compared to the early 2016, the major production drop in 2017 was in refrigeration ships (100 %), container and offshore tonnage (61 %), passenger vessels (13 %), RO-RO ships (12 %), and product and specialised tankers (1 %). Other types of tonnage experienced a notable growth in 2017, ranging from 24 to 304 % (Hrvatska brodogradnja, 2017).

Figure 3 also demonstrates that, in early 2017, most of tankers, in terms of their value (CGT), were ordered at shipyards in South Korea, China and Japan. Likewise, it can be noticed that most of LNG carriers, in terms of their CGT, were ordered at shipyards in South Korea, Japan, the Rest of the World, with China ranked at the 4th place. The highest value of production of bulker tonnage was recorded at shipyards in China, Japan and the Rest of the World. It is obvious that South Korea does not participate significantly in building these simple and low-cost vessels. As far as container ships are concerned, most of their CGT was ordered in China, Japan and South, with the Rest of the World lagging behind. The largest global value of passengers, cruise and offshore tonnage was recorded in Europe, while the Chinese, Japanese and South Korean shipyards were lagging far behind.

In the following years, a reduced demand for offshore vessels may be expected because of the lowered oil prices and decreased activities in new investment, exploration and exploitation of hydrocarbons. Likewise, a reduced demand for LNG carriers may be expected due to their high percentage in the present order books. It is assumed that the demand for bulk carriers will remain stable, as will the demand for passenger and cruise tonnage (Poslovni.hr, 2017).

The analysis of the global market of the shipbuilding and the most relevant shipbuilding economies over the period of the next several years, results in the probable scenarios, as follows:

1. South Korea: decrease in new-build LNG and offshore tonnage orders and the continuing demand for tankers and container ships,
2. China: continuing demand for bulk carriers, container ships, tankers, passenger vessels and cruise ships, and declining production of offshore vessels and LNG carriers,
3. Japan: continuing demand for bulk carriers, tankers, container ships, passenger vessels and cruise ships, and declining production of offshore vessels and LNG carriers,
4. Europe: continuing demand for passenger vessels and cruise ships, and drop in offshore tonnage orders, and
5. the Rest of the World: continuing demand for bulk carriers, tankers, container ships, and reduced LNG and offshore tonnage demand.

4. QUANTIFICATION OF THE VARIABLES OF THE INFORMATION MODEL FOR GLOBAL SHIPBUILDING OVER THE PERIOD 2016-2020

The variables selected for creating the information model for the global shipbuilding industry over the period 2016-2020 include: South Korea, China, Japan, Europe and the Rest of the World (RoW).

In terms of value of the newbuildings (in thousand CGT) and according to the world order books, this was the situation found in December 2016 (see Figure 2):

1. South Korea:	25.0	=>	38 %
2. China:	22.4	=>	34 %
3. Japan:	13.0	=>	20 %
4. Europe:	1.5	=>	2 %
5. RoW:	4.2	=>	6 %
Total:	66.1	=>	100 %

In terms of value of the newbuildings (in billion US$) and according to the world order books, this was the situation found in February 2017 (see Figure 3):

1. South Korea:	25.0	=>	35 %
2. China:	22.4	=>	33 %
3. Japan:	13.0	=>	20 %
4. Europe:	1.5	=>	5 %
5. RoW:	4.2	=>	7 %
Total:	66.1	=>	100 %

Taking into the consideration the synergetic effect of the percentage obtained from the world order books, in terms of tonnage (CGT) and value (US$) of the selected variables, the variable values for the year 2016 have been produced, as follows:

1. South Korea:	33
2. China:	31
3. Japan:	20
4. Europe:	7
5. RoW:	9
Total:	100

Note: It is assumed that the total number of points for the selected variables will always be 100 for each year presented in Table 1. Each variable is quantified on the index scale from zero to 100. On the basis of the mental and verbal insights into the scientific aspects of the global shipping market variables of the information model for the global shipbuilding, and on the basis of the study presented in the above paragraphs, the values of the variables are quantified for the years of 2018 and 2020, as shown in Table 1.

Table 1.
Points allocated to the variables of the information model for the global shipbuilding industry over the period 2016-2020.

Variables of the information model for the global shipbuilding industry over the period 2016-2020		Inputs y			Variations (growth/fall)
		2016	2018	2020	2016/20
1.	South Korea	33	32	30	-3
2.	China	31	32	34	+3
3.	Japan	20	21	22	+2
4.	Europe	7	7	6	-1
5.	Rest of the World	9	8	8	-1

The vector of the model growth is: $\Delta Y_{2020} \begin{bmatrix} -3 \\ +3 \\ +2 \\ -1 \\ -1 \end{bmatrix}$ (1)

$$R_{2020} \begin{bmatrix} \frac{-3}{30} & \frac{-3}{34} & \frac{-3}{22} & \frac{-3}{6} & \frac{-3}{8} \\ \frac{3}{30} & \frac{3}{34} & \frac{3}{22} & \frac{3}{6} & \frac{3}{8} \\ \frac{2}{30} & \frac{2}{34} & \frac{2}{22} & \frac{2}{6} & \frac{2}{8} \\ \frac{-1}{30} & \frac{-1}{34} & \frac{-1}{22} & \frac{-1}{6} & \frac{-1}{8} \\ \frac{-1}{30} & \frac{-1}{34} & \frac{-1}{22} & \frac{-1}{6} & \frac{-1}{8} \end{bmatrix};$$

The vector of the model's reciprocal values:

$$\frac{1}{Y_{2020}} = \left(\frac{1}{30}, \frac{1}{34}, \frac{1}{22}, \frac{1}{6}, \frac{1}{8}\right) \quad (2)$$

Matrix calculation: $\Delta Y_{2020} x: \frac{1}{Y_{2020}} =>$ (3)

$$R_{2020} \begin{bmatrix} -0{,}100 & -0{,}088 & -0{,}136 & -0{,}500 & -0{,}375 \\ 0{,}100 & 0{,}088 & 0{,}136 & 0{,}500 & 0{,}375 \\ 0{,}067 & 0{,}059 & 0{,}091 & 0{,}333 & 0{,}250 \\ -0{,}033 & -0{,}029 & -0{,}045 & -0{,}167 & -0{,}125 \\ -0{,}033 & -0{,}029 & -0{,}045 & -0{,}167 & -0{,}125 \end{bmatrix};$$

The matrix calculation produces Table 2.

Table 2.
Values of the direct and indirect growth rates of the information model for the global shipbuilding industry over the period 2016-2020, on the index scale from 0 to 100.

Model variables	1	2	3	4	5
1	**-10.0**	-8.8	-13.6	-50.0	-37.5
2	10.0	**8.8**	13.6	50.0	37.5
3	6.7	5.9	**9.1**	33.3	25.0
4	-3.3	-2.9	-4.5	**-16.7**	-12.5
5	-3.3	-2.9	-4.5	-16.7	**-12.5**

Table 2 shows that the points (i.e. values) referring to the direct growth rates of the selected variables of the information model for the global shipbuilding over the period 2016-2020 are placed diagonally, ranging from +9.1 to -16.7.

Due to limited space, this scientific paper does not discuss the values of indirect growth rates of the model variables.

There are notable differences between the values presented in the last column (Variations) of Table 1 and the values of the direct growth rates of the selected variables of the information model for the global shipbuilding over the period 2016-2020, shown diagonally in Table 2. These disparities arise from the mutual influence (competition) of the largest shipbuilding nations in the global market for the period observed in the information model.

5. CONCLUSION

In this scientific study, for the first time in the process of analysing the world's modern shipbuilding industry, the growth matrix was used to produce the values of the selected variables, i.e. the direct growth rates of the information model for the global shipbuilding in the period 2016-2020. In addition to the matrix and modelling, the study has also involved a combination of scientific methods, including statistics, induction, deduction, description, comparative analysis and synthesis, with an aim of producing relevant results.

Japan will have the highest positive value of the information model's direct growth rates over the period 2016-2020, amounting to 9.1, whereas China will have the lowest positive value amounting to 8.8. The highest negative value of

the direct growth rates of the information model for the global shipbuilding in the period 2016-2020 will be experienced in Europe (16.7), while South Korea will have the lowest negative value of the growth rates, amounting to 10.0.

The research results indicate that, by 2020, South Korean shipbuilding industry will have experienced a decline in LNG and offshore tonnage orders. Over the same period, the demand for newly-built tankers and container ships remains stable. By the year 2020, Chinese shipyards will have experienced continuous demand for bulk carriers, container ships, tankers, passenger vessels and cruise ships, while the demand for offshore vessels and LNG ships will decrease.

There will be continuous demand for new bulk carriers, container ships, tankers, passenger vessels and cruise ships from Japanese shipyards by 2020, while the demand for offshore vessels and LNG ships will decrease. European shipyards will experience steady commissions for passenger vessels and cruise ships by 2020, while there will be fewer commissions of offshore vessels. Finally, in the rest of the world, there will be continuous demand for new-build bulk carriers, tankers and container ships by 2020, but commissions of new LNG carriers and offshore vessels will be reduced.

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CONTRIBUTION

An Overview of the English-Croatian Maritime Dictionary
Pjesma / Poem
Guidelines

An Overview of the English-Croatian Maritime Dictionary

by Bisera Plančić and Tomislav Skračić

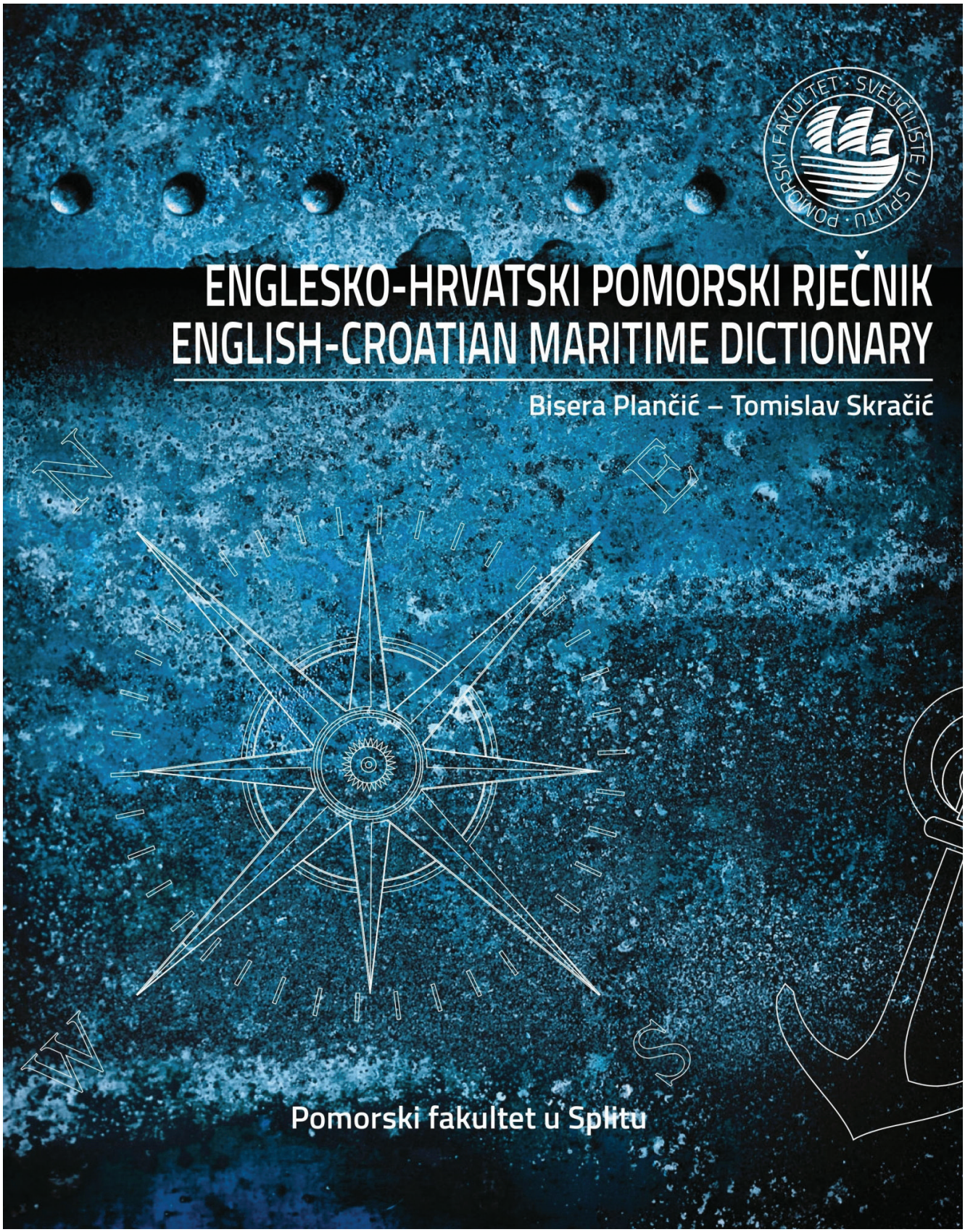
The University of Split Faculty of Maritime Studies has published a bilingual English-Croatian Maritime Dictionary, written by Bisera Plančić and Tomislav Skračić, senior lecturers of Maritime English.

Comprising 570 pages, the dictionary uses alphabetic, descriptive and cognitive criteria to arrange the complex lexical corpus. Word clusters attached to leading words provide examples and explanations of terms consisting of one or more lexical units and these associated units can be found as distinct entries at appropriate alphabetic position in the dictionary, whether they refer to the maritime or general vocabulary.

Although maritime affairs represent an exceptionally large and complex area, the authors manage to encompass the most relevant maritime terminology, including navigation, ship stability and construction, marine engineering, onboard equipment, power systems and electronics, maritime technologies, meteorology, nautical tourism, management, economy of shipping, sea-borne transport, maritime law, insurance, medicine and other trades closely associated with maritime affairs. In addition to English terms and Croatian equivalents, whenever possible and deemed necessary, the authors provide loanwords, regional idioms and seamen's jargon. Moreover, there are neologisms, synonyms, homonyms, false friends, and examples of using the same words in different contexts.

Additional value of this lexicographic endeavour has been created by incorporating phrasal verbs as separate clusters, as well as the most common general terms, therefore enabling a more accurate and comprehensive understanding of the specific maritime terminology. The dictionary also features numerous entries referring to student and academic activities, thus representing a valuable source of explanation and information for the academic community, and contributing to the development and dissemination of maritime science.

The English-Croatian Maritime Dictionary by Bisera Plančić and Tomislav Skračić can be considered as a comprehensive dictionary of maritime terminology, intended for seafarers, students and teachers at maritime higher education institutions and for any person engaged in maritime affairs in any way. The dictionary is a valuable asset to any user due to its simplicity, transparency, applicability and suitability for everyday use.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ENGLISH-CROATIAN MARITIME DICTIONARY
Bisera Plančić – Tomislav Skračić
N
E
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Pomorski fakultet u Splitu

MLADOST MORU OSTAVILI

Elio Žuvela

YOUTH SACRIFICED TO THE SEA

trans. by Mirna Čudić

Di san ja, Bože, svoj život potrati
Po tujin morima – pod tujin vitrima
Tuje san brode krpi i jezike govori
I tujin se portima veseli.

A doma su dica bez oca resla
I žena je bez muža starila
A misto mene na posteju do sebe
Sliku je moju stavila.

A ja san ko mona za dva šolda više
Proša sve nevere i bure i kiše,
I mladost san svoju po moru satra
Od mora od soli ki starac osta.

A dica su bez oca naresla
I žena je bez muža ostarila,
I ona je uza me bidna
Mladost moru ostavila.

Where have I wasted my life, o Lord,
In foreign seas – to foreign winds
Foreign boats have I mended, and foreign languages have I spoken
Foreign ports have I been looking forward to and I rejoiced in.

While back at home the children were growing up fatherless
And my wife was growing old husbandless
And instead of me she kept my picture
In bed, next to her.

And I, as a fool, for two farthings more
Have endured all the storms, gales, and rains,
And I have squandered my youth at sea,
I let the sea and salt leave me rugged and beaten like an old man.

And my children grew up fatherless
And my wife grew old husbandless,
And she, wretched soul, along with me
sacrificed her youth to the sea.

RJEČNIK

porat	luka
mona	budala
šoldi	novac
nevera	oluja, nevrijeme

About ToMS: Ethics, Conflict of Interest, License and Guides for Authors

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6.2. Guidelines for Authors: Manuscript Preparation and Submission

6.2.1. Organization of the manuscript

First (title) page

The first page should carry:

a. the paper title;

b. full names (first name, middle – name initials, if applicable), and last names of all authors;

c. names of the department(s) and institution(s) to which the work should be attributed. If authors belong to several different institutions, superscript digits should be used to relate the authors' names to respective institutions. Identical number(s) in superscripts should follow the authors names and precede the institution names;

d. the name, mailing address and e-mail of the corresponding authors;

e. source(s) of research support in the form of financial support, grants, equipment or all of these.

Last page

The last page should carry:

a. ethical approval, if required;

b. authors' declarations on their contributions to the work described in the manuscript, their potential competing interests, and any other disclosures. Authors should disclose any commercial affiliations as well as consultancies, stock or equity interests, which could be considered a conflict of interest. The details of such disclosures will be kept confidential but ToMS urges the authors to make general statements in the Acknowledgement section of the manuscript.

c. a list of abbreviations used in the paper (if necessary);

Other pages

Each manuscript should follow this sequence:

- title page;
- abstract;
- text (Introduction, Methods, Results, Conclusions/ Discussion);
- acknowledgments;
- references;
- tables (each table complete with title and footnotes on a separate page);
- figures and figure legends, and the last page.

6.2.2. Text organization and style

6.2.2.1. Abstract

The second page should contain the Abstract. ToMS requires that the authors prepare a structured abstract of not more than 250 words. The abstract should include (at least) four sections: Aims, Methods, Results, and Conclusion, not necessarily separated.

Aim. State explicitly and specifically the purpose of the study.

Methods. Concisely and systematically list the basic procedures, selection of study participants or laboratory/ experimental/simulation setup, methods of observation (if applicable) and analysis.

Results. List your primary results without any introduction. Only essential statistical significances should be added in brackets. Draw no conclusions as yet: they belong in to the next section.

Conclusion. List your conclusions in a short, clear and simple manner. State only those conclusions that stem directly from the results shown in the paper. Rather than summarizing the data, conclude from them.

6.2.2.2. Main text

Do not use any styles or automatic formatting. All superscripts or subscripts, symbols and math relations should be written in MathType or Equation editor.

Introduction

The author should briefly introduce the problem, particularly emphasizing the level of knowledge about the problem at the beginning of the investigation. Continue logically, and end with a short description of the aim of the study, the hypothesis and specific protocol objectives. Finish the section stating in one sentence the main result of the study.

Results

Key rules for writing the Results section are:

a. the text should be understandable without referring to the respective tables and figures, and vice versa;

b. however, the text should not simply repeat the data contained in the tables and figures; and

c. the text and data in tables and figures should be related to the statements in the text by means of reference marks.

Thus, it is best to describe the main findings in the text, and refer the reader to the tables and figures, implying that details are shown there. The formulations such as "It is shown in Table 1 that the outcome of Group A was better than that of Group B" should be replaced by "The outcome of Group A was better than that of Group B (Table 1)."

The need for brevity should not clash with the requirement that all results should be clearly presented.

Discussion/Conclusions

The discussion section should include interpretation of study findings in the context of other studies reported in the literature. This section has three main functions:

a. assessment of the results for their validity with respect to the hypothesis, relevance of methods, and significance of differences observed;

b. comparison with the other findings presented in the relevant literature; and

c. assessment of the outcome's significance for further research.

Do not recapitulate your results, discuss them!

6.2.2.3. Tables

Information on significance and other statistical data should preferably be given in the tables and figures. Tables should not contain only statistical test results. Statistical significances should be shown along with the data in the text, as well as in tables and figures.

Tables should bear Arabic numerals. Each table should be put on a separate page. Each table should be self-explanatory, with an adequate title (clearly suggesting the contents), and logical presentation of data. The title should preferably include

the main results shown in the table. Use tables in order to present the exact values of the data that cannot be summarized in a few sentences in the text.

Avoid repetitive words in the columns: these should be abbreviated, and their explanations given in the footnotes. Present data either in a table or a figure.

Each column heading for numerical data given should include the unit of measurement applied to all the data under the heading. Choose suitable SI units.

Place explanatory matter in footnotes, not in the heading.

Explain in footnotes all nonstandard abbreviations that are used in each table.

6.2.2.4. Figures

Figures should be numbered in sequence with Arabic numerals. Legends to figures should be listed on a separate page, in consecutive order. Minimum resolution for all types of graphics is 300 dpi and 600 dpi is recommended. The legend of a figure should contain the following information:

a. the word "Figure", followed by its respective number;
b. figure title containing major finding (e.g. Manuscripts which follow Guidelines for Authors had higher acceptance rate, and not Relationship with manuscripts style and their acceptance rate).

Use simple symbols, like closed and open circles, triangles and squares. Different types of connecting lines can be used. The meanings of symbols and lines should be defined in the legend.

Each axis should be labeled with a description of the variable it represents.

Only the first letter of the first word should be capitalized. The labeling should be parallel with the respective axis. All units should be expressed in SI units and parenthesized. Make liberal use of scale markings.

Graphs, charts, titles, and legends in accepted manuscripts will be edited according to ToMS style and standards prior to publication.

Preferred format for graphs or charts is xls. Graphs and charts saved as image (raster) files such as JPG, TIF, or GIF and imported or copied/pasted into Word or Power Point are not acceptable.

The resolution for photographic images should be at least 300 dpi, and minimum image width should be 6 cm. Please submit files in RGB format. For published manuscripts, image files will be posted online in their original RGB format, maintaining the full color of your original files. Note that we will still need to convert all RGB files to CMYK for printing on paper and color shifts may occur in conversion. You will not receive a CMYK proof. You can view an approximation of print results by converting to CMYK in Adobe® Photoshop® or Adobe® Illustrator®.

6.2.2.5. Authorship statement

All contributing authors must fill out and sign these statements and submit them to the Editorial Office. Accepted manuscripts will not be published until signed statements from all authors have been received.

6.2.2.6. Acknowledgments

Technical help, critical reviews of the manuscript and financial or other sponsorship may be acknowledged. Do not acknowledge paid services, e.g. professional translations into English.

6.2.2.7. References

References cited in the manuscript are listed in a separate section immediately following the text. The authors should verify all references. Usage of DOIs is mandatory.

Examples of citation in text:

It is well known fact (Strang and Nquyen, 1997; Antoniou, 2006) that FT is not an appropriate tool for analyzing nonstationary signals since it loses information about time domain.

First group of authors (Vetterli and Gall, 1989) proposed Multiresolution Signal Analysis (MRA) technique or pyramidal algorithm. Second group (Crochiere et al., 1975; Crochiere and Sambur, 1977) proposed subband coding algorithm. Legal acts are cited as in example: The Constitution of the Republic of Croatia (Constitution of the Republic of Croatia, 2010) is the main legal source for this subject matter, as well as any other subject matter relating to the Croatian legal system. References from the Web are cited in the text as (Author(s) last name, year of origin if known (year of accessed in other cases). If the author is unknown, such as in case of company web page, instead of author's name, title of the web page is used.

Examples for reference section:

Journals

Petrinović, R., Wolff, V. S., Mandić, N. and Plančić, B., (2013), International Convention on the Removal of Wrecks, 2007. – a New Contribution to the Safety of Navigation and Marine Environment Protection, Transaction on Maritime Science, 2(1), pp. 49-55., https://doi.org/10.7225/toms.v02.n01.007

Pennec, E. and Mallat, S., (2005), Sparse Geometric Image Representations with Bandelets, IEEE Transactions on Image Processing, 14(4), pp. 423 – 438., https://doi.org/10.1109/TIP.2005.843753

Web links

Donoho, D., Duncan, M. R., Huo, X. and Levi, O., (1999), Wavelab, available at: http://www.stat.stanford.edu /_wavelab/, [accessed 12 August 2011.].

Unknown, Wavelab, available at: http://www.stat.stanford.edu /_wavelab/, [accessed 12 August 2011.].

ToMS home page, available at: http://www.toms.com.hr, [accessed 12 July 2012.].

Books

Mallat, S., (2009), A Wavelet Tour of Signal Processing, 3rd Edition, New York: Academic Press.

Chapter in book

Hymes, D. H., (1972), On Communicative Competence, in: Pride, J. B. and Holmes, J. (eds), Sociolinguistics, Selected Readings, pp. 269-293. (Part 1 if exists), Harmondsworth: Penguin.

Šoda, J., Beroš, S. M., Kuzmanić, I. and Vujović, I., (2013), Discontinuity Detection in the Vibration Signal of Turning Machines, in: Öchnser A. and Altenbach, H. (eds), Experimental and Numerical Investigation of Advanced Materials and Structures, Advanced Structured Materials (serial name if applicable), 41 (volume number if applicable), pp 27-54. (part if applicable), Heidelberg: Springer., https://doi.org/10.1007/978-3-319-00506-5_3

Conference proceedings

Łutowicz, M. and Lus , T., (2013), Effect of Loss of Cylinder Pressure Indicating Channel Patency on Parameters Values Obtained from Indicating Graph, Proc. 5th International Maritime Science Conference, Solin, Croatia, April 22 – 23, pp. 382-389., available at: http://www.pfst.hr/imsc/archive/2013/IMSC2013_proceedings.pdf

Kingsbury, N.G. and Magarey, J.F.A., (1997), Wavelet Transforms in Image Processing. Proc. First European Conference on Signal Analysis and Prediction, Prague, Czech Republic, June 24 – 27, Birkhauser, pp. 23 – 24., available at: http://www.sigproc.eng.cam.ac.uk/~ngk/publications/ngk97b.zip, [accessed 12 August 2011.].

Regulations, standards or legal acts:

Constitution of the Republic of Croatia, (2010), Narodne novine, 2010(76), pp. (if known).

6.2.2.8. Supplementary materials

Supplementary materials are optional. Authors can submit different types of materials which will be available on-line.

6.2.2.9. Language

Authors may use standard British or American spelling, but they must be consistent. The Editors retain the customary right to style and, if necessary, shorten texts accepted for publication.

This does not mean that we prefer short articles – actually, we do not limit their size - but rather a resection of the obviously redundant material.

The past tense is recommended in the Results Section.

Avoid using Latin terms; if necessary, they should be added in parentheses after the English terms. Real names rather than "levels" or "values" should refer to parameters with concrete units (e.g. concentration).

6.2.2.10. Abbreviations

Only standard abbreviations and symbols may be used without definition and may be used in the title or the page-heading title.

Non-standard abbreviations should not be used in the title or page-heading title. They must be explained in the text in the following way: the term should be written in full when it appears in the text for the first time, followed by the abbreviation in parentheses; from then on, only abbreviation is used in the text. This applies separately to the Abstract and the rest of the text.

6.2.3. Submission of manuscripts

Paper submission via ToMS web page Open Journal System.
www.toms.com.hr