Brodogradnja/Shipbuilding Volume 66 Number 3, 2015

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ISSN 0007-215X
eISSN 1845-5859

SWOT ANALYSIS OF DEFICIENCIES ON SHIP COMPONENTS IDENTIFIED BY PORT STATE CONTROL INSPECTIONS WITH THE AIM TO IMPROVE THE SAFETY OF MARITIME NAVIGATION

UDC 629.5.072:629.5.078.4:629.5.011
Review paper

Summary

This paper analyses components of the ship system with regard to the recommendations that have impact on the safety of maritime navigation according to the evaluation of port control inspections. What the research particularly examined are recommendations (deficiencies), i.e. cases when ships are not allowed to proceed to sea and continue their navigation. The results of the comparative and SWOT analyses are presented, as well as the functional dependence (tendency) of not complying with specific ship components concerning the age of the ship. Both the results of the research and the performed analyses show that the majority of recommendations concern the emergency systems, i.e. the safety of navigation and rescue appliances, while the least number of recommendations has been recorded in the training and drills of the crew for emergency situations. What has also been established is that by a better on-board training of the crew and better education of seafarers it is possible to reduce the number of recommendations (deficiencies). The age of the ship, which has also been found to contribute to the increasing number of recommendations (deficiencies), constitutes the objective reason for this due to the current unsatisfactory financial situation in the market.

Key words: port control inspections, recommendations, deficiencies, tendencies, SWOT analysis

1. Introduction

Port State Control (PSC) is the inspection of foreign ships in national ports, carried out by authorised port State control inspectors to verify that the competences of the master and the crew, the condition of the ship and its equipment comply with the requirements of international conventions and regulations [1]. It is only the authorised Port State Control inspectors who carry out these inspections in Croatia. However, it has to be said that the inspection that takes place cannot be considered to be the port State control [2] when the ship comes into the port of the state in which it was registered.

Although the responsibility for the implementation of international conventions and regulations has been ceded to the “flags” of ships, i.e. authorities that provide the ship’s registration, port State authorities have the right and duty to inspect foreign ships in national ports [3]. It is common that regionally connected states associate and sign the memorandum of understanding as in this way the inspection of one of the state signatories of the memorandum, is recognised in all other states signatories of the same memorandum. A Memorandum of Understanding (MoU) is a document that defines a relationship between signatories, being less formal than a contract. It is thus avoided that the inspection of the port State control takes place in every port the ship calls at. There are ten such associations in the world, Croatia being the signatory of the *Paris Memorandum of Understanding (Paris MoU).* The Paris MoU has been signed by 27 states, namely European Union coastal states, joined by Canada and Russia (i.e. its ports in the European part of Russia). Besides the Paris MoU, the best known PSC associations are the Tokyo MoU, the Indian Ocean MoU, the Mediterranean MoU, the US Coast Guard and the Caribbean MoU [4].

As Croatia is the signatory of the Paris Memorandum and makes part of the Paris MoU organisation, this paper will deal with the principles of work of port States controls in the countries signatories of this Memorandum only, presenting the results of the research regarding port State controls in the period from the year 2011 to the year 2013, as well as the results of the research concerning the same period dealing with the grounds for the detention of ships, when, according to the evaluation of inspection, the identified recommendations significantly decreased the ability of the ship for the continuation of navigation and execution of a specific task. In the case of detention, the ship is not allowed to proceed to sea and continue navigation until deficiencies have been rectified, such cases being specifically analysed in this paper.

Using the tabular display, data on the number of inspections and the number of detentions of ships in the period from the year 2011 to the year 2013 are presented, while it is by diagrams (graphs) that tendencies of a specific component (which caused the detention of the ship) regarding the age of the ship are shown. The SWOT analysis is presented at the end of the paper.

2. Port Authority Inspections of Ships

Fundamental principles governing the inspection of a ship by port authorities are the same worldwide or very similar. However, there are differences in the statistical processing and the interpretation of deficiencies that have been identified during the inspection [5]. Accurate records are kept on inspections performed by a port State control, the data of which are then recorded on the central computer database partly available online [1], namely on the official Paris MoU website, where statistically processed data for each month and each year respectively can be found. The findings recorded upon the inspection of a ship by a port State control can be the following:

a) Upon the performed inspection no recommendations have been recorded;

b) Upon the performed inspection deficiencies have been identified, however, according to the evaluation of the inspection, they do not have impact on the ability of a ship to execute a specific task (in this case the ship is allowed further exploitation under the condition that identified deficiencies be rectified in the time given) and

c) The inspection has been performed identifying deficiencies, which, according to the evaluation of the inspection, do have impact on the ability of the ship to proceed to sea and execute a specific task (in which case the ship is forbidden to continue navigation until the deficiencies have been rectified).

What was analysed were only the cases found under c), Table 1 presenting the number of inspections and the number of ship detentions in the period from the year 2011 until the year 2013[6].

Table 1 Number of inspections and number of detentions in the period from 2011 until 2013

Year	**2011**	**2012**	**2013**
Number of inspections	19,058	18,308	17,687
Number of individual ships inspected	15,268	14,646	14,108
Number of detentions	688	669	668
Number of deficiencies	50,738	49,261	49,074
Number of detention related deficiencies	2,414	2,691	3,057

(Source material: www.parismou.org)

The Paris MoU organisation has divided detention related deficiencies into 18 categories, the list of which is presented in Table 2 [7].

Table 2 Deficiencies categorised according to the Paris MoU organisation

Number of category	Category of deficiencies
01	Certificates & Documentation
02	Structural condition of the hull
03	Water / weathertight condition
04	Emergency systems
05	Radio communication appliances
06	Cargo operations including equipment
07	Fire safety
08	Different alarms
09	Working and living conditions
10	Safety of navigation appliances
11	Life saving appliances
12	Dangerous goods appliances
13	Propulsion and auxiliary machinery
14	Sea pollution prevention appliances
15	ISM Code – International Safety Management Code for the safe management and operation of ships and for pollution prevention
16	ISPS Code - The International Ship and Port Facility Security Code
17	Other
18	MLC Code – Regulations and Code of the Maritime Labour Convention

(Source material: www.parismou.org)

The above-mentioned deficiencies from Table 2 focus on 11 components of the ship [8], i.e.:

1) Group of technical components:
   a) Ship hull and watertight condition;
   b) Propulsion and auxiliary machinery, alarms;
   c) Emergency systems;
   d) Structural fire safety;
   e) Safety of navigation and life saving appliances and
   f) Sea pollution prevention appliances.

2) Group of administrative components:
   a) Master and crew certificates, as well as
   b) Ship certificates and mandatory manuals.

3) Group of other components:
   a) Training of the crew for emergency situations;
   b) ISM Code and

c) Working and living conditions on board.

Proceeding from the above-mentioned classification and on the basis of our analysis of the report on detention of ships by inspections of port State controls that are members of the Paris MoU organization, diagrams have been made presenting the functional dependence of the number of detentions (in percentages) with regard to the age of the ships for the period from 2011 until 2013.

3. Analysis of Functional Dependence

The above-mentioned functional dependence is in fact the tendency of a specific ship component and can be defined as the ratio of the number of detentions performed on the grounds of deficiencies identified on that component and the total number of inspected ships in the first 36 years of the age of the ship. Diagrams (graphs) obtained in this way (Figures 1 – 3) show the tendency for each component, focusing on a specific technical, administrative or other component. These diagrams have been made on the basis of the carried out research on the detentions of ships in the period from 2011 to 2013.

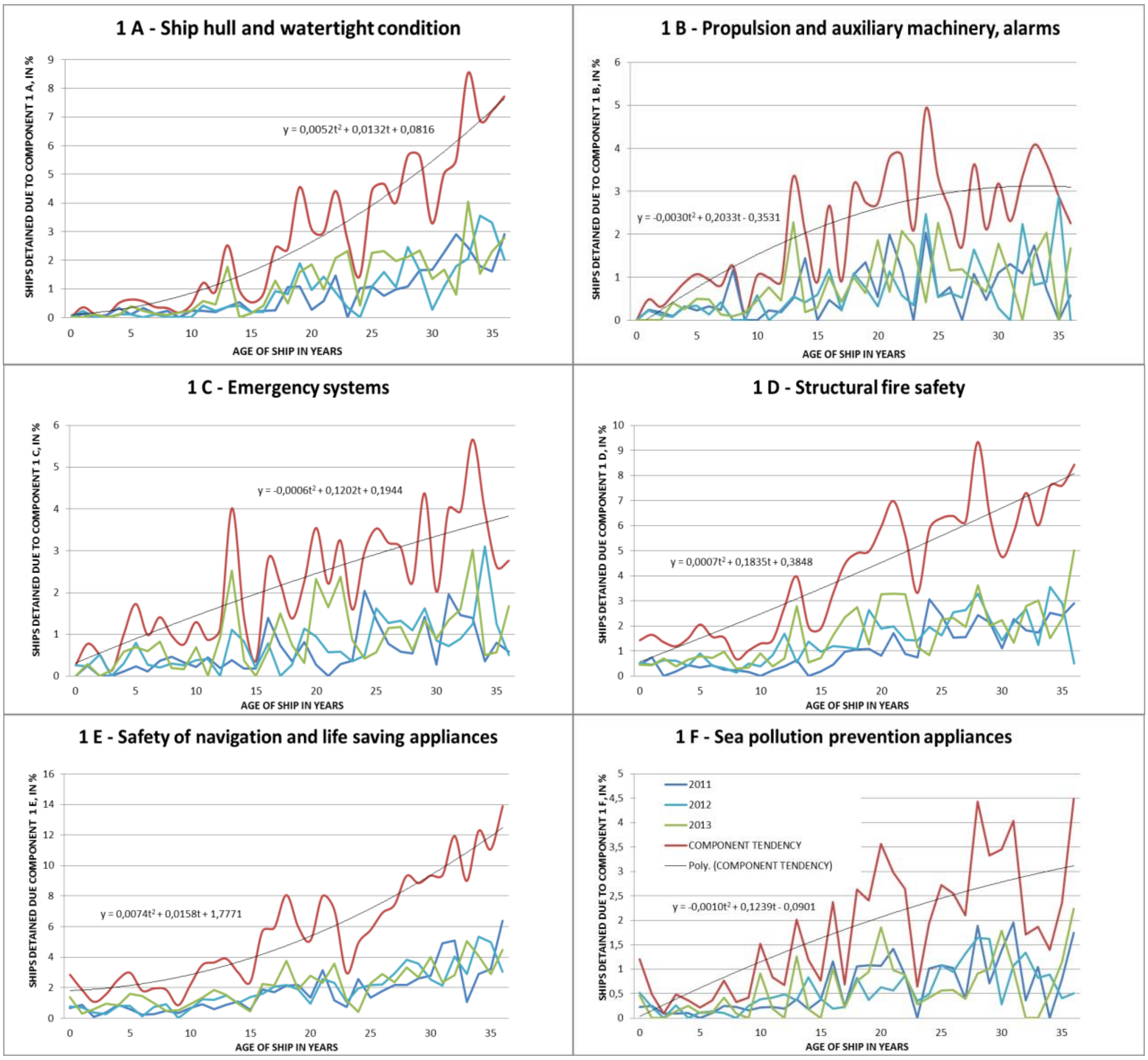

Fig. 1 Diagrams of tendencies for technical ship components

(Source material: copyright work based on the carried out research)

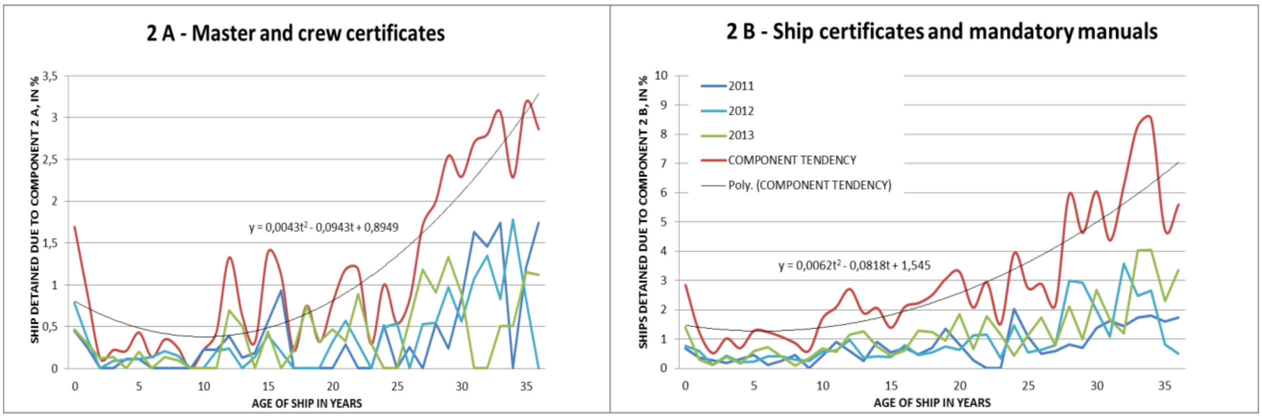

Fig. 2 Diagrams of tendencies for administrative ship components

(Source material: copyright work based on the carried out research)

Fig. 3 Diagrams of tendencies for other ship components

(Source material: copyright work based on the carried out research)

Functional dependence (tendencies) of ship components presented in Figures 1, 2 and 3 can be approximated by quadratic functions, the results of which are shown in Table 3.

On the basis of quadratic approximations shown in Table 3, Figure 4 shows tendencies of detentions of ships due to deficiencies on a specific component concerning the age of the ship.

Table 3 Functional dependence (tendencies) of ship components

Component	Approximation
1A - Ship hull and watertight condition	$y = 0.0052t^2 + 0.0132t + 0.0816$
1B - Propulsion and auxiliary machinery, alarms	$y = -0.0030t^2 + 0.2033t - 0.3531$
1C – Emergency systems	$y = -0.0006t^2 + 0.1202t + 0.1944$
1D – Structural fire safety	$y = 0.0007t^2 + 0.1835t + 0.3848$
1E - Safety of navigation and life saving appliances	$y = 0.0074t^2 + 0.0158t + 1.7771$
1F - Sea pollution prevention appliances	$y = -0.0010t^2 + 0.1239t - 0.0901$
2A - Master and crew certificates	$y = 0.0043t^2 - 0.0943t + 0.8949$
2 B - Ship certificates and mandatory manuals	$y = 0.0062t^2 - 0.0818t + 1.5450$
3A – Training of the crew for emergency situations	$y = 0.0019t^2 - 0.0000t + 0.1724$
3B - ISM Code	$y = 0.0007t^2 + 0.2929t + 0.8714$
3C - Working and living conditions on board	$y = 0,0005t^2 + 0,0676t + 0,2430$

(Source material: copyright work based on diagrams in Figures 1, 2 and 3)

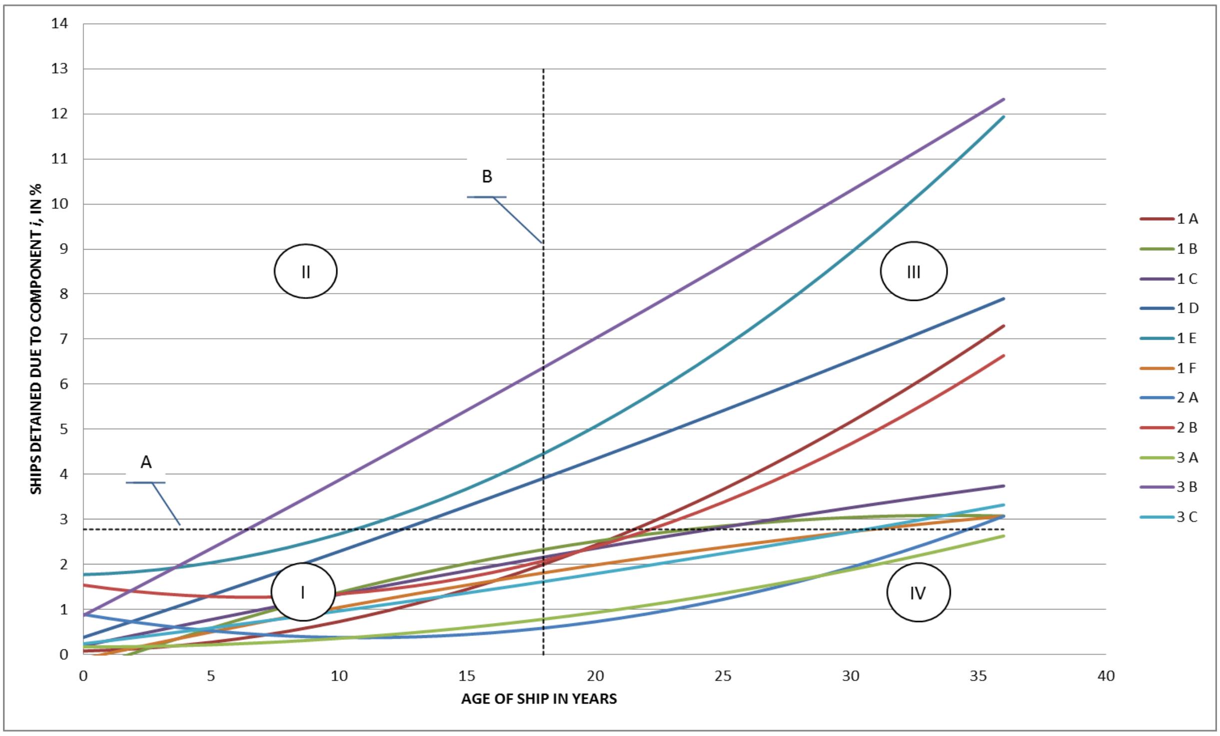

Fig. 4 Diagram showing the percentage of detained ships with regard to the age of the ship according to components

(Source material: copyright work based on diagrams in Figures 1, 2 and 3)

What follows are the results of this research and the performed comparative analysis.

4. Results of Comparative Analysis

On the basis of the diagram in Figure 4, it is possible to conclude that the biggest number of recommendations made according to the evaluation of inspection, namely recommendations which affect the ability of the ship to continue navigation and perform a specific task are those which concern emergency systems, where the functional dependence increases in the greatest degree with the increase of the age of the ship (having almost a linear dependence, Function 1C). The second place is taken by recommendations concerning the safety of navigation and life saving appliances (dependence being exponential, Function 1E), while the smallest increase regarding the age of the ship has been recorded with the training of the crew for emergency situations (Function 3A).

Because of the comparative analysis of trends, the coordinate system shown in Figure 4 is divided in four quadrants determined by directed lines A and B. The directed line A presents the calculated mean value of all recommendations and amounts to 2.78%, while the directed line B presents half the period of the identified age of the ship (18 years).

Figure 5 presents a diagram with six characteristic cases concerning the relation between the age of the ship and the percentage of detentions for a specific component. The tendency of each component from the diagram in Figure 4 can be assigned to one of the six characteristic cases. Characteristic cases are depicted by a quadrant in which they start, by their tendency and the quadrant in which they end.

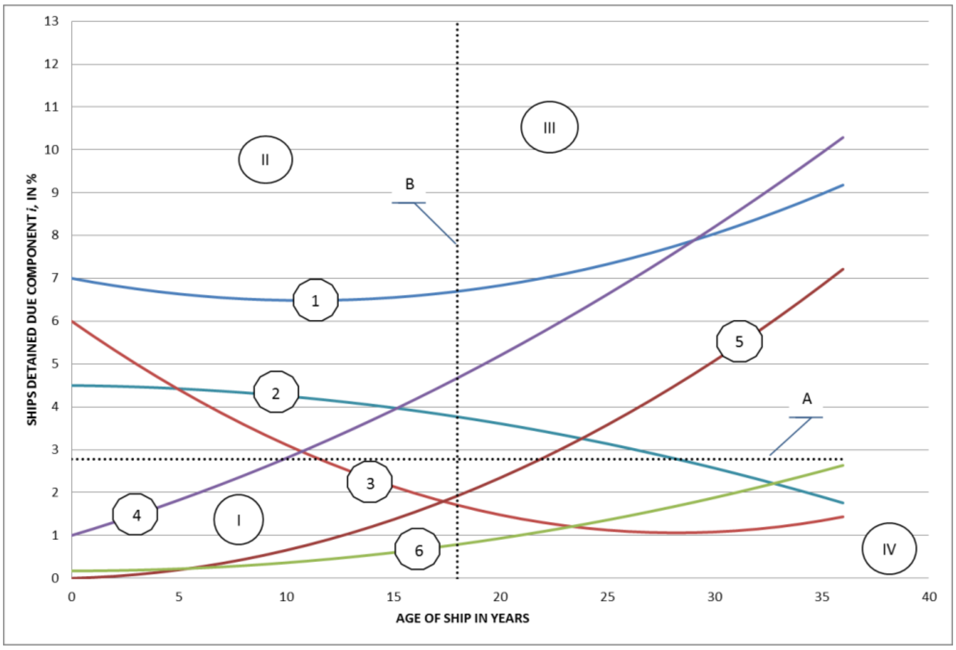

Fig. 5 Diagrams of characteristic cases

(Source material: copyright work)

Characteristic cases are as follows:

Characteristic case 1: The component starts in quadrant II and ends in quadrant III, possessing a high, above-average number of deficiencies during the whole of the ship's life cycle.

Characteristic case 2: The component starts in quadrant II, goes through quadrant III and ends in quadrant IV. In the beginning of exploitation there is a high number of deficiencies, this number decreasing slowly over time.

Characteristic case 3: The component starts in quadrant II, goes through quadrant I and ends in quadrant IV. In the beginning of exploitation there is a high number of deficiencies, this number decreasing fast during the exploitation.

Characteristic case 4: The component starts in quadrant I, goes through quadrant II and ends in quadrant III. In the beginning of exploitation this component has a small number of deficiencies, however, the number of deficiencies increases fast during the exploitation.

Characteristic case 5: The component starts in quadrant I and goes through quadrant IV, ending in quadrant III. In the beginning of exploitation, this component has a small number of deficiencies, this number increasing during the exploitation.

Characteristic case 6: The component starts in quadrant I and ends in quadrant IV. During the whole of the ship's life cycle, this component has a small, below-average number of deficiencies.

On the basis of the comparative analysis (diagrams in Figures 4 and 5), it can be concluded that in the analysed example this concerns cases from 4 to 6, as shown in Table 4. Not one component in the analysed example has been found to have acquired the characteristic cases from 1 to 3, the common characteristic of which is a high number of deficiencies in the beginning of ship's exploitation.

Table 4 Results of the analysis of characteristic cases

	Component	**Grade**
Characteristic case 1	Nil	6
Characteristic case 2	Nil	5
Characteristic case 3	Nil	4
Characteristic case 4	1D, 1E, 3B	3
Characteristic case 5	1A, 1B, 1C, 1F, 2A, 2B, 3C	2
Characteristic case 6	3A	1

(Source material: copyright work)

It is beyond dispute that it can be affirmed and concluded that the greatest number of deficiencies occur in components 1D, 1E and 3B, namely, the component has a small number of deficiencies in the beginning of exploitation, however, this number of deficiencies rapidly increases with the age of the ship.

5. Results of the SWOT Analysis

The SWOT analysis is concerned with the analysis of internal processes and external environment with the aim of identifying its internal strengths in the process in order to take advantage of its external opportunities and avoid its external threats, while addressing its inner weaknesses. This technique is attributed to Albert Humphrey, who led a research project at Stanford University in the 1960s and 1970s of the last century. The SWOT analysis is used to evaluate the **S**trengths, **W**eaknesses, **O**pportunities, and **T**hreats involved in a project, having received its name after the first letters of the analysed factors [9].

Proceeding from the research results and the performed comparative analysis with the aim to determine strengths, weaknesses, opportunities and threats, a SWOT analysis has been made [10] [11], the results of which are shown in Table 5.

Table 5 SWOT analysis results

	STRENGTHS	**WEAKNESSES**
INTERNAL FACTORS	On-board training of the crew	Insufficient number of educated seafarers on board
	Ship maintenance procedures	Poor motivation of the crew due to bad financial conditions
	Dissemination of information on new regulations	Careless service provided for the ship by agents
	OPPORTUNITIES	**THREATS**
EXTERNAL FACTORS	Education of the crew	Sudden breakdown of appliances, the ones on which direct impact cannot be made
		Insufficient inflow of educated seafarers
	Ship maintenance with services that are expert in specific areas	Age of the ship
		Poor ship maintenance due to ever more difficult financial conditions of shipping companies

(Source material: [11] and copyright work)

Table 6 shows the matrix of reciprocal impacts of SWOT factors upon the tendency of a specific component. The impact of each component according to the analysis of characteristic cases (Table 4) was marked with grades from 1 to 6. Grade 1 means that a small number of deficiencies were recorded on the component, according to the diagram in Figure 4, the component consequently belonging to Case 6. In the same way grades were given for components that make part of Case 5 (grade 2), Case 4 (grade 3), Case 3 (grade 4), Case 2 (grade 5) and Case 1 (grade 6). Not one component in this research has been found to have acquired the characteristic cases from 1 to 3.

The impact of a specific SWOT factor on the occurrence of deficiencies in a specific component was marked with grades from 1 to 5. Grade 1 means that the SWOT factor has a small impact on the occurrence of deficiencies in a specific component; while grade 5 means that the SWOT factor has a great impact on the occurrence of deficiencies in a specific component.

Table 6 The matrix of reciprocal impacts of SWOT factors upon the tendency of a specific component

SWOT factor		Component / Impact											Σ
		1D / 3	1E / 3	3B / 3	1A / 2	1B / 2	1C / 2	1F / 2	2A / 2	2B / 2	3C / 2	3A / 1	
Internal factors	On-board training of the crew	3 / 9	5 / 15	5 / 15	2 / 4	5 / 10	5 / 10	5 / 10	4 / 8	5 / 10	5 / 10	5 / 5	106
	Ship maintenance procedures	2 / 6	5 / 15	5 / 15	5 / 10	3 / 6	5 / 10	4 / 8	4 / 8	3 / 6	3 / 6	5 / 5	95
	Dissemination of information on new regulations	5 / 15	5 / 15	5 / 15	3 / 6	2 / 4	2 / 4	3 / 6	4 / 8	3 / 6	2 / 4	3 / 3	86
	Insufficient number of educated seafarers on board	5 / 15	5 / 15	5 / 15	3 / 6	4 / 8	4 / 8	4 / 8	4 / 8	3 / 6	4 / 8	3 / 3	100
	Poor motivation of the crew due to bad financial conditions	3 / 9	4 / 12	3 / 9	3 / 6	4 / 8	3 / 6	3 / 6	1 / 2	1 / 2	4 / 8	3 / 3	71
	Careless service provided for the ship by agents	5 / 15	3 / 9	3 / 9	5 / 10	4 / 8	3 / 6	4 / 8	5 / 10	5 / 10	3 / 6	1 / 1	92
External factors	Education of the crew	4 / 12	3 / 9	5 / 15	3 / 6	4 / 8	5 / 10	5 / 10	4 / 8	4 / 8	3 / 6	3 / 3	95
	Ship maintenance with services that are expert in specific areas	3 / 9	5 / 15	3 / 9	2 / 4	5 / 10	2 / 4	5 / 10	1 / 2	1 / 2	1 / 2	1 / 1	68
	Sudden breakdown of appliances, the ones on which direct impact cannot be made	1 / 3	5 / 15	3 / 9	5 / 10	5 / 10	5 / 10	5 / 10	1 / 2	1 / 2	3 / 6	3 / 3	80
	Insufficient inflow of educated seafarers	3 / 9	4 / 12	5 / 15	3 / 6	3 / 6	4 / 8	4 / 8	4 / 8	4 / 8	3 / 6	2 / 2	88
	Age of the ship	5 / 15	5 / 15	4 / 12	5 / 10	5 / 10	5 / 10	5 / 10	1 / 2	1 / 2	5 / 10	5 / 5	101
	Poor ship maintenance due to difficult financial conditions of shipping companies	5 / 15	4 / 12	4 / 12	5 / 10	5 / 10	3 / 6	3 / 6	1 / 2	1 / 2	5 / 10	3 / 3	88

(Source material: [12] and [13] and copyright work)

According to Table 6 it is clear that factors that have the greatest impact are the on-board training of the crew, the insufficient number of educated seafarers on board and the age of the ship. The assessment of the impact of each SWOT factor can be ascribed to the subjective judgment of the authors, this subjective judgement being the only limitation of this method.

6. Conclusion

This paper presents the results of the research and the carried out analysis of recommendations that according to the evaluation of the inspection have impact on the ability of a ship to proceed to sea and execute a specific task (in which case the ship is forbidden to continue navigation until the deficiencies are rectified) in compliance with the criteria of the Paris Memorandum (Paris MoU). Eleven components of the ship system were singled out, for each of them a comparative and SWOT analysis made. The function of tendency of deficiency incidence regarding the age of the ship was calculated for each component, while all the components were divided into three groups with regard to the detention related impact they possess.

What was also made was the SWOT analysis of internal and external factors that can have impact on the incidence of deficiencies on components during the port State control inspection, while three factors were singled out, namely those have the greatest impact on the incidence of deficiencies, *on-board training of the crew, insufficient number of educated seafarers on board and the age of the ship*. Two of these factors concern the crew of the ship while one regards the characteristics of the ship.

On the basis of the presented results and the performed analysis, it can be concluded that by a better on-board training of the crew and a better education of seafarers it is possible to decrease the number of deficiencies, the most significant being the structural fire safety and safety of navigation and life saving appliances. The age of the ship is linked with the financial situation in the market, so that until financial conditions of shipping companies running a business are improved, this factor will present a significant influence. The introduction of new ships will certainly help decrease deficiencies that are identified by port control during the inspection.

The presented research results and analyses can be of help to shipping companies in undertaking measures with the help of which the safety of ships will be increased, that is, the requirements of fulfilling international convention that Croatia accepted met, while we hold it necessary to direct further research to the area of the design and building of ships, as well as to the contemporary forms of education and training of seafarers.

ACKNOWLEDGMENTS

We express our gratitude to Mr. Mladen Mandić from the Ministry of Maritime Affairs, Transport and Infrastructure for his great help in our collecting data on inspections of ships by port State controls.

REFERENCES

[1] www.parismou.org

[2] Resolution A.1052(27), procedures for Port State Control, IMO, London, 30 November 2011.

[3] Zhang, L-F., Gang, L-H., Liu, Z-J.: "Analyzing Inspection Results of Port State Control by Using PCA", Applied Mechanics and Materials, Volume 686 (2014), pages 730 – 735.

[4] Knapp, S., Franses, P. H.: "Econometrics Analysis on the Effect of Port State Control Inspections on the Probability of Casualty", Marine Policy 31 (2007) pages 550 – 563.

[5] Cariou, P., Mejia, M. Q., Wolff, F.C.: "Evidence on Target Factors Used for Port State Control Inspections", Marine Policy 33(2009), pages 847 – 859.

[6] Annual Report of the Paris MoU on Port State Control - 2011, 2012 and 2013, www.parismou.org

[7] List of Paris MoU deficiency codes, www.parismou.org

[8] Knapp, S.: "The Econometrics of Maritime Safety – Recommendation to Enhance Safety at Sea", Doctoral thesis, Erasmus University Rotterdam, 2007.

[9] Wang, K.: "A Process View of SWOT Analysis", The 51st Annual Meeting of the International Society for the Systems Sciences, Tokyo, 2007.

[10] Valentin, E. K.: "Away with SWOT Analysis: Use Defensive / Offensive Evaluation Instead", The Journal of Applied Business Research, Volume 21, Number 2, Spring 2005.

[11] Gonan Božac, M.: "SWOT analiza i TOWS matrica – sličnosti i razlike", Ekonomska istraživanja, Vol. 21, No 1, March 2008.

[12] Kostelac, D.: "Implementation of Project Planning at the Level of Strategic Planning", Doctoral thesis, University of Rijeka, Technical Faculty, Rijeka 2014.

[13] Cheng, H-H., Huang, W-C.: "Application of a Quantification SWOT Analytical Method", Mathematical and Computer Modelling 43, pages 158 – 169, 2008.

Submitted: 29.04.2015.

Accepted: 19.06.2015.

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