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A PROPOSED CRITERION FOR THE ASSESSMENT OF THE PARAMETRIC ROLLING OF SHIPS IN LONGITUDINAL WAVES

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Abstract
Intact stability is one of the most important nautical qualities of the ship. Today, due to newly design trends, especially in container ships, vessels are exposed to stability variations in waves resulting in loss of stability and even capsize. Thus, vessels are subject to dynamic instabilities due to phenomena like parametric rolling. A proposed criterion for assessment the parametric rolling of ships in longitudinal waves using the actual loading condition as well as the form and hydrostatic characteristics of the ship is described in this paper. The method describes the possibility of calculation the variation of metacentric height in waves, assuming the vessel on the wave crest and wave trough, considering the total ship's damping coefficient and the conditions necessarily for the parametric rolling to occur. The method can be used as a computational tool for the officers on board vessels for assessment the vulnerability of ships to such phenomenon prior commencement of the voyage.
Keywords: *stability, ship, parametric rolling.*

Introduction

Vessel's intact stability is a fundamental component of seaworthiness so it is in the interest of all owners, operators, charterers and naval architects to learn about this topic and ensure that their vessel possesses a satisfactory level of stability in order to ensure its safety as well as that of the people on board the ship.

The present paper addresses the impact of extreme sea conditions upon intact ship stability. It fits into a complex system of research concerning the intact stability of ships, more exactly to modes of ship stability loss in heavy weather conditions and the possibility of assessment intact ship stability to prevent such losses.

In recent years, the number of accidents involving loss of ship stability was on the rise leading to damage of goods, loss of ships and lives. With the increasing of commodity transported and delivered to destinations as fast as possible, the speed of the ships increased which required major changes in ships design and construction, in terms of deadweight capacity as well as hydrodynamic forms.

Presently, it appeared modes of ship stability failure that a long period was treated only experimental. Moreover, a number of factors that in the past were only suppositions amplified the already known modes of ship stability failure.

The main objective of the paper is dedicated for the development of a sustainable criterion for assessment ship's intact stability in waves for the phenomena like parametric rolling. The proposed criterion is based on the mathematical model correlated with the ship design characteristics and environmental conditions. The aim of the proposed criterion is to determine functional and practical relationships between stability principles and applicability on board ships and to be used as guidance, in a form of a computational tool, by ship's officers on board vessel.

The present work is important because is approaching the problem of assessment the ship's intact stability through the study of dynamic ship behaviour in severe sea condition. The proposed criterion can be important not only from the theoretical point of view but also from practical point of view because it offers a solution for assessment the dynamic intact ship stability in waves for a situation which presently is not covered by any regulations / stability criteria. The researches related to ship dynamic instabilities are considered topical and desirable, considering the interest for which the international maritime community is given for finding solutions to avoid or prevent such events.

Parametric rolling on board ships

A physical mechanism of ship's intact stability failure, caused by restoring lever variation in waves, is parametric roll resonance. Parametric roll behavior may lead to sudden increase in large roll amplitude angles experienced by the ship typically in longitudinal waves, caused by parametric roll resonance (the encounter frequency of waves, of length similar or larger than the ships length, is comparable to twice the ship's roll natural frequency).

In calm water, ships can be externally excited by wind. If due to the wind the ship develops a roll motion, than the roll motion decrease to zero after a few periods of time, due to the roll damping of the ship [13] (Figure 1).

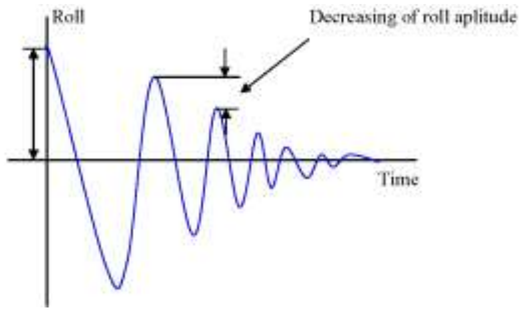

Figure 1. Rolling motion of ship in calm sea, [13]

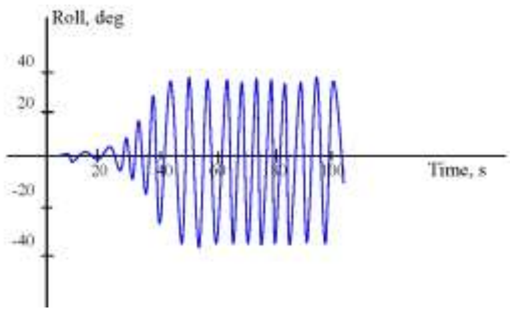

Figure 2. Illustration of parametric roll resonance, [13]

In the situation when the sea is not calm, the instability is caused due to large variation in a model parameter and the ship will encounter the parametric roll resonance. Then, the ship starts to roll until capsize or stabilizes up to a certain roll angle, as illustrated in Figure 2 [13].

Ship stability is fully dependent on her actual waterplane area. Periodic stability variations due to variations of waterplane area, occurring with certain frequency (about twice the roll frequency), are the cause of development the parametric rolling. This is illustrated in Figure 3.

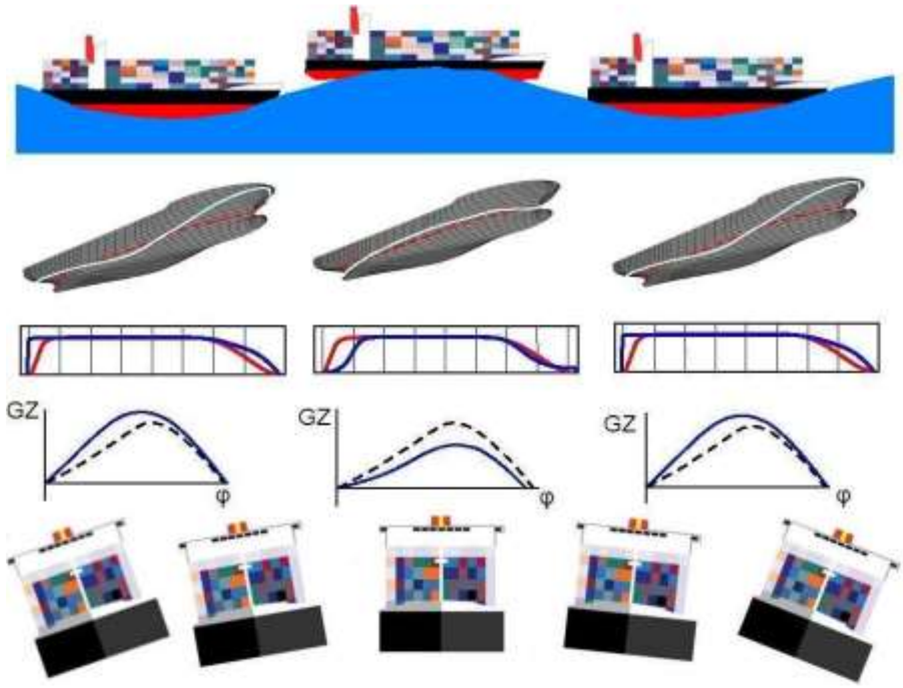

Figure 3. Developing of parametric roll

If the ship is rolled on the wave trough, due to a wide waterline, the restoring moment is increased over its magnitude in still water. There is more stability than in still water (this means that is need of a bigger force to push the ship away from it's equilibrium point) and the ship rolls to the other side with an increasing roll angle with time. If the wave crest is amidship at that time, due to the greater
speed of rolling and less resistance of heeling, the stability is decreased and the ship will roll further the opposite side. So, the push back force is smaller and the roll speed increases.

Finally, the vessel comes again with midship section on the wave trough, where the stability is again large. This situation leads to a large push back force and the ship roll more over (because the roll speed was increased in previous step) which leads to a larger roll angle and the ship reaches its maximum amplitude roll. The scenarios repeats until the ship capsize or stabilize up to a certain roll angle.

The emergence of ship intact stability failures in rough seas has focused attention on the problem of researchers. Studies were undertaken by American Bureau of Shipping (ABS), [1], the Society of Naval Architects & Marine Engineers (SNAME), [18], the International Maritime Organization (IMO), [7], and many others. The research on parametric roll phenomenon has started in Germany in 1930's [17]. The studies continued in 1950's, Kerwin [12], Paulling and Rosenberg [15] who studied a 1-DOF model based on Mathieu equation. France et. al. [3] and Shin *et. al.* [16] point out that a Mathieu type one degree of freedom model can easily be used to show when ships encounter parametric resonance used the same approach later. In 2006 Bulian [2] came up with a 1.5 DOF model where the assumption of quasi-static heave and pitch leaded to an analytical description of the GZ curve. This model is valid for moderate ships speed in head seas and gives reasonable results for the prediction of parametric roll resonance.

Proposed criterion for assessment of minimum GM variation for onset of parametric rolling

The proposed criterion is based on the assessment whether or not a combination of multiple factors like ship loading condition, ship speed and heading angle as well as wavelength, steepness and celerity can lead to the inception of parametric rolling as a result of the instability in upright position due to stability variations in waves.

The criterion, for assessment the ships vulnerability to parametric rolling, is based on static characteristics of the hull form which provides an indication of the change of the hull shape, from the volume projected, using a maximum and a minimum waterplane dimensions.

It is important to be noted that, the ship was considered in exactly longitudinal waves (head or following waves) and the parametric rolling was studied only for the situation when the encounter frequency is almost twice the roll natural frequency.

The waves were considered as regular waves, being more appropriate having in mind the balancing between simplicity and effectiveness. To create an exact correspondence between regular wave and irregular wave it is theoretically impossible, based on the simple reason that regular wave is a deterministic process while irregular wave is stochastic process.

In order to establish a method for assessment the parametric rolling on board ships, it is very important to limit the method of calculation for using only conventional computation tools. Thus, the hydrostatic calculations in longitudinal waves, for which the naval architects use additional and complicated software, have to be simplified.

In the particular case of parametric rolling, when the condition of wavelength is equal with the ship length, it is assumed a simple model of assessment the hydrostatic elements, based on the model proposed in Annex 2 of SLF 53/INF.10 [8] for the situations when the wave crest or trough is at midship.

Our proposed model, presented in this work, may be considered as an adapted version of earlier work, by a close to reality mode of positioning the upper and lower waterlines. In this way, we considered that the value of wave height can be more easily ascertained by the officers on board vessel, from the Beaufort Scale having the weather forecasts of the area covering the intended voyage and correlated with the condition for occurring parametric rolling that the wave length is equal with the ship's length.

Thus, based on [5], a set of environmental conditions can be designed, where a deterministic relation between the wave spectral period T_w [s], wind speed U [m/s] and the significant wave height H_w [m] is provided. If a regression of data is used from [5], then the following relations, between the above three parameters, are obtained:

$$H_w = 0.07915 \cdot U^{1.5} ,\qquad (1)$$

$$U^{0.75} = 0.97728 \cdot T_w .\qquad (2)$$

If the Equations (1) and (2) are combined, then relation for the wave height is obtained as

$$H_w = 0.07560 \cdot T_w^{\ 2} .\qquad (3)$$

The relation that calculates the wave period in correlation with the wavelength is given by

$$T_w = \sqrt{\frac{2\pi\lambda}{g}} = 0.8\sqrt{\lambda} .\qquad (4)$$

From the Equations (3) and (4) is obtained a relation of wave height based on wavelength as

$$H_w = 0.04838 \cdot \lambda \qquad (5)$$

The Equation (1) can be compared with the values of wave height calculated from the values of wind speed provided from the Beaufort Scale, as in Table 1.

Table 1. Correlation between wind speed and wave height as per Beaufort Scale

Beaufort Scale	4	5	6	7	8	9	10	11	12
Wind speed U , m/s	5.5-7.9	8.0-10.7	10.8-13.8	13.9-17.1	17.2-20.7	20.8-24.4	24.5-28.4	28.5-32.6	>32.8
Wave height H_w, m	1-2	2-3	3-4	4-5.5	5.5-7.5	7-10	9-12.5	11.5-16	>14

In this way, based on the Equations (1) and (5) and the values of wave height from the Table 2, we can assume, for our proposed method, the following deterministic values of the wave height in correlation with the wavelength as per Table 3. However, the large values of wave heights will be limited by the condition $H_w \le D - d_m$, where D is the depth and d_m is the mean draft.

Table 2. Assumed relation between wave length and average wave height

Wave length λ, m	50	100	150	200	250	300	350
Wave height H_w, m	2.5	4.8	7.25	9.7	12.1	14.5	16.9

In this respect, the calculation of assumed waterlines used in our proposed criterion based on the considered wave height, is modeled as follows:

- When the wave crest is situated amidship, the waterline is considered a straight line for the lowest draft, lower waterline – LWL (Figure 4).

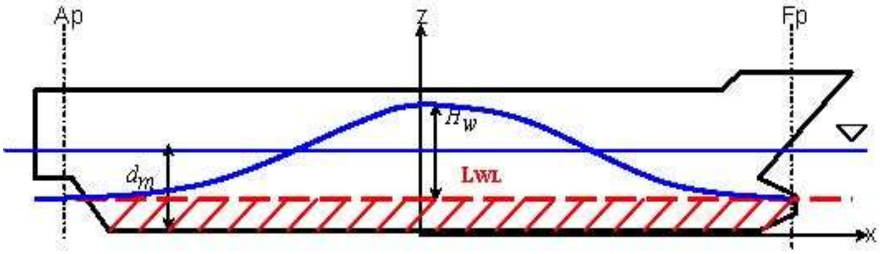

Figure 4. Considered lower water line – LWL - for wave crest amidship

- When the wave trough is situated amidship, the waterline is considered a straight line for the highest draft (upper waterline – UWL), at a vertical distance defined as the height of the wave, measured from the lower waterline (Figure 5).

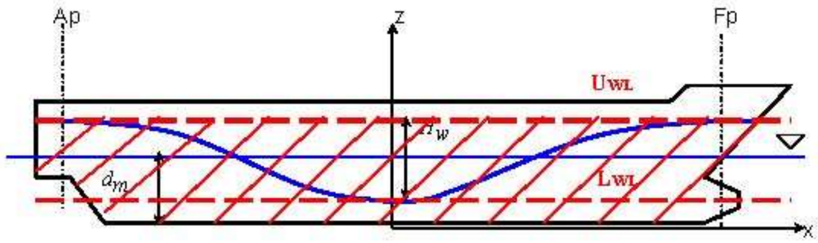

Figure 5. Considered upper water line – UWL - for wave trough amidship

The above-described simplified way of calculation, is based on the idea that waterplane variation amidships has less influence on stability changes, considering the ship's hulls in this region are box type with vertical sides. The stability variations in waves are mainly related to the waterplane variations at the fore and aft part of the ship where the changes in hull shape are considerable (Figure 6).

Figure 6. Illustration of water plane variation at ship's fore and aft part

The draft for lower and upper waterline is calculated from the relation (6), which is a combination between ABS relation [1] and wave relation obtained from [17], and quotations from Figure 7, as follows:

$$d_{(x_c,x_i)} = d_m - x_F \tan\theta \pm 0.5 \times H_w \times \cos\frac{2\pi(x_i - x_c)}{\lambda} \qquad (6)$$

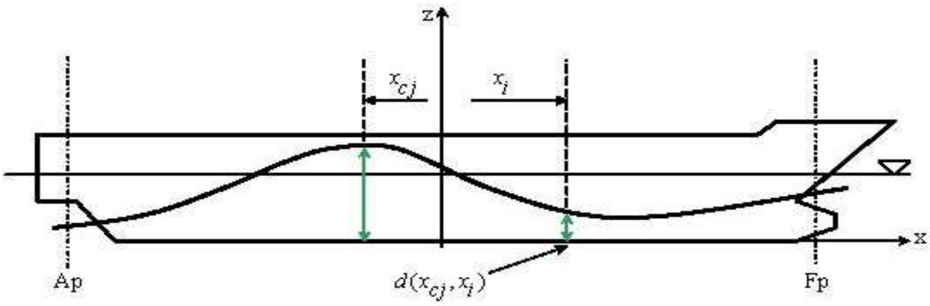

Figure 7. Definition of draft in relation with position of wave crest

For our proposed critrion of assessment the parametric rolling we considered the wave crest at midship position, where $x_i = x_c$, and the vessel is considered in a even keel situation (which means that angle of longitudinal inclination is zero) thereafter the formula for the draft at upper and lower waterline will become

$$d_{U,L} = d_m \pm 0.5 \cdot H_w \qquad (7)$$

where, the height of the wave is used from the Table 3 based on the wavelength or from the Beaufort Scale based on the wind speed and d_m is mean draft corresponding to actual loading condition.

In the calculation procedure the ship is considered in equilibrium on the wave while the pressure under the wave was considered as hydrostatic. In this way, the calculation of the variation of metacentric height in waves can be done with conventional software.

The metacentric height, for the two waterline considered, can be easily calculated from the relation

$$GM_{U,L} = BM_{U,L} - KG + VCB_{U,L} . \tag{8}$$

As the ship's vertical position KG of the centre of gravity has not usually a strong influence over the ship's trim, the stability changes in waves can be seen as a variation of the vertical position of the metacentre, which is almost independent from KG.

Actually, the simplified way of calculation the metacentric height, for upper and lower assumed horizontal waterlines, implies the simplification of assessment the moments of inertia of waterplane in the wave crest and wave trough conditions. This is due to the fact that restoring variation is nonlinear and it is a difficult task to determine the worst wave height for restoring variation in longitudinal waves. Thereafter, the variation of metacentric height can be determined as

$$\delta GM = \frac{GM_U - GM_L}{2} . \tag{9}$$

The equation of ship rolling in longitudinal waves can be considered in a way presented by Francescutto [4], as

$$I_x \ddot{\varphi} + D(\dot{\varphi}, \varphi) + R(\varphi, t) = 0 . \tag{10}$$

If the onset of parametric rolling is considered at $\varphi(t) = 0$, in the situation of restriction for the moment to analysis of stability, the problem is simplified and the Equation (10) can be written in a linearised form as

$$I_x(\ddot{\varphi}) + D\dot{\varphi} + \Delta\overline{GM}(t)\varphi = 0 . \tag{11}$$

If it is considered that the variation of transversal metacentric height is in a sinusoidal form, then the Equation (11) becomes a Mathieu type equation as follows

$$\ddot{\varphi} + 2\eta\dot{\varphi} + \omega_\varphi^2 \left[1 + \frac{\delta GM}{GM_0} \cos(\omega_E t) \right] \varphi = 0 , \tag{12}$$

which is a differential equation with periodic coefficients and its solution are solved through Floquet theory.

Since the occurrence of parametric rolling is fully dependent by the conditions for wave encounter frequency, large variations of metacentric height and sufficiently low damping, a threshold value for the onset of parametric rolling is obtained from Equation (12) in a reduced form as

$$2 - \frac{1}{2}\left(\frac{\omega_E}{\omega_\varphi} \right)^2 < \frac{\delta GM}{GM_0} < \frac{1}{2}\left(\frac{\omega_E}{\omega_\varphi} \right)^2 - 2 , \tag{13}$$

and reveals a minimum threshold value in the proximity of the condition $\omega_e = 2\omega_\varphi$ that can be written as

$$\frac{\delta GM}{GM_0} = \frac{4\eta}{\omega_\varphi} , \tag{14}$$

where, η is the total roll damping coefficient, ω_φ is the ship natural roll frequency and GM_0 is the metacentric height for draught corresponding to actual ship loading condition. The Equation (14) expresses the fact that stability variation is sufficient to induce parametric rolling.

The occurrence of parametric rolling is high when the ratio is large, then the threshold can be expressed as the critical minimal value of $\frac{\delta GM}{GM_0}$ for which large resonance occurs, as

$$\frac{\delta GM}{GM_0} > \frac{4\eta}{\omega_\varphi}. \tag{15}$$

In ship's roll motion, damping is of particular attention and should be calculated as accurately as possible. An empirical form, for the assessment of the total roll damping coefficient, can be applied from the model test of Miller [14]. Through this method, it is calculated the total damping in roll motion as a sum of two components (the linear and non-linear damping roll) as follows

$$\eta = \eta_1 + \eta_2 \cdot \sqrt{\varphi_a} \tag{16}$$

where:

$$\eta_1 = C_v \cdot 0.00085 \cdot \frac{L}{B} \cdot \sqrt{\frac{L}{GM_0}} \cdot \left[\left(\frac{F_n}{C_b}\right) + \left(\frac{F_n}{C_b}\right)^2 + 2 \cdot \left(\frac{F_n}{C_b}\right)^3 \right] \tag{17}$$

$$\eta_2 = 19.25 \cdot \left(A_{bk} \cdot \sqrt{\frac{l_{bk}}{r_b}} + 0.0024 \cdot L \cdot B \right) \cdot \frac{r_b^3}{L \cdot B^3 \cdot d \cdot C_b} \tag{18}$$

in which:

A_{bk} - one sided area of bilge keel (m²)

l_{bk} - length of bilge keel (m)

h_{bk} - height of bilge keel (m)

r_{bk} - distance center line of water plane to turn of bilge (m)
(first point at which turn of bilge starts, relative to water plane)

L - length of ship (m)

B - breadth of ship (m)

d - draft of ship (m)

C_b - block coefficient

F_n - Froude number, ($v / \sqrt{gL}$)

φ_a - amplitude of roll (rad)

C_v - correction factor for speed, generally is 1.

It is a simple method for calculation of roll damping, but what is more important is that the method uses the data of ships like A_{bk}, l_{bk}, h_{bk}, r_{bk}, L, B, d, C_b, that is available and easy accessed by ship's officers on board vessel.

The Miller's method for calculation of roll damping coefficient was chosen instead of Ikeda's method [6] because with the last one the prediction of accuracy of roll damping it might decrease considerably at small roll angles. Ikeda's method has been experimental tested and proved, by Kawahara *et. al.* [11], that is not a practical solution for the ships that have buttock flow stern, such as large passenger ship or pure car carrier, and overestimates the roll damping for flat ships with large bilge keels. Moreover, the results of experiments showed that the method is not so accurate for the ships with high location of centre of gravity, such as container ship's and car carrier ships.

Validation of the proposed criterion for an extended number of ships

In order to show the sustainability of the proposed criterion, for the assessment of parametric rolling, sample calculations were carried out for an extended number of 34 ships of different types and sizes. The main particulars are given in the Table 3.

Table 3. Main characteristics of ships used for sample calculations

Ship Type		LBP (m)	Breadth (m)	Depth (m)	Draught (m)	GM0 (m)
Containerships	C1	167.00	27.60	15.90	10.70	1.298
	C2	210.00	32.24	18.70	10.50	1.58
	C3	256.50	32.20	19.10	12.50	1.839
	C4	257.40	40.0	21.70	13.50	1.67
	C5	262.00	40.00	24.70	12.43	1.724
	C6	265.80	40.30	24.10	14.00	1.697
	C7	283.80	42.80	24.20	14.00	1.803
	C8	319.00	42.80	24.60	14.50	1.93
	C9	320.00	42.80	24.80	14.65	2.11
	C10	348.00	45.60	29.74	15.53	1.90
Ro – Ro Ships	R1	110.50	20.40	6.80	5.00	0.563
	R2	120.40	20.40	6.80	5.00	0.851
	R3	127.50	23.40	8.60	5.80	0.883
	R4	147.00	24.80	7.90	6.15	0.915
	R5	164.60	24.80	9.00	6.00	0.921
	R6	178.00	24.90	9.26	6.24	0.978
Pure Car Carriers	PCC1	187.70	24.50	21.32	6.90	1.19
	PCC2	192.00	32.26	31.70	8.18	1.23
	PCC3	199.94	32.26	34.80	10.33	1.46
Oil Tanker	OT1	88.00	17.00	7.50	5.80	1.87
	OT2	126.00	22.00	10.60	7.50	2.01
	OT3	217.00	32.26	21.00	14.50	2.32
	OT4	264.00	48.00	24.00	17.30	2.543
	OT5	316.00	60.00	29.70	21.50	2.687
	OT6	320.00	60.00	31.15	22.10	2.745
Liquefied Gas	LG1	213.00	36.00	22.30	11.70	2.895
	LG2	271.00	42.50	25.40	12.40	2.962
Multi-purpose Ships	MP1	98.60	19.00	10.60	8.31	1.89
	MP2	178.80	27.20	14.30	10.42	2.51
Bulk carriers	B1	133.00	22.80	10.80	7.20	2.32
	B2	170.80	27.60	13.90	10.15	2.67
	B3	183.30	32.26	18.50	13.00	3.30
	B4	217.00	32.26	19.60	14.25	2.567
	B5	282.00	45.00	24.80	18.30	5.11

Part of the container ships and Ro-Ro ships used in our sample calculations, are of the same sizes with the ones available in the existing literature, which developed large roll angles and suffered cargo loss / collapse in situations of extreme weather conditions.

All of the ships used for sample calculations are real and well documented ships, with well defined geometry and load cases. Part of the ships used here, were also used for sample calculations by the Correspondence Group on Intact Stability, established by IMO's SLF Subcommittee, in there reports SLF 53/INF.10 [8] and SLF 54/INF.12 [10] that contains status of developments for new dynamic intact stability criteria. The draughts have been determined from the load cases, calculations being performed for all vessels at even keel draught, whilst the other factors necessary for calculations were determined from the hydrostatic particulars contained in their stability booklet.

The sample calculations were performed for the vessels in full loaded condition with the exception of container ships, which were considered 80 – 90% from the total deadweight (TEU) capacity. This consideration was based on the fact that only in very rare condition, the container ships are loaded up to maximum capacity.

The wave height used for sample calculations was determined from the Table 3 based on the consideration that for every ship the wave length is equal with the ship's length in order to fulfill the first condition for parametric rolling and pure loss of stability phenomena, as the change in stability is most evident for this condition. The calculations were performed only for the situations of exactly longitudinal waves and only two wave crest positions were used, wave crest and wave trough amidship.

Sample calculations, for assessment of parametric rolling, were performed following the described methodology of assessment the minimum value of GM variation for onset of parametric rolling. The results are illustrated in the Table 4.

Table 4. Results of calculations for assessment of parametric rolling

Ship type	$\frac{\delta GM}{GM_0}$	$\frac{4\eta}{\omega_\varphi}$	$\frac{\delta GM}{GM_0} > \frac{4\eta}{\omega_\varphi}$	Comply
C1	1.83	1.45	No	Failed
C2	2.01	1.51	No	Failed
C3	2.28	1.37	No	Failed
C4	2.43	1.73	No	Failed
C5	2.67	1.79	No	Failed
C6	2.85	1.69	No	Failed
C7	2.92	2.17	No	Failed
C8	3.12	2.26	No	Failed
C9	3.38	2.41	No	Failed
C10	3.51	3.76	Yes	Yes
R1	1.84	1.30	No	Failed
R2	1.71	1.36	No	Failed
R3	1.98	1.81	No	Failed
R4	2.14	1.92	No	Failed
R5	2.38	2.04	No	Failed
R6	2.24	2.17	No	Failed
PCC1	0.58	2.95	No	Yes
PCC2	0.67	3.03	No	Yes
PCC3	0.78	3.21	No	Yes
OT1	0.24	2.54	Yes	Yes
OT2	0.27	2.84	Yes	Yes
OT3	0.21	3.27	Yes	Yes
OT4	0.23	3.98	Yes	Yes
OT5	0.16	4.28	Yes	Yes
OT6	0.16	4.31	Yes	Yes
LG1	0.43	2.61	Yes	Yes
LG2	0.58	3.47	Yes	Yes
MP1	0.95	1.25	Yes	Yes
MP2	1.11	1.90	Yes	Yes
B1	0.27	2.72	Yes	Yes
B2	0.26	2.83	Yes	Yes
B3	0.28	2.92	Yes	Yes
B4	0.31	3.01	Yes	Yes
B5	0.29	3.56	Yes	Yes

Based on the results of sample calculations the following conclusions, related to assessment of parametric rolling, can be stated:

- *Container ships* - Almost all container vessels used for sample calculation, i.e. 9 ships from 10, proved to be susceptible to parametric rolling.
- *Ro - Ro ships* - All Ro - Ro vessels used for sample calculation proved to be susceptible to parametric rolling.
- *Pure Car Carrier, Tanker, Gas Carrier, Multipurpose carrier and Bulk carrier ships*

The sample calculations for the above considered types of ships, in assumed loading conditions, revealed as not be susceptible to parametric rolling according to this criterion.

Conclusions

The paper offers a simplified criterion of assessment the parametric rolling of ships. The criterion is based on the assumption that the vessel is "frozen" on the wave crest and wave trough and the variation of the metacentric height for those two conditions are leading to the onset of a very dangerous phenomenon in extreme seas, namely parametric rolling. Sample calculations revealed that the hull form of the ship has a great influence over the phenomenon of parametric rolling and in this context it revealed that container ships and Ro-Ro ships are most vulnerable.

The criterion can be useful for officers on board ships in order to determine the vulnerability to parametric rolling prior commencement of the intended voyage, considering the actual ship loading condition. Moreover, the method can be integrated as an additional dynamic stability criterion into already existing one for the assessment of intact ship stability in waves.

As the method was studied only for longitudinal waves (head and following waves) further studies can be carried out for quartering waves.

References

1. American Bureau of Shipping (ABS), Guide for the assessment of parametric roll resonance in the design of container carriers. Technical Report, Huston, Texas, 2004.
2. Bulian, G., Development of Analytical Nonlinear Models for Parametric Roll and Hydrostatic Restoring Variations in Regular and Irregular Waves, Ph.D. Thesis, 2006.
3. France, N.W., et. al. An Investigation of Head-Sea Parametric Rolling and its Influence on Container Lashing Systems, SNAME Annual Meeting Presentation, 2001.
4. Francescuto, A. Nonlinear Modelling of Large Amplitude Ship Rolling in longitudinal Waves, 8emes Journee de L'hydrodynamique, Nantes, 5, 6, 7 Mars 2001.
5. Francescutto, A., et. al. Experiment –Supported Weather Criterion and Its Design impact on large passenger Ships, Proceedings of 2nd International Maritime Conference on Design for Safety, 27-30 October, Sakai, Japan, 2007.
6. Ikeda, Y., Himeno, Y., Tanaka, N. A prediction Method for Ship Roll Damping, Osaka prefecture, department of naval Architecture, Report No.00405, 1978.
7. IMO MSC.1/Circ.1228, Revised Guidance to the Master for Avoiding Dangerous Situations in Adverse Weather and Sea Conditions, London, January, 2007.
8. IMO Document SLF53/INF.10, Information collected by the Correspondence Group on Intact Stability, Submitted by Japan, 9 November 2010.
9. IMO Document SLF53/INF.11, Information collected by the Correspondence Group on Intact Stability, Submitted by Japan, 9 November 2010.
10. IMO Document SLF54/INF.12, Information collected by intersessional Correspondence Group on Intact Stability, Submitted by Japan, November 2011.
11. Kawahara, Y., Maekawa, K., Ikeda, Y. A Simple Prediction Formula of Roll Damping of Conventional Cargo Ships on the Basis of Ikeda's Method and Its Limitation, Journal of Shipping and Ocean Engineering 2, 2012.
12. Kerwin, J.E. Note on Rolling in Longitudinal Waves, International Shipbuilding Progress, 1955.
13. Larhooven, B.J.H., Stability Analysis of Parametric Roll Resonance, DCT 2009.062, Eindhoven University of Technology, Department Mechanical Engineering Dynamics and Control Group, Eindhoven, June 2009.
14. Miller, E.R. Roll damping, Technical Report 6136-74-280, NACSPEC, 1974.
15. Paulling. J.R., Rosenberg, R.M. On unstable ship motions resulting from non-linear coupling, Journal of Ship Research, Vol.3, No.1, 1959
16. Shin, Y.S., et. al. Criteria for Parametric Roll of Large Containerships in Longitudinal Seas. Transactions of SNAME, 2004.
17. Vidici-Perunovici, J. Ship Dynamic Intact Stability. Focus on Parametric Roll, Technical Report, Technical University of Denmark, Lyngby 2009.
18. "***" http://www.sname.org/home/

THE IMPACT OF THE PROSPECTIVE RAILWAY LINK ON THE PORT CAPACITY: THE SOUTH BLACK SEA

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Abstract

The added-value created in logistics sector owing to the combination among various modes of transportation, supports the development of new transportation systems. The intermodal transportation which meets the requirement of varying delivery needs of all kinds of cargo is the most important outcome of these development efforts. In this study, the examination of the volume of cargo at the port of Trabzon which is an important port in the South of Black Sea, in terms of the result of the combination between the most economical kinds of intermodal transport - rail and maritime transport - is discussed. In this study, one of the other ports in the south Black Sea, Samsun assumed as a sample port and to explain the effects of railway to the port capacity, a regression analysis is performed by using the parameters of provinces road, railway freight transportation amount and GDP. As a result of the analysis, the effect of railway transport to the port of Samsun is calculated as percentage. Another regression model for the port of Trabzon is generated by using the parameters of road transportation amount and GDP. As a result of this model, the port of Trabzon freight estimation until 2025 is achieved. The percentage of the railway transportation effect results of the port of Samsun is added to the percentage results of Trabzon port supposing that the planned railroad has been constructed. Finally, the estimated handling freight at the port of Trabzon is calculated.

Keywords*:* *South Black Sea, Multimodal Transport, Railway Transport, Trabzon Port*

Introduction

Sea transport is preferred more over other transport methods including road, air and railway transport, for longer routes as it offers the minimal unit transport cost per load compared to the other methods. Sea and Railway transport constitute the key systems for multi-modal transport that have active role in combating road congestions and progressively growing air pollution.

Although combined transport in Turkey grows in parallel to the global trends, infrastructure shortcomings besides poor operation prevent railway from getting an active role in such transport mode. Therefore, the efficiency of the whole transport infrastructure, primarily including railways, should be enhanced such that it facilitates to the evolution of combined transport [15].

Selecting the most appropriate transport system in providing transport represents the key issue of today's logistics approach. However, for seaway-coupled transport processes, correct future load forecasting should be in place for our ports to guide the current progress. Dundovic and Vilke (2010) performed a study on the significance of coupling railway to the Rijeka port in Zagreb, the capital of Croatia. In that study, it was suggested that the railway on the Rijea - Koper - Trieste route proposed to be built as coupled with railway between Rijeka and Zagreb would interlink three major ports of the North Adriatic. Furthermore, they reported that such connection would ease the North Adriatic traffic as it would link South East Europe to the center and west of Europe. In addition, in their study, Esmer and Kişi (2004) made a load forecast on the ports of Aegean and Marmara Regions for the future period. In that study, the regression analysis, addressing the correlation of socio-economic indicators of regional hinterlands with load capacities handled at the ports of those regions, was employed. Additionally, they reported that, tracing back into a history of minimum twelve years in variables utilized for the regression analysis would be necessary for the reliability of the study. In their study, Esmer and Oral (2008) employed the regression method in load forecasting of ports offering container handling services in Turkey to analyze the correlation between the historic load movements of such ports and the socio-economic indicators of the hinterland.

Linking Trabzon to the current railway network would bring about a fast acceleration, hence South East would be linked to East and South East Anatolia, and countries with border to the Black Sea would enjoy a shortcut to Middle East. Furthermore, this route that would stand as the shortcut offering minimal distance for European countries opening into Black Sea through the Rhine-Danuba watercourse would serve as a valuable means of opportunity [13]. A review of ship traffic on Black Sea reveals that ships arriving at the Trabzon port primarily originate from countries with border to the Black Sea and the Mediterranean basin [2].

Methodology

The project has been designed as 2 separate round lines both for passenger and load traffic proposed to be built within the provincial administrative borders of Erzincan, Gümüşhane, Giresun and Trabzon and their districts by the Turkish Ministry of Transport, Shipping and Communication's General Directorate for the Construction of Railways, Ports and Airports. The "Trabzon-Tirebolu-Gümüşhane-Erzincan Railway project" designed to allow the operation of trains is composed of two portions, one being the 240+000 km Erzincan-Trabzon portion (master line) as illustrated in Figure 1, and the other being the 85+670 km Gümüşhane-Tirebolu portion (link). The project has been designed as 2 separate round lines both for passenger and load traffic proposed to be built within the provincial administrative borders of Erzincan, Gümüşhane, Giresun and Trabzon and their districts on the route illustrated in the figure [14].

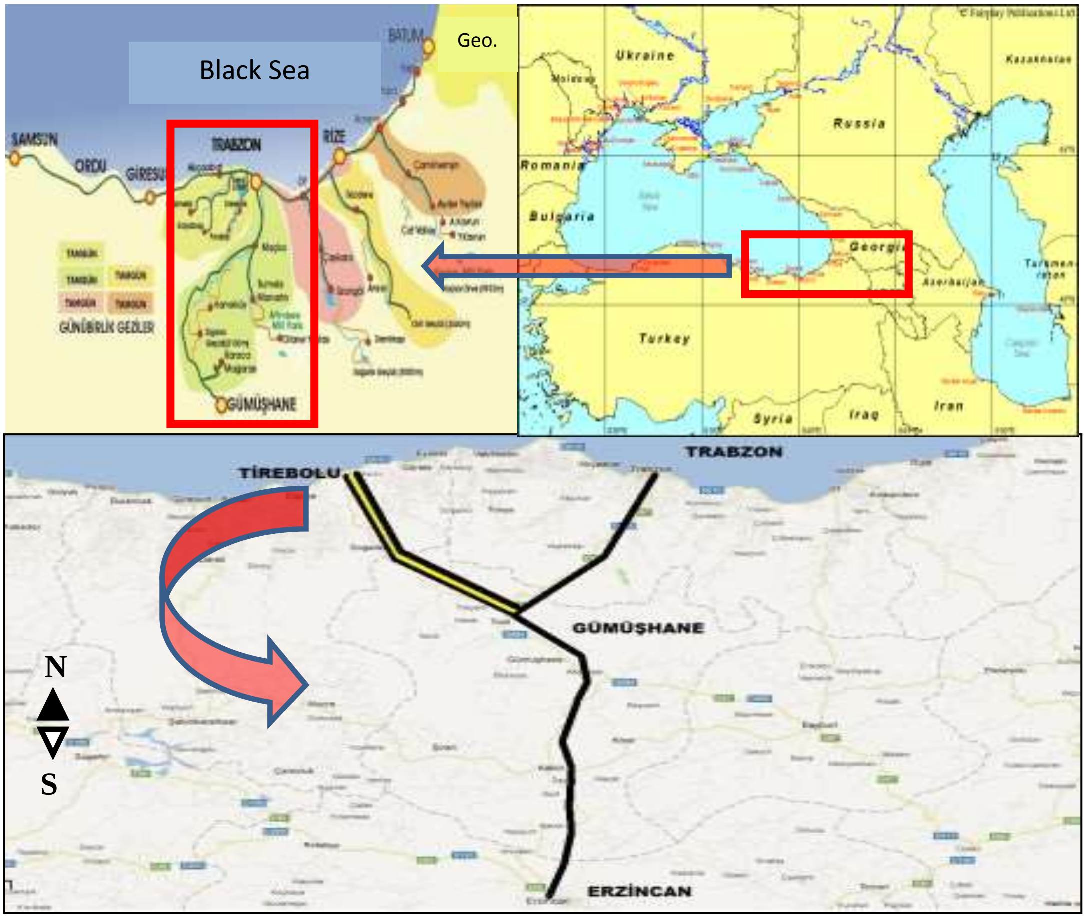

Figure 1. Destination of planned project [14].

The SPSS software has been utilized to carry out a regression analysis based on findings so as to survey the impact of the railway on the port capacity. Regression is a method where the value of a variable (relative variable) is estimated based on its relation to the value of the other variable (independent estimator variable). Accordingly, the relationship between the values of two variables may be demonstrated with a function like y = f(x). This expression shows that the value of y is a function of the value of x, in other words, y value is dependent on the x value [1].

Data Employed for the Samsun and Trabzon Ports

Within the scope of the study, first, amount of load (tons) handled at the Samsun port annually was assigned as the dependent variable to examine the impact of railway transport on the annual load handling capacity of the Samsun port [5]. And the Gross Domestic Product (GDP) figures for Samsun, annual amount of load (tons) inbound to Samsun by road, amount of annual load (tons) inbound to Samsun by railway, and GDP figures for provinces involved in the provincial hinterland of Samsun were assigned as independent variables. By utilizing the road transport and GDP ratios for Samsun, the regression model was built as presented in Table 1, and load forecasting for the Samsun port was developed up to 2025 in the light of such parameters.

Table 1. Handling data of Samsun port arising from highway transportation [3], [4].

Years	Handled in port (tons)	GDP (1000 TL)	Carried Over Highway (million tons)
1998	2.866.077	1.039.007	12.177
1999	2.871.007	1.548.020	12.078
2000	3.036.329	2.466.539	12.924
2001	3.201.651	3.555.316	12.114
2002	3.839.041	5.187.046	12.073
2003	2.986.944	6.730.754	12.173
2004	3.342.985	8.273.689	12.548
2005	3.130.556	9.604.189	13.346
2006	4.338.067	11.224.184	14.192
2007	5.692.963	12.479.041	14.506
2008	6.474.729	14.067.907	14.555
2009	7.283.607	14.097.867	14.116
2010	6.691.606	16.335.497	15.229

Secondly, as provided in Table 2, railway transport and railway-driven GDP figures for provinces involved in the hinterland were employed in addition to the road transport and GDP parameters. In the light of these parameters, load forecasting for the Samsun port was rebuilt up to 2025. The next effort was to calculate the difference, as percent, yielded by both forecasting procedures, and figure out the impact of the railway on the amount of load handled at the port.

Table 2. Handling data of Samsun port arising from highway and railway transportation [11].

Years	Handled in port (tons)	Total Gross Domestic Product in the Hinterland (1000 TL)	Carried Over Highway (million tons)	Carried Over Railway (1000 tons)
1998	2.866.077	4.514.064	12.177	602.163
1999	2.871.007	6.725.518	12.078	593.355
2000	3.036.329	10.716.110	12.924	695.254
2001	3.201.651	15.446.408	12.114	528.462
2002	3.839.041	22.535.612	12.073	536.767
2003	2.986.944	29.242.398	12.173	609.051
2004	3.342.985	35.945.823	12.548	710.580
2005	3.130.556	41.726.310	13.346	498.731
2006	4.338.067	48.764.527	14.192	440.882
2007	5.692.963	54.216.372	14.506	509.813
2008	6.474.729	61.119.351	14.555	948.697
2009	7.283.607	61.249.516	14.116	1.170.285
2010	6.691.606	70.971.113	15.229	999.971

With a view to identifying the most appropriate regression equation for each port, the curve forecasting function in the SPSS software was employed, and the parameters of the equation yielding the load handling capacities of ports for subsequent years were found as a result of the statistical analysis carried out.

First, the regression analysis was carried out to forecast the impact of the railway link on the Trabzon port as well as the load capacity that the port would be capable of handling in subsequent years [5]. In the regression analysis so carried out, amount of load handled at the Samsun port was assigned as the dependent variable, and the GDP figures for Trabzon relating to the period 1998-2010 as well as road transport figures for the same period were assigned as the independent variables. Data employed in the regression analysis was provided in Table 3.

Table 3. Cargo estimation analyzes data of Trabzon port [3; 4; 11].

Years	Handling in port (tons)	Gross Domestic Product (1000 TL)	Carried Over Highway (million tons)
1998	902.082	702.031	4.566
1999	920.986	1.045.959	4.529
2000	1.042.494	1.666.580	4.847
2001	1.164.002	2.402.241	4.543
2002	1.602.159	3.504.761	4.527
2003	1.925.160	4.547.807	4.565
2004	2.045.308	5.590.330	4.706
2005	1.888.671	6.489.317	5.005
2006	2.239.692	7.583.908	5.322
2007	2.648.794	8.431.784	5.440
2008	2.850.139	9.505.343	5.458
2009	2.582.938	9.525.586	5.294
2010	2.678.755	11.037.498	5.711

The Prospective Hinterland for the Trabzon port and the Railway Hinterland for the Samsun Port Within the Railway Project

The current hinterland of the Trabzon port embodies Artvin, Bayburt, Giresun, Gümüşhane, Ordu and Rize provinces. Once the project is implemented, such hinterland may be extended to cover Gaziantep, Malatya, Erzincan, Elazığ, Diyarbakır, Van, Erzurum and Kars provinces. In this respect, gross domestic product figures of such provinces may be incorporated into the analysis method as well. GDP figures of such provinces for the 1998-2010 periods are based on 98 data [12].

Findings

In order to survey the impact of railway transport on Samsun port, load forecasting was conducted through two separate regression analyses. The regression analysis yielded the following equation.

Total Cargo = -3.952.264+(0,172×GDP)+ (516,124× COH) (1)
COH = Carried Over Highway

Estimated amount of load to be handled at the Samsun Port until 2025 was calculated based on the forecast equation derived and provided in Table 4.

In the second analysis conducted to identify the impact of railway transport on port capacity, again the amount of load handled at the Samsun port was assigned as the dependent variable, whereas the amount of load transport by road for Samsun during the 1998-2010 period, amount of load transport by railway for Samsun, and sum of GDP figures for Samsun and other provinces involved in the railway hinterland were assigned as independent variables [10]. The regression analysis yielded the following equation.

Total Cargo = -5.293.174 + (0,0244×GDP) + (512,36× COH)+ (2,838399× COR) (2)
COR = Carried Over Railway

Table 4.Cargo estimation of Samsun port

Years	Handling in port (tons)	Gross Domestic Product (1000 TL)	Carried Over Highway (million tons)
2013	8.699.672	25.067.007	16.156
2014	9.445.164	28.201.783	16.555
2015	10.220.893	31.366.428	17.003
2016	11.030.429	34.611.422	17.489
2017	11.863.745	37.962.416	17.987
2018	12.706.802	41.485.675	18.445
2019	13.549.933	45.148.929	18.858
2020	14.440.304	49.058.032	19.279
2021	15.386.416	53.171.267	19.741
2022	16.718.241	59.225.796	20.303
2023	18.101.274	65.785.663	20.795
2024	19.576.511	72.821.693	21.308
2025	21.149.960	80.376.485	21.837

Estimated amount of load to be handled at the Samsun Port driven by the contribution of railway transport until 2025 was calculated based on the forecast equation derived and provided in Table 5.

Table 5. Cargo estimation of Samsun port arising from railway transportation

Years	Handling in Port (tons)	Carried Over Highway (million tons)	Gross Domestic Product (1000 TL)	Carried Over Railway (1000 tons)
2013	9.219.948	16.156	108.906.015	1.258.953
2014	10.128.939	16.555	122.525.359	1.389.844
2015	11.133.654	17.003	136.274.478	1.544.564
2016	12.207.096	17.489	150.372.680	1.713.503
2017	13.326.510	17.987	164.931.414	1.892.735
2018	14.677.976	18.445	180.238.573	2.154.237
2019	16.252.521	18.858	196.153.958	2.497.494
2020	18.015.088	19.279	213.137.463	2.896.068
2021	19.519.953	19.741	231.007.840	3.189.003
2022	21.266.478	20.303	257.312.368	3.476.378
2023	23.298.454	20.795	285.812.390	3.857.916
2024	25.539.824	21.308	316.381.157	4.291.820
2025	28.011.810	21.837	349.203.740	4.784.435

Based on the results obtained with both analysis methods, a comparison was made as provided in Table 6.

Table 6. Comparison table

Years	Carried Over Highway (1000 tons)	Carried Over Railway (1000 tons)	Difference between (1000 ton)	Difference as percentage
2013	8.699.672	9.219.948	520.277	5,98
2014	9.445.164	10.128.939	683.775	7,24
2015	10.220.893	11.133.654	912.761	8,93
2016	11.030.429	12.207.096	1.176.667	10,67
2017	11.863.745	13.326.510	1.462.765	12,33
2018	12.706.802	14.677.976	1.971.174	15,51
2019	13.549.933	16.252.521	2.702.589	19,95
2020	14.440.304	18.015.088	3.574.784	24,76
2021	15.386.416	19.519.953	4.133.537	26,86
2022	16.718.241	21.266.478	4.548.237	27,21
2023	18.101.274	23.298.454	5.197.179	28,71
2024	19.576.511	25.539.824	5.963.312	30,46
2025	21.149.960	28.011.810	6.861.850	32,44

First, the regression analysis was carried out to forecast the impact of the railway link on the Trabzon Port as well as the load capacity that the port would be capable of handling in subsequent years. The regression analysis yielded the following equation.

$$\text{Total Cargo} = 2.349.000 + (0{,}235 \times GDP) + (-355{,}707 \times COH) \quad (3)$$

Estimated amount of load to be handled at the Trabzon Port until 2025 was calculated based on the forecast equation derived and provided in Table 7.

Table 7. Cargo estimation of Trabzon port

Years	**Handling in port (tons)**	**Gross Domestic Product (1000 TL)**	**Carried Over Highway (million tons)**
2013	4.174.185	16.937.161	6.058
2014	4.618.674	19.055.249	6.208
2015	5.061.423	21.193.519	6.376
2016	5.511.766	23.386.078	6.559
2017	5.977.511	25.650.258	6.745
2018	6.475.756	28.030.833	6.917
2019	7.002.429	30.505.997	7.072
2020	7.566.869	33.147.275	7.230
2021	8.158.385	35.926.478	7.403
2022	9.044.806	40.017.365	7.614
2023	10.020.702	44.449.693	7.798
2024	11.069.551	49.203.753	7.991
2025	12.198.460	54.308.324	8.189

Besides this increase, the Iranian Ambassador stated that, construction of the railway would introduce an approximate load volume of 5 million tons in the Trabzon Port. Substantially relying upon the Trabzon Port for import until the Iran-Iraq war and thereafter preferring the Dubai Port instead, Iran currently proposes to import via the Trabzon Port again [9]. It has been reported that, supplemental of a railway link to Trabzon would lead to an intensive engagement of the Trabzon Port by Iran. Further report is that once a railway link is, around 5,000,000 tons of loads would be inbound from Iran starting with 2018 [9]. Load potential after the construction of the railway link to the Trabzon Port as extrapolated in the light of statistical data obtained in this respect is provided in Table 8 and Figure 2.

Table 8. Cargo estimation of Samsun port arising from railway transportation and possible cargo income from Iran

Years	**Trabzon Estimation without Railway (tons)**	**Rate from Samsun (%)**	**Trabzon Estimation with Railway (tons)**	**Possible cargo income from Iran (tons)**	**Total Cargo (tons)**
2013	4.174.185	5,980417422	4.423.819	-	4.423.819
2014	4.618.674	7,239419580	4.953.039	-	4.953.039
2015	5.061.423	8,930343867	5.513.425	-	5.513.425
2016	5.511.766	10,667466303	6.099.732	-	6.099.732
2017	5.977.511	12,329703930	6.714.520	-	6.714.520
2018	6.475.756	15,512745732	7.480.324	5.000.000	12.480.324
2019	7.002.429	19,945402491	8.399.091	5.000.000	13.399.091
2020	7.566.869	24,755600286	9.440.093	5.000.000	14.440.093
2021	8.158.385	26,864842856	10.350.122	5.000.000	15.350.122
2022	9.044.806	27,205237731	11.505.467	5.000.000	16.505.467
2023	10.020.702	28,711676186	12.897.813	5.000.000	17.897.813
2024	11.069.551	30,461566940	14.441.510	5.000.000	19.441.510
2025	12.198.460	32,443796226	16.156.104	5.000.000	21.156.104

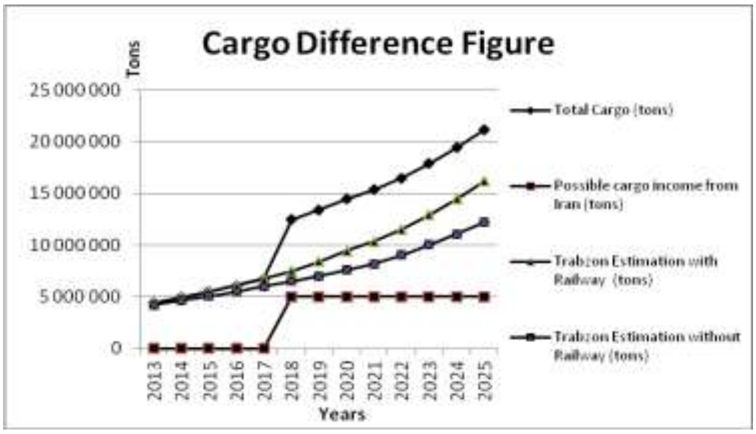

Figure 2. Cargo difference figure

Conclusions

One of the critical means for the development and global upgrade of Trabzon as one of the crucial passages of the historical Silk Road is to launch the Trabzon-coupled railway project as practically soon as possible. The railway line to be built will both help to create new fields of employment and serve as a valuable step in imparting an industrial attribute to the city. The transport cost that constitutes the major cost item in the raw material procurement and finished product sale will be minimized thanks to this new line, hence re-characterizing the city as a brilliant venue for industrial investments thanks to its status as a coastal town and in-depth trade history.

In the analysis conducted exclusively on road transport for the Samsun port, the load handling capacity throughout the year 2011 in the province was reviewed, leading to a finding of 7,347,209 tons. Second, results as to the variation of the aforesaid figure upon the inclusion of railway transport into the analysis were reviewed, revealing that handling capacity was boosted by 400,305 tons reaching 7,747,514 tons in 2011 as driven by the railway transport. Surveying the difference between both analyses in percentage terms reveals a finding of 5.45%. The Turkish State Railways' Master Plan on Transport Coastal Structures for 2009 presents a data of 3.12% for the Samsun port, exhibiting how consistent our analysis is.

With a view to surveying the impact of railway transport as the primary objective of the analyses herein, we can see the extent of improvement to be brought by the prospective railway construction in the load handling capacity of the port by adding the ratios of railway transport having impact on the load handling capacity of the Samsun port to the load forecasting facts for the Trabzon port. While the load handling capacity at the Trabzon port in 2015 without railway transport was found to be 5,061,423 tons, the contribution of railway transport to load increase was calculated to be 5,513,425 tons. Likewise, according to the findings, load handling capacity calculated as 7,566,869 tons and 12,198,460 tons for 2020 and 2025 respectively were improved to 9,440,093 tons and 16,156,104 tons by an increase of 1,873,224 tons and 3,957,644 tons respectively through railway contribution. The analysis further reveals that, the Trabzon port offering an actual annual load handling capacity of 10,000,000 tons would fail to meet such increase starting with 2021.

By adding a load increase of 5 million tons originating from Iran upon railway construction to these results, the load handling capacity calculated for 2018 sums 12,089,178 tons. This is anticipated to reach 21,156,104 tons in 2025. It should further be specified that, given the foregoing sum exceeding the actual capacity of the Trabzon port by 11 million tons, the port will fail to meet such increase.

An analysis of ports around the globe receiving high levels of transport and load handling capacities proves efficient contribution of railways links to ports. The analysis further reveals the fact that capacity increase and load handling improvement for the Trabzon port is directly associated with the railway link.

Given the railway networks and international transport projects in our country, failure to upgrade railways to particular levels would narrow down our share in international transport. Due to the lack of a railway link in the Trabzon port, many opportunities of handling transit loads are missed. The evident assessment is that, construction of a railway link to the Trabzon port to incorporate it in the domestic railway network would help transporting local and international loads at more budget-friendly costs and increase our share in global transport.

References

1. Akmut, Ö., Akdağ, R. ve Binay, S., H. Öngörü Teknikleri ve Finans Uygulamaları. Ankara Üniversitesi Siyasal Bilgiler Fakültesi Yayını: 584, Siyasal Kitabevi, 1. Baskı, 1999, p. 272.
2. Başar E. ve Erol S., Karadeniz'deki Tanker Trafiğinin Belirlenerek Tahmini Kaza Alanlarının Tespiti. In: Kıyı Alanları Konferansı (Trabzon,Türkiye, Nisan, 2010, Karadeniz Teknik Üniversitesi), 2010, pp.1401-1408.
3. Denizcilik Müsteşarlığı,. Kabotaj Taşımacılığı Saha Etüd Çalışması, SUDOPAK Uluslararası Mimarlık Mühendislik ve Müşavirlik Ltd. Şti., 2006, p. 310
4. DLH. Ulaştırma Kıyı Yapıları Master Plan Çalışması, 2. Ara Rapor, T.C. Demiryolları Limanlar ve Hava Meydanları İnşaatı Genel Müdürlüğü, 2009, p. 59
5. DTO. Deniz Sektörü Raporu 2010, İstanbul, 2011. Available (accessed on 11.10.2010): http://www.denizticaretodasi.org.tr/Shared%20Documents/sektorraporu/sektor_raporu_2010tr.pdf
6. Dundoviç, S., Vilke, S.,. The Significance of High-Efficiency Railway Zagreb-Rijeka for the Port of Rijeka Development. Scientific Journal of Maritime Research, 2010, pp. 165-188.
7. Esmer, S. ve Kişi, H. Ege ve Marmara Bölgesi Limanları Arz ve Talep Projeksiyonu. In: Türkiye'nin Kıyı ve Deniz Alanları 5. Ulusal Konferansı (Adana, Türkiye, Mayıs, 2004, Bildiriler Kitabı), 2004, pp.527-536.
8. Esmer, S. ve Oral, E., Z. Türkiye'de Konteyner Limanlarının Geleceği. Türkiye'nin Kıyı ve Deniz Alanları 7. Ulusal Konferansı (Ankara Mayıs, 2008 , Bildiriler Kitabı), 2008, pp. 510-518.
9. İran Büyükelçisinin Söylemi. Available (accessed on 30.04.2012): http://www.denizhaber.com.tr/limanlar/18733/iran-trabzon-limanini-us-olarak-secti.html
10. STSO, Samsun Ticaret ve Sanayi Odası İktisadi Rapor, 2008, Samsun Ticaret ve Sanayi Odası Yayınları, Samsun, pp. 157-167. Available (accessed on 11.10.2009): http://www.samsuntso.org.tr/Samsun/Ulas.pdf.
11. TCDD. 2006-2010 İstatistik Yıllığı, Türkiye Cumhuriyeti Devlet Demiryolları, 2010, p. 21
12. TÜİK,. Bölgesel Göstergeler 2010, TR90 Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane, TÜİK Yayın No: 3278, TÜİK Matbaası, Ankara, 2012, p.157
13. Trabzon Liman Müdürü Muzaffer Ermiş'in Konuşması Available (accessed on 20.05.2012): http://www.denizgazete.com/haber/25023-trabzon-liman-demiryolu-muzaffer-ermis.html.
14. UBAK. T.C. Ulaştırma Denizcilik ve Haberleşme Bakanlığı Trabzon-Erzincan Demiryolu Projesi Fizibilite Raporu, Ankara, 2011.
15. Vitoşoğlu, Y. ve Evren, G. Türkiye'de Demiryolu Ağırlıklı Kombine Yük Taşımacılığı Olanaklarının Araştırılması, İTÜ Dergisi / D mühendislik, İstanbul, 2008, pp.77-88.

A COMPARISON OF THE HANDLING OF CONTAINERS IN KLAIPEDA AND KALININGRAD PORTS

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Abstract
Containerisation started with using some converted ships and progressed with designing of container ships to maximize possible number of containers to be carried. Containers remarkably changed the port activities; the contrast between the container and the previous loading operations is unexpectedly high: first, it reduced the time the vessel is in port, reduced manpower requirements. The results and the need for economic cooperation between Lithuania and Kaliningrad region become especially clear evaluating the activities of maritime sectors. Container flows in Klaipeda and Kaliningrad ports prove that there is a strong relation between container turnover and export in both ports, especially in port of Klaipeda. Moreover, this tendency complies with a close cooperation of port authorities and stevedoring companies as well as a geopolitical regional strategy of country. On the other hand, Kaliningrad port becomes an active centre of the distribution of goods and has the potential to take a leading position in the regional market.
Key words: *containerisation, port infrastructure, Klaipeda port, Kaliningrad port.*

Introduction

The results and the need for economic cooperation between Lithuania and Kaliningrad region become especially clear when the activities of Lithuanian maritime sector, i.e. Klaipeda port, are analyzed. The peculiarities of Kaliningrad region are free economic zone, port and well-developed ship building as well as the privileged situation in transporting Russian cargo transit via Kaliningrad port. Responding to the needs of Kaliningrad region for the cooperation and the development with Lithuania, from the point of view of global economics it can be stated that the activities of maritime sector companies are connected with the development of the countries as inseparable parts of the world, regional economy.

Object of the research – container cargo flows in Klaipeda (Lithuania) and Kaliningrad (Russia) ports.

The objectives of the research are:

1. To describe relation between port development and containerised cargo flow.
2. To compare infrastructure of Klaipeda and Kaliningrad ports.
3. To compare container handling turnover in Klaipeda and Kaliningrad ports.
4. To analyse import and export of container flow in Klaipeda and Kaliningrad ports.

Research methods are scientific literature analysis and statistical analysis.

Statistical analysis of Klaipeda port (together with Butinge terminal) and Kaliningrad port shows that cargo turnover in 2012 in comparison with 2011 decreased in Klaipeda port by 3,9%, in Kaliningrad by 5%. At the same time, containerised cargo flow increased in both ports, particularly, in Kaliningrad.

According to the Ministry of Foreign Affairs of the Republic of Lithuania, Russia intends to turn Kaliningrad region to important transport and logistics centre of the Baltic Sea region. Therefore, in the strategy for 2007-2031 of the social and economic development of Kaliningrad region the following aims are included: the integration of Kaliningrad region (economics, labour market, capital, infrastructure) into the region of the Baltic Sea states, the re-orientation of the economics of Kaliningrad region from re-export to export and making Kaliningrad the economic leader of the Baltic macro-region. Analysis of containerised cargo flow proves this tendency.

Port development and competitive factors of containerisation

The international market and country have contact in the ports. They play an important role in shaping the country's transport system, the development of international relations [13]. Today's modern ports can attract customers and make the greatest impact on nearby regions offering efficient and reliable services to ships and cargo, and basically become a production chain. The ports are often a vital factor of the country's competitive advantage, so it is important to exploit the possibilities of the port effectively and not to lose the potential economic advantage [2].

Modern port is not only place to swap the goods – today port became a functional dynamic element of logistics network [15]. A port usually is described as a location on a coast or shore containing one or more harbours, where ships can dock and transfer people or cargo to or from land [3]. Also, seaports are areas where there are facilities for berthing or anchoring ships and where there is the equipment for the transfer of goods ship to shore or ship to ship. Ports are main transport hub in international trade and all modes of transport interact in ports [4]. Every port has various competitions levels: competition between transport, competition between regions, competition between ports, internal competition [7; 10].

Containerisation is a global trend that is expected to continue in the future. Containers remarkably changed the port activities: the contrast between the container and the previous loading operations is unexpectedly high: firstly, reduced vessels turn around time in the port, reduced manpower requirements [1]. Nowadays, the overseas transport of finished consumer goods is almost always carried out in these standardised steel boxes, containers, on deep sea container vessels. In addition, the fraction of liquids as well as piece and bulk goods shipped in specialised containers is also increasing.

Container logistics comprises more than just the overseas transport that is carried out by container vessels. Moreover, also stripping, stuffing, storing and handling containers as well as its hinterland transportation are included in the container logistics. According to the definitions of logistics, containers logistics can be defined as the integrated planning, coordination, execution and control of all flows of standardised ISO 668 steel boxes and of the related information from the origin to the final destination [11]. In comparison to conventional bulk transportation, the usage of containers has the advantages of less packaging, less damaging and being more productive [9].

Moreover, the huge amounts of containers handling requires port authority to make investments in e.g. intermodal transport to offer the terminal a choice of modes of transport (rail, water, and road) depending on desired speed of delivery [8]. Doing container handling jobs in a container terminal is a complicated problem, for all terminal resource, because mobile trucks, yard cranes and quay cranes must cooperate to offer handling services to thousands of containers each day [12].

The port needs modernizing, expanding, deepening. It leads to increasing capacity of handle and improves port work every year [5]. Containers terminal structure and structure functions are important in terminal operations. Containers terminal must have a large area. So, port infrastructure and technical specifications are main competitive factors in containerised cargo handling market.

Advantages and disadvantages of Klaipeda and Kaliningrad ports infrastructure

Klaipeda and Kaliningrad ports are neighbouring ports, situated on the eastern Baltic Sea coast, and for effective competition it is important to analyse the advantages and disadvantages of the ports infrastructure. Technical specifications of the port are important to port successful activity (Table 1).

Table 1. Klaipeda and Kaliningrad ports specifications [6; 8]

Specification	Klaipeda port	Kaliningrad port
Geographical position	ice-free	ice-free
Area	498 ha	66,4 ha
Quay depth	14,5 m	9,4 m
Quay length	24,9 km	6,1 km
Number of terminals	39	20

One of considerable advantages of these two ports is being ice-free. It makes impact on increasing handle and growing competition (Table 1). If specifications of Klaipeda and Kaliningrad ports are compared, it can be concluded, that Klaipeda port is larger and its area is 498 hectares. Kaliningrad port is smaller and it’s area is 66,4 hectares. Klaipeda port quay depth is 14,5 meters whereas Kaliningrad port depth is 9,4 m. Thus, Kaliningrad quay depth is less than Klaipeda port quay by 5,1 meters. Length of berths is intended to service various types of ships. If day length of berths in Klaipeda port is nearly 25 kilometres, in Kaliningrad port it is 6 kilometres. Each port has its own terminals, which enables to store cargo. As special equipment is used to load cargoes, particular attention should be paid to the number of terminals. Klaipeda port has 19 cargo terminals more than Kaliningrad port does. Despite their infrastructural differences, Klaipeda and Kaliningrad ports compete with each other.

Flows of container cargo in Klaipeda and Kaliningrad ports

Analysing the changes in Klaipeda and Kaliningrad port handling capacity, an upward trend is observed in both ports (Figure 1).

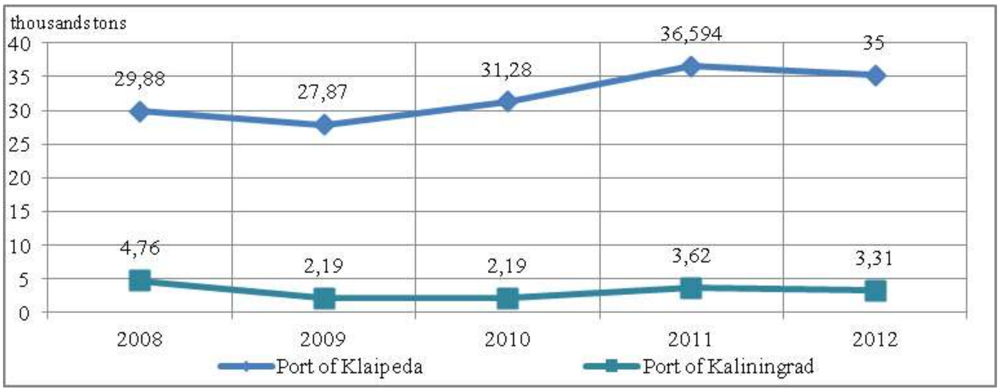


Figure 1. The graph of total cargo turnover at Klaipeda and Kaliningrad ports [6; 8].

Successful oil transportation was the main reason for the increase in cargo handling in Klaipeda port during the years 2007 and 2008. In the same period the oil transportation was also popular in Kaliningrad port. However, the transportation of such products as grains, steal and other decreased (Figure 1). In 2010, Klaipeda port transported mainly petroleum products and much less fertilizer, containers, RO-RO cargo. At the same time, in Kaliningrad situation was different. The containerisation was dominating as well as general cargo, especially the black metal transportation. A smaller part of cargo consisted of dry cargo and petroleum products.

In 2011 in Klaipeda port a new good result was achieved with regard to the transportation of oil and container handling. In Kaliningrad port oil cargo handling was not so significant while containerisation did not change considerably. In 2012 in Kaliningrad handling of dry goods remained at the same level as in 2010. In contrast, containerisation in Klaipeda port still took a leading position in comparison with other goods.

Graphical analysis of containerised cargo turnover in Klaipeda and Kaliningrad ports during the period from 2006 to 2012 revealed an upward trend in Klaipeda (Figure 2). Container cargo handling dynamics data were calculated using statistics on both ports (Table 2).

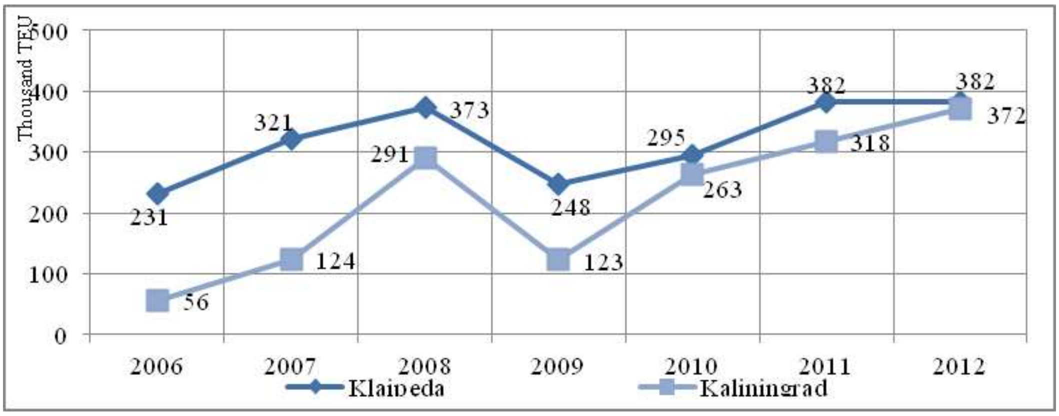


Figure 2. Klaipeda and Kaliningrad containers cargo amount [6; 8]

Table 2. Dynamics indicators[1] of containerised cargo volume in Klaipeda and Kaliningrad ports [6; 8]

Year	Empirical data, thousand TEU		Absolute changes, thousand TEU		Relative changes, %	
	Klaipeda	Kaliningrad	Klaipeda	Kaliningrad	Klaipeda	Kaliningrad
2006	231	56	base	base	base	base
2007	321	124	90	68	39%	121%
2008	373	291	52	167	16%	135%
2009	248	123	-125	-168	-34%	-58%
2010	295	263	47	140	19%	114%
2011	382,2	318	87,2	55	30%	21%
2012	382,3	372	0,1	54	0,03%	17%

In the years from 2006 to 2008 container loading steadily increased due to import of wide range consumer goods (Figure 2, Table 2). In 2007 container flow in Klaipeda port increased by 39 % compared with 2006. Kaliningrad port increased its cargo volume by 21 % in 2007. Before the crisis in 2008 cargo handling in Kaliningrad increased by 2.3 times while it decreased by 1.2 times in Klaipeda port. In comparison with 2007, container flows in 2008 in Klaipeda port grew by 16%, whereas in Kaliningrad port container handling grew by 135%.

Financial crisis in 2008-2009 made radical changes in many businesses. GDP decreased and it resulted in decreasing cargo handling amounts. So, in Kaliningrad port cargo handling droped by 58 % and total amount was 123 thousand TEU. In Klaipeda port decline was 34 % and cargo handling total amount was 248 thousand TEU. In winter of the year 2010 Kaliningrad port started recovering. In 2010 in Kaliningrad port container handling turnover was 114% higher than in 2009 and reached the pre-crisis level (Table 2). Klaipeda turnover increased by only 19% but the container traffic demonstrated an upward trend. Both ports bore resemblance: in Klaipeda total volume was 295 thousand TEU and in Kaliningrad – 263 thousand TEU.

In 2011 the Baltic ports increased the circulation of products due to goods from Russia as well as the container loading of wide range consumer goods. In 2011 in comparison with 2010, Klaipeda port turnover increased by 30%, whereas Kaliningrad port - by 19%. In 2012 Kaliningrad port container handling increased by 17% while in Klaipeda there was the same turnover as in 2011 (Table 2).

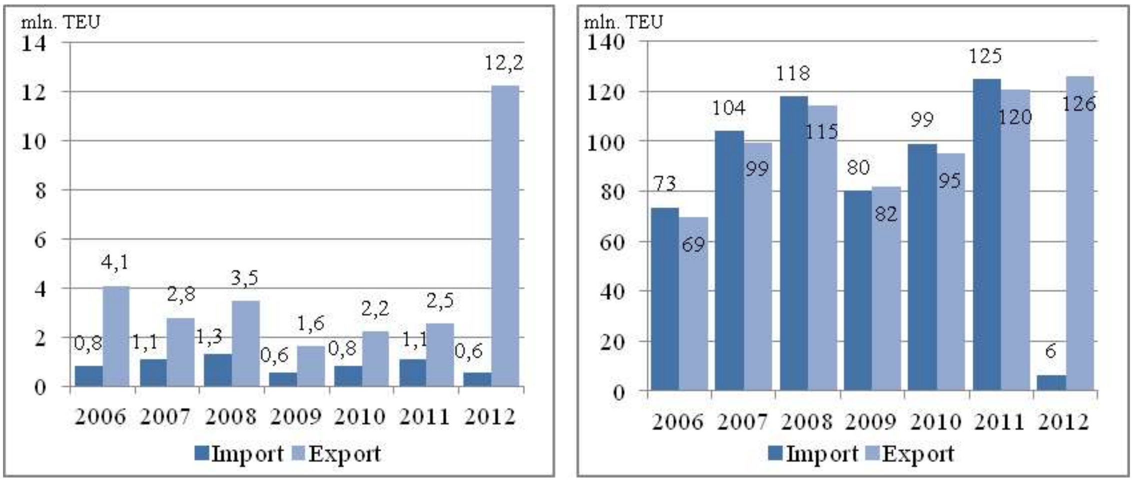
Analysis of container handling dynamics during the period from 2006 to 2012 showed that cargo flow in Kaliningrad port grew more than six times and reached 372 thousand TEU. In Klaipeda port the cargo flow was 382,3 thousand TEU. Consequently, Kaliningrad port becomes active as a distribution centre of goods and has the potential to take a leading position in the regional market.

Import and export analysis of Klaipeda and Kaliningrad ports

Import containers are distributed over the hinterland via the landside modalities or even back to deep-sea vessels. Exports containers are collected from hinterland locations and arrive with various transport modalities [11]. In 2011 and 2012, mainly due to Russia the Baltic ports increased circulation of export goods in containers and transported mostly consumer goods. If Russian cargo in Klaipeda port was 12% in 2011 and about 9% in 2012, it is forecast that in 2013 it would be about 10%. However, this situation is dangerous for Klaipeda port. It seems that port may lose leading position in container handling market because of active position of Ust Luga port and changes in Russian cargo flow management policy. At the same time the proportion of Belarusian goods is increasing in Klaipeda port. For example, last year they made up over 30% of cargo in Klaipeda.

An import and export is an important part of international trade designed to meet the users’ needs and influence containers' flows (Figure 3).

[1] Dynamics indicators show the intensity of changes from period to period. An absolute increase is the difference between the two levels of dynamic queue and describes the extent to which one level exceeds the basic level. An increase (or a decrease if it comes with minus) is a change in empirical data calculated as percentage [7].



a) b)

Figure 3. The graph of import and export in Kaliningrad (a) and in Klaipeda (b) ports [6; 8]

Table 3. Dynamics indicators of import and export in the port of Klaipeda [8]

Year	Empirical data, thousand TEU		Absolute changes, thousand TEU		Relative changes, %	
	Import	**Export**	**Import**	**Export**	**Import**	**Export**
2006	73360	69483	-	-	-	-
2007	103988	99401	30628	29918	42%	43%
2008	117752	114507	13764	15106	13%	15%
2009	80156	81712	-37596	-32795	-32%	-29%
2010	99095	95013	18939	13301	24%	16%
2011	124694	120402	25599	25389	26%	27%
2012	6460	125706	-118234	5304	-95%	4%

During the period 2006 to 2012, Klaipeda port imported in total 605109 thousand tonnes of cargo (Figure 1, 3; Table 3). From 2006 to 2008, container import annually increased by an average amount of 15314 TEU. In 2009, due to external influence on Klaipeda port, the volume of imported goods decreased and made up 80156 TEU, which was almost identical to handling of 73360 TEU in 2006. A significant increase occurred during the period 2009 to 2011 and was equal to 303945 TEU. In 2012 due to decline imports was 6460 thousand TEU. In 2006 the volume of exported items in Klaipeda port was 69483 thousand TEU. Before crisis cargo handling was 114507 thousand TEU. It was less by 15106 thousand TEU than in the year 2007. In 2009 turnover decreased to 81712 TEU. Nevertheless, since 2010 the load factor has been growing. Good results were achieved in 2011 – 120,402 TEU and in 2012 –125706 TEU.

Table 4. Dynamics indicators of import and export in port of Kaliningrad [6]

Year	Empirical data, thousand TEU		Absolute changes, thousand TEU		Relative changes, %	
	Import	**Export**	**Import**	**Export**	**Import**	**Export**
2006	820	4089	-	-	-	-
2007	1108	2789	288	-1300	35%	-32%
2008	1307	3457	199	667	18%	24%
2009	577	1609	-730	-1847	-56%	-53%
2010	842	2223	265	613	46%	38%
2011	1094	2530	252	307	30%	14%
2012	576	12224	-518	9694	-47%	383%

In 2006 in Kaliningrad port import was low and reached only 820 thousand TEU (Figure 2, Table 4). During the year, imports grew and reached 1108 thousand TEU. The highest rate of imported goods was observed in 2008 – 1307 thousand TEU. Similar to Klaipeda port, the port of Kaliningrad experienced a decline in 2009, but in 2012 import was only 576 thousand TEU. It was more then 2 times smaller than in 2011. During the period 2006 to 2012 in Kaliningrad port the total amount of exported goods was 28921 thousand tones. Particularly low it was in 2007 - 2789 thousand TEU. In 2009 it increased to 1609 thousand TEU whereas in 2010 it was 2223 thousand TEU. Like Klaipeda port, in 2012 Kalinigrad port also demonstrated the higher turnover - 12224 thousand TEU.

The correlation analysis of containerised cargo flows in Klaipeda and Kaliningrad ports was performed and correlation between total container cargo volume, imports and export was calculated (Table 5). Correlation has showed that container traffic in Klaipeda port is directly dependent on exports (correlation coefficient r = 1, Table 5). Container cargo flow in Kaliningrad port also depends on export (correlation coefficient r = 0,5), but import of goods is not statistically significant (correlation coefficient r = 0,1).

Table 5. Correlations between container cargo turnover, import and export in ports of Klaipeda and Kaliningrad

Parameters	**Turnover, TEU**		**Import, TEU**		**Export, TEU**	
	Klaipeda	Kaliningrad	Klaipeda	Kaliningrad	Klaipeda	Kaliningrad
Turnover, TEU	1	1	-	-	-	-
Import, TEU	0	***0,1***	1	1	-	-
Export, TEU	***1***	***0,5***	-0,1	-0,4	1	1

Klaipeda State Seaport Authority and stevedoring companies cooperate together in order to increase infrastructural and technological parameters for more competitive position in container handling market of Eastern Baltic seaports. Stevedoring company JSC “Klaipedos Smelte” is very successful and has got 65 million for new container distribution centre building. For this company and Klaipeda port 2013 will be a breakthrough year.

Since mid 2013, port has developed plans to achieve a new quality of goods in containers for Russia market. It was a reason for stevedoring company JSC “Klaipeda Container Terminal” to plan a growth of approximately 5% in container cargo handling in 2013. Similar growth was planned for 2012, but the actual turnover grew by more than 10%. Containerised cargo flow will increase with growing flows of Belarussian cargo transported by large ships directly from China.

According to Klaipeda port development plan, Post-Panamax ships meet its prospective needs. In 2012 Klaipeda port handled 36,37 mln. tons of cargo. As the potential of Klaipeda port is 80-90 mln. tons per year, a new level could be achieved within 20 years. Thus, it is very important to evaluate new opportunities for the large Post-Panamax vessels to enter Klaipeda port as they help the port to compete with other neighbouring ports in the Baltic Sea. The analysis of navigational opportunities, possible revenues, techinical parameters and options of Klaipeda port should be performed in the future. Stevedoring companies could be attracted by an opportunity to handle cargo from larger ships. Infrastructure could be advantage and a great argument in competition with neighbouring ports.

Conclusions

1. Containerisation is a global trend, expected to continue in the future, because finished consumer goods are usually transported in containers. That is one of the prerequisites of international trade. Containers remarkably changed the port activities. Various container handling operations lead to increasing area of terminal. Port infrastructure and technical specifications are main competitive factors in containerised cargo handling market.
2. In comparison with Kaliningrad port, advantages of Klaipeda port are geographical location, depth and length of berths, area of container terminals. In addition, Klaipeda port encourages building of container cargo terminals and increasing cargo turnover. Cooperation between Lithuanian state institutions and private business significantly increases port competitiveness in the market of Eastern Baltic sea region.
3. In 2006-2012 containerised cargo flow in Kaliningrad port grew more than six times from 56 to 372 thousand TEU and reached the port of Klaipeda level - 382 thousand TEU. Flow of containers demonstrated steady and slightly upward trend in Klaipeda port. Klaipeda port competes with Kaliningrad port in container handling market. Kaliningrad port becomes active as a distribution centre of goods and has the potential to take a leading position in the regional market.
4. Results of correlation analysis of import and export of container flows in Klaipeda and Kaliningrad ports prove that in both ports, especially in port of Klaipeda, the strongest correlation is between container turnover and export. These tendencies comply with close cooperation of port authorities and stevedoring companies in developing Klaipeda port infrastructure as well as depend on geopolitical regional strategy of country.

References

1. Alderton, P. Port Management and Operations. London: Informa, 2008.
2. Belova, J., Mickienė, R. Uosto veiklos valdymas: ekonominis aspektas (Port management: economical aspect). Klaipeda: Klaipėdos universiteto leidykla, 2012.
3. Belova, J., Mickiene, R. Economic Efficiency Assesment Problems of Maritime Sector under Globalization Conditions. In: Transport Means. Proceedings of the 12th International Conference (Kaunas, Lithuania, October 23-24, 2008, Kaunas University of technology), 2008, pp. 75-77.
4. Belova, J., Mickienė, R. The Efficiency Formation Problems of Maritime Sector Companies Under Crisis Conditions. Human resources – the main factor of regional development. No. 3. Klaipėda: Klaipėdos universiteto leidykla, 2010. pp. 320-324.
5. Kaliningrad Chamber of Commerce and Industry. Available (accessed on 16.03.2013): http://eng.kaliningrad-cci.ru/
6. Kaliningrad Sea Commercial Port website. Available (accessed on 13.03.2013): http://www.kscport.ru/?p=&lang=en
7. Kim, H., Gunther, H., O. (ed.) Container Terminals and Cargo Systems: Design, Operations Management, and Logistics Control Issues. Berlin, New York: Springer, 2007.
8. Klaipeda State Sea Port Authority website. Port Statistics. Available (accessed on 16.03.2013): http://www.portofklaipeda.lt/uosto-statistika
9. Lukauskas, V. Lithuanian ports: development strategy towards intermodalizm and logistics. Port Technology International, No. 34. London, ISG publishing, 2007. pp. 8-11.
10. Mak, K. L., Zhang, L. Simultaneous scheduling of import and export containers handling in container terminals. World Congress on Engineering. Vol. 1. 2009, pp. 604-609.
11. Paulauskas, V., et. al. Uosto technologija. Klaipėda: Klaipėdos universiteto leidykla, 2001.
12. Plačienė, B., et. al. Assesment and Optimization of Container Terminal Facilities. Transport means 2005. Kaunas: Technologija, 2005. pp. 108-111.
13. Stevens, H. The Institutional position of seaports. An international comaprison. The Netherlands: Kluwer Academic Publishers, 1999.
14. UNCTAD database. Container port throughput, annual report, 2008-2010. Available (accessed on 15.03.2013): http://unctadstat.unctad.org/TableViewer/tableView. aspx? ReportId=13321
15. Белова, Е., Мицкиене, Р. Эффективности деятельности морского сектора Литвы в условиях циклических колебаний экономики. In: proceedings of IX Международная научно-практическая конференция «Морская индустрия, транспорт и логистика в странах региона Балтийского моря: новые вызовы и ответы» (Калининград, Российская Федерация, 24-27 мая 2011, Балтийская государственная академия рыбопромыслового флота).

SEAFARERS' PSYCHIC SELF-REGULATION FROM THE EDUCATIONAL POINT OF VIEW

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Abstract
This paper presents the scientific data of the psychic self-regulation expression of future seafarers from the educational point of view. Educational orientation to abilities of the maritime students' self-regulation is an integral part of seafarers' leadership development in general. The international convention on standards of training, certification and watchkeeping for seafarers, existentialism and personalism create the methodological basis of the research. A quantitative paradigm of the research is applied. Methods of scientific literature analysis, written survey, statistical analysis, comparison, interpretation and systemization are used in the research. The self-regulation of maritime students in everyday activities and significant and extreme situations is discussed at educational level. Results of the research raise a need of the educationally professional assistance to future seafarers by separating the self-regulation and self-control, developing the valuable maritime self-concept, learning to feel a professional satisfaction in everyday activities, perceiving the sense of own activity that stimulates positive emotions, and learning to communicate. This is appropriate in educational reference to the work at sea in extreme conditions.
Keywords: *seafarers, future seafarers, psychic self-regulation, situation, education, attitudes, satisfaction.*

Introduction

Extreme conditions of the seafarers' work at sea and problems of their recreation raise a need to regularly take care of an educational development of psychic self-regulation abilities in difficult situations. This development is valid as a part of the qualitative self-development and self-expression of seafarer's personality from the more comprehensive point of view. Permanent improvement of the future seafarers' self-regulation is related to maritime studies at academy, and their professional praxis in extreme conditions at sea.

A problem of development of psychic self-regulation abilities seafarers' is regularly raised at the International maritime organization in reference to the policy of safety at sea. It is usually associated with modern educational technologies, especially with a digital ship technology.

The grade of the exploration

Problems of the self-regulation and expression of self-regulation abilities of future and contemporary seafarers are examined at the level of scientific research, in regard to the physic and psychic health, psycho-emotional stress, needs of self-education, self-management of the career, values, altruistic position, difficult situations, psycho-prophylactics and generally socio-humanitarian development of seafarers at maritime studies [2; 8; 11; 12; 13; 14; 16; 20; 21].

It is lack of scientifically educational researches of the psychic self-regulation expression of Lithuanian future seafarers. So, the need of seafarers' self-regulation development, that is required in the policy of seafarers' preparation, has insufficient basis of the psycho-educationally important data for the process of seafarers' psychological preparation at the higher maritime school. Only indirect scientific references to the problem of seafarers' psychic self-regulation are on hand.

Very high attention is paid to the technological, but not to hodegetical and psychosocial problem of the seafarers' preparation from the self-educational point of view of the development of self-regulation abilities regarding the international maritime policy. There is lack of scientific basis in reference to the empirical data, and of regular researches on purpose to directionally and adequately organize the seafarers' preparation at the level of the personality's spiritual expression. It is appropriate to give scientifically a sense to the problem of psychic self-regulation of future seafarers.

Goal and tasks of the research

The research goal is an identification of future seafarers' psychic self-regulation expression from the educational point of view.

Tasks are as follows:

1. Definition of the psychic self-regulation conception that is important to this research of the maritime students' self-regulation.
2. Revelation of an expression of the future seafarers' self-regulation in everyday situations.
3. Determination of a state of the maritime students' self-regulation in significant situations.
4. Development of an expression of the future seafarers' self-regulation in extreme situations.

The research object is a psychic self-regulation of maritime students. The object is researched at educational level of an expression of the future seafarers' self-regulation in mentioned everyday, significant and extreme situations.

The research methodology

The methodology of the research is based on the STCW convention, existentialism and personalism. Methodological attitudes are as follows:

- *International Convention on Standards of Training, Certification and Watchkeeping for Seafarers* [7] requires an improvement of the shipping safety. Not only technologic education of seafarers, but also their positive world-view, leadership, creativity, understanding of the constructive philosophy and psychology for a development of personality, wide intellectual horizon and development of internal culture influence on the safety at sea. All mentioned components could help to develop self-regulation abilities of seafarers.
- *Existentialism* refers to the human fear on land and especially at sea. Existential psychology is a cause for personality's hope. This psychology denies an attachment to life pleasures, and promotes the personality liberation and purification of his / her existence. A development of the maritime self-concept expands the horizon and helps people overcome the tragedy of existence, improve the emotional state and find unique comfort. So, existentialism helps to get a valuable basis for the self-regulation in extreme conditions. This valuable basis as a methodological attitude is grounded psycho-educationally.
- *Personalism* highlights the reality of the world as a manifestation of creative activity of the personality. This methodological attitude refers to the possibility of personality's development by changing and improving his / her individual system of values. Personalistic philosophy requires a priority of the cognitively psychic activity for an improvement of the seafarers' self-regulation activity.

Methodological type of the empirical research is statistically quantitative.

Methods and limits of the research

Methods such as scientific literature analysis, written survey of future seafarers and statistical analysis of the empirical data, comparison, interpretation and systemization are used in the research.

Expression of the maritime students' self-regulation is examined applying a quantitative paradigm from the point of view of seafarers' preparation improving, and the questionnaire of prof. R. Grossarth-Maticek, who created it and publically approved for use [6]. The questionnaire consists of 16 closed questions that are oriented to everyday, significant and extreme situations.

Results of researches usually depend much on a method. So, three diagnostic sections of the statistical analysis are used to make the research more objective:

- Determination of the percentage distribution of population characteristics;
- Comparison of the distribution of characteristics in different groups of respondents;
- Applying of the *Spearman's rho* correlative analysis.

Statistical data of the research is processed with the SPSS (*Statistical Package for Social Sciences*) software version 12.0. The sample size of respondents consists of 51 first-year maritime students and 46 third-year students at the Lithuanian maritime academy. The size of this sample is based on a number of the future seafarers, who participated in lessons during the research. Answers of returned questionnaires are sufficient for the empirical research. Obvious signs of no-thoroughness were not detected in answers.

Results of the research can be applied only to the selected population.

The psychic self-regulation conception

The psychic self-regulation is understood as a purposeful regulation of an individual's own activity from the psychological point of view. The basis of the self-regulation consists of providing objectives that become motivation for the activity, and activity itself, providing satisfaction after the implementation of the activity. So, it is particularly appropriate to orient education to the *cognitive* level of internalization of values, senses and purposes of life, combining this level with *emotional* experience, developing future seafarers' abilities of the psychic self-regulation in difficult situations at psycho-educational level.

It is important that the self-regulation with self-regulating mechanisms can enable a personality to respond to external and internal effects, and maintain or recreate the functional balance for a successful adaptation and achievement of objectives and personal integration [15].

The process of the self-regulation can be differentiated into three practical steps that should not necessarily be followed strictly consecutively from the cognitive point of view:

– The first step is a phase of *providence*. Objectives are analyzed, strategies are selected for them and possibilities of the achieving of objectives are evaluated during the providence. The factor of "I effectiveness" determines the motivation to achieve selected objectives, it mean, a person must not only desire to achieve objectives, but also to feel, that he / she is able to achieve them.
– The second step is a phase of *performance*. A personality selects objectives and aims, if he / she has a sufficient motivation and knows behavior-forms that personality needs for the achievement of objectives. An appropriate monitoring and a timely correction of the personality's behavior are important for the successful achievement of objectives. Although, the correction should not let deviate from selected objectives. Systems of introspection and self-control can help to perform these functions.
– The third step is a phase of *reflection*. It means that a personality evaluates the achieved result, his / her efforts and environmental influence, and feels accordingly self-satisfaction or self-dissatisfaction after the activity [5; 19]. Scientific researches in reference to the cognitive level of the internalization of values, revealed unique possibilities of the human cognitive activity. These possibilities let him / her consciously achieve long-term objectives.

Educology highlights the cognitive level of the values internalization foremost [1]. It is very important, that personality knows himself / herself and his / her own psyche. It all starts with thoughts. Thinking manages human actions and reactions, and the personal approach to the environment, and attitude toward oneself, how is the human and how is formed his / her personality, depending on the thinking [9].

It is appropriate to separate a self-regulation and self-control from the educational and psychotherapeutic point of view:

– *Self-control* is a more static process, which is characterized by functions of the self-discipline and so called a "numbness effect" that genesis is associated with a naturally defensive reaction to the set of stimuli.
– *Self-regulation* is a dynamic, creative and flexible process, which is characterized by long-term adaptation. This process can help personality activate and integrate himself / herself [4].

It is natural that modern vocational preparation of seafarers is oriented to changing conditions of work and life in general and cannot be limited with studies of self-control mechanisms only. It is appropriate that future seafarers develop a creativity, flexibility and integrity of their behavior. These abilities characterize the psychic self-regulation. Integral studies can help maritime students improve themselves and prevent psychologically negative results because a regular and semi-consciousness self-control as a self-destruction.

The function of the self-control can be effective only at short-term stage of the behavior. However the self-regulation, being dynamic, flexible and integral, characterized by constructive expression, can help personality effectively and consciously achieve the long-term objectives, successfully solve problems in a long-term perspective, in non-standard situations at maritime work and in life in general.

Tendencies of the self-regulation expression of future seafarers are revealed in a context of the scientific concept of the psychic self-regulation for the purpose of improving of the vocationally axiological and psychological preparation of seafarers.

Self-regulation of future seafarers in everyday situations

It is examined how often respondents are able with their appropriate behavior to successfully get into situations, where they can fully satisfy their desires and needs at the level of everyday situations (Figure 1).

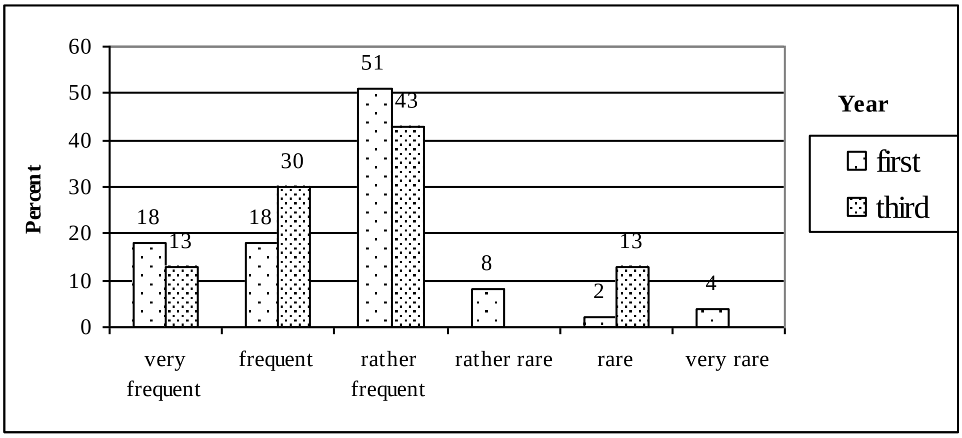

Figure 1. The behavior of accessing into successful situations

It is found that a position of maritime students is positive from the point of view of their psychic self-regulation. The behavior of a half of first-year future seafarers and of a smaller number of third-year respondents is rather frequent and helps them satisfy their desires and needs, and feel well in everyday situations. One-third of third-year maritime students and one-fifth of first-year students state that their behavior is a frequent cause of accessing everyday into successful situations.

It is important to note that the same number of first-year students and a smaller number of third-year respondents show their successful behavior as very frequent in everyday situations. This data of psychic self-regulation abilities is *a priori* appropriate for the work in extreme conditions. Results of the successful behavior of maritime students are generally positive in everyday situations.

It is important to determine how often future seafarers are able to experience the physical and psychical satisfaction by engaging in everyday activities (Figure 2).

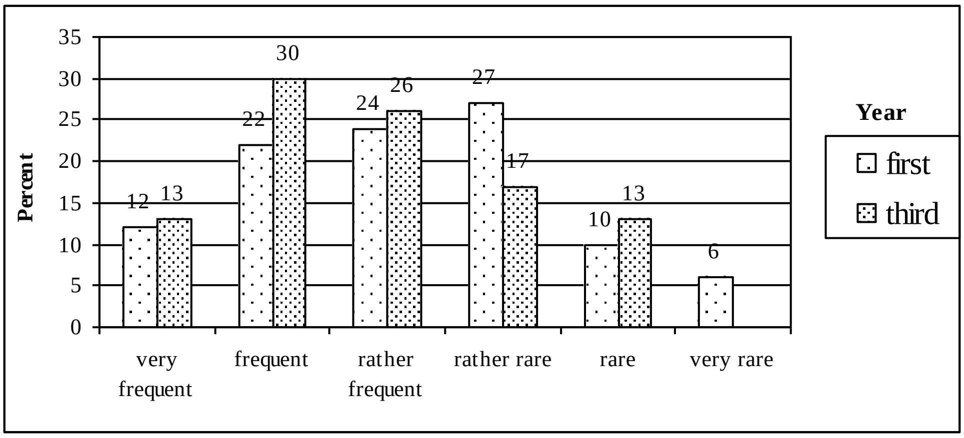

Figure 2. Physical and psychical satisfaction in everyday activities

It is found, that a state of maritime students' self-regulation is not so positive, compared with results of their successful behavior in everyday situations. The physical and psychical satisfaction mostly of one-third of third-year students and only of one-fifth of first-year students by engaging in everyday activities is frequent. Almost the same number of respondents in both groups shows an everyday satisfaction as rare and very frequent. A tenth of future seafarers in both groups indicates a mentioned physical and psychical satisfaction.

It is appropriate to note, that 6 % of first-year respondents showed their position that their experience of everyday satisfaction is very rare. It is considered as an important signal for the seafarers' preparation at psycho-educational level. However, results of the research show a mostly positive position of maritime students' physical and psychical satisfaction in general.

The future seafarers' communication with people important to them is examined from the point of view of everyday social situations. It is scrutinized how maritime students are able to apply an adequate behavior and not only to befriend with important people, but also to maintain a required distance to them. In other words, how future seafarers are able to flexibly and creatively communicate and maintain their own and other persons' dignity (Figure 3).

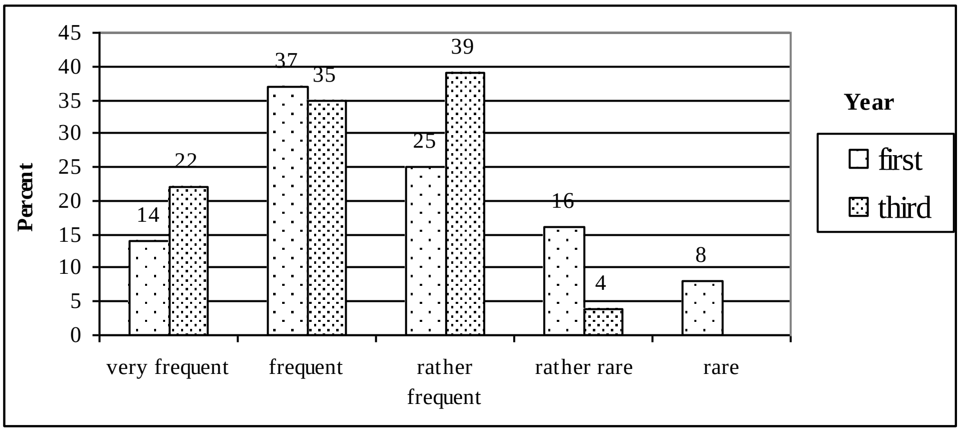

Figure 3. Flexible, creative and dignified communication

It is found that a flexible, creative and dignified communication, that characterizes abilities of more than one-third of third-year students and almost one-third of first-year students, is frequent or rather frequent. This data shows that respondents communicate with persons who are important to them well enough.

However, we must note that one-sixth of first-year future seafarers state that they are able to successfully communicate rather rare. Almost one-tenth of first-year students is able to successfully communicate rare when only 4 % of third-year respondents have a position of the rather rare well-communication with important persons. Nobody stated that they communicate successfully rare. The majority of both courses future seafarers is able to flexibly, creatively and dignifiedly communicate. We can positively value this result in general. Though, third-year maritime students communicate a little better.

It is additionally investigated, how students' position of physical and psychical satisfaction correlates with success of their flexible, creative and dignified communication, because the goal to get a more reliable data of future seafarers' abilities of their psychic self-regulation. The research is revealed a weak, positive and statistically significant correlation between the mentioned emotional satisfaction of students, by their engaging in everyday activities, and a flexible communication with important persons ($r = 0{,}203$; $p < 0{,}05$).

The regularity was highlighted. On the one hand, positive emotions of the physical and psychical satisfaction can help to communicate better. On the other hand, the more successful communication gives the better feeling to participants of the communication.

Future seafarers' self-regulation in significant situations

It is examined how future seafarers feel by implementing their most significant desires, satisfying most important needs and achieving long-term objectives at the level of significant situations (Figure 4).

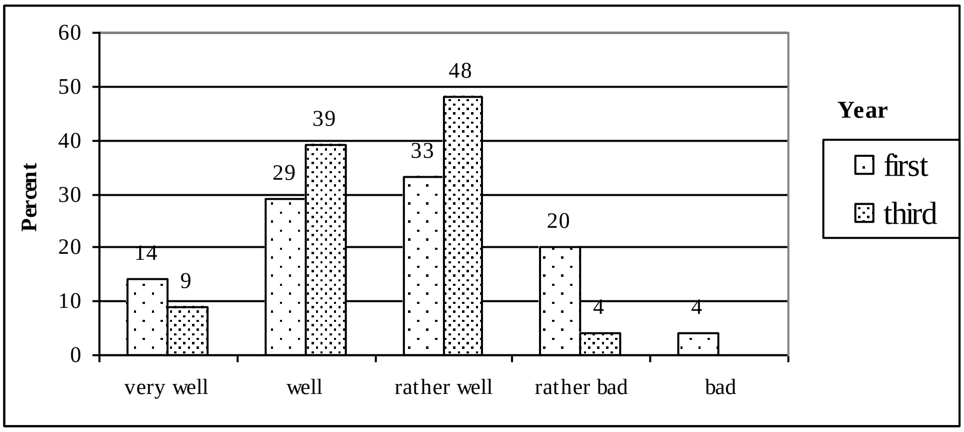

Figure 4. Feeling by implementing most significant things in life

It is revealed that the majority of maritime students in both groups feels well by implementing their most significant desires, satisfying most important needs and achieving long-term objectives. However, the data of third-year students is better for an assurance of the psychic self-regulation. The majority of respondents (33 % of first-year and 48 % of third-year) states that they feel rather well in mentioned situation.

The position of first-year students highlights an important signal from the educational point of view. One-fifth of mentioned students states that they feel rather bad and 4 % of the same group students' note that they feel bad. However, a tendency of the well-being, especially of third-year future seafarers is stated in general.

Efforts as abilities of maritime students to connect the different areas of their life (for example, job, recreation, personal life, hobby, adequate nutrition, communication) for an assurance of the long-term welfare at the level of universal efforts are examined (Figure 5).

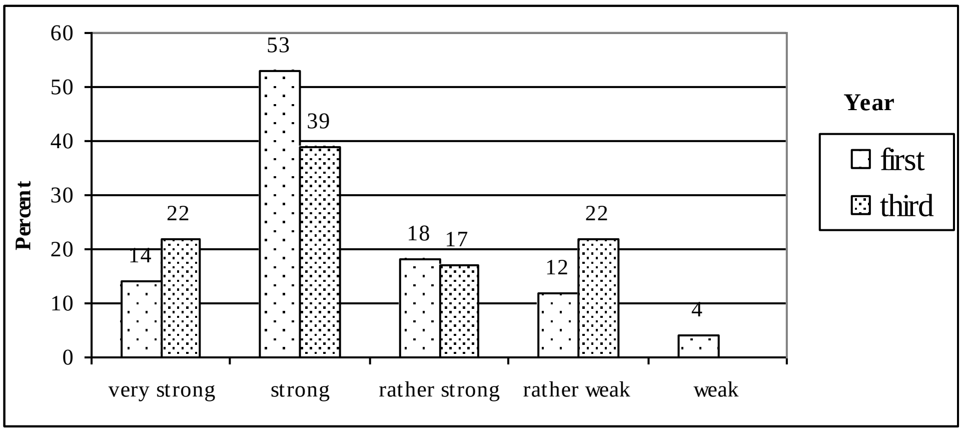

Figure 5. Efforts to connect different areas of life for the long-term welfare

It is found that abilities of universal efforts more characterize first-year students. A half of mentioned students states that they implement strong efforts for the connection of different areas of life for the long-term welfare. More than one-third of third-year students have the same position.

A clear positive trend is not found. A large part of future seafarers indicates that their efforts are strong and very strong. However, one-fifth of third-year students claim that their efforts are rather weak. That shows a similar position of respondents in both groups. Perhaps a position of first-year students more highlights a positive direction of strong efforts. A problematical situation is revealed. Future seafarers use own abilities of the self-control more. Abilities of the self-regulation are used less when their long-term welfare is very important. Other researchers of a relationship between the self-control and self-regulation of youth state this problem, too [4].

Abilities of maritime students to achieve most important objectives in life at the level of behavior are examined (Figure 6).

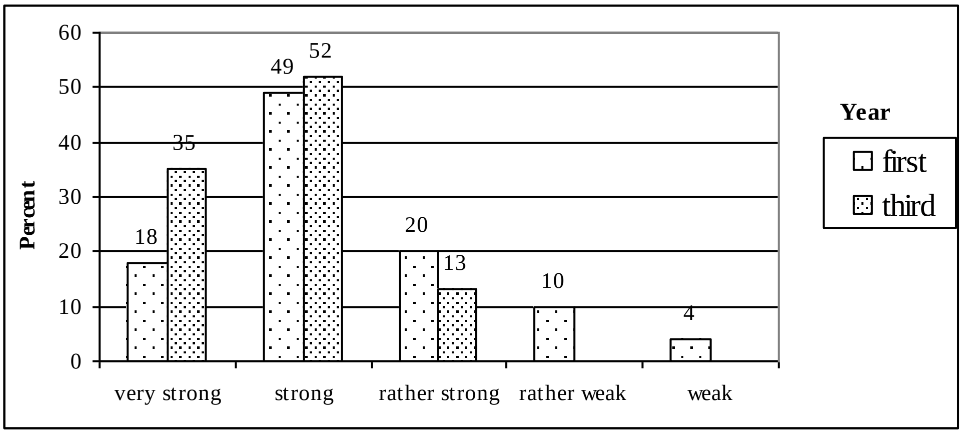

Figure 6. Behavior achieving most important objectives in life

The research revealed that a behavior of a half of third-year and first-year students in achieving their most important objectives in life is strong. The behavior of almost one-fifth of first-year students and one-third of third-year students achieving mentioned objectives is very strong. A tendency that the majority of future seafarers intensively and practically seek their own most important objectives in life is stated. However, this aspiration is highlighted more at the behavior-position of third-year respondents.

Future seafarers' self-regulation in extreme situations

Abilities of maritime students to change their attitudes and found an unexpected solution of a problem at the level of extreme situations are examined (Figure 7).

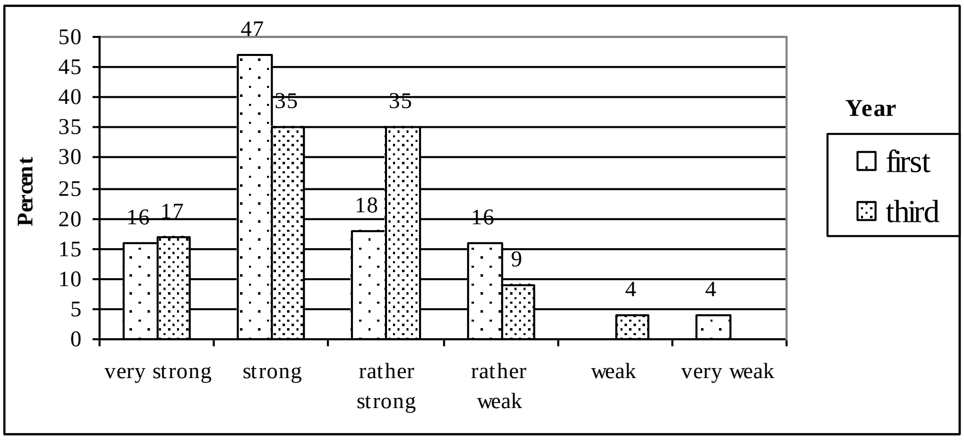

Figure 7. Abilities to change attitudes and creatively search for a solution

It is found that answers of third-year respondents are more weighed because their data is almost proportionally distributed in a context of positive positions (*rather strong, strong, very strong*). A half of first-year students revealed that their abilities to change attitudes and search for a solution of problems creatively are strong.

Data of first-year future seafarers is better. However, 4 % of them recognize that their abilities are very weak. This position equalizes a general situation of the first-year students' data. However, results of respondents' abilities to change their attitudes in extreme situations in both groups are positive in general.

The cognitive level is very important for the internalization of values from the humanistic point of view. So, the research of students' abilities to change attitudes is purposefully specified. The specified research is enriched with the data of potential correlations. A correlative analysis showed a positive and statistically significant relation of abilities to change attitudes with the following parameters:

– A weak relation ($r = 0,249$; $p < 0,05$) with efforts to connect different areas of life for the long-term welfare at universal level;

– An average strength relation (r = 0,403; p < 0,01) with abilities to change own behavior, when usual behavior does not assist to achieve a satisfactory result;
– An average strength relation (r = 0,381; p < 0,01) with abilities to test new ways of the behavior for an achievement of purposes;
– An average strength relation (r = 0,407; p < 0,01) with abilities to flexibly and creatively communicate and maintain one's own and other persons' dignity.

Correlations revealed that future seafarers' abilities to change attitudes in both groups are closely connected with their abilities to apply various measures, change the behavior, test new ways of the behavior, flexibly interact seeking a purpose.

Maritime students' abilities to change the behavior in an extreme situation are examined, and situation how various threats and failures promote desperation or rather stimulate to change own behavior is searched (Figure 8).

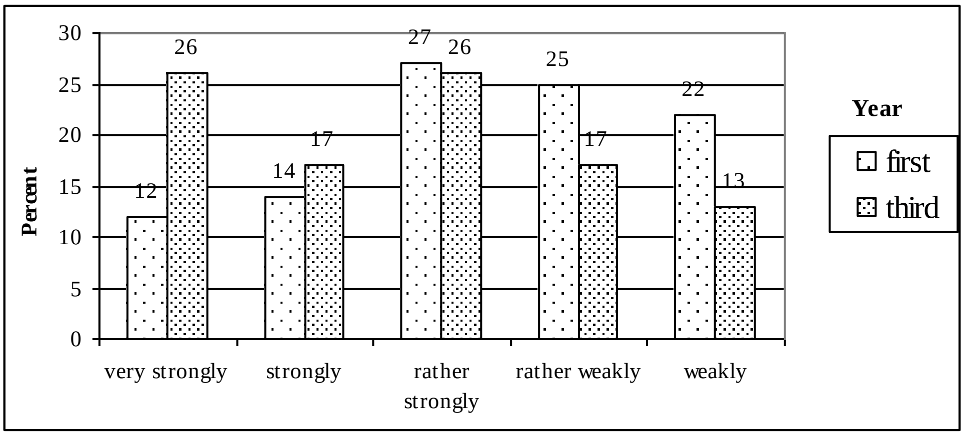

Figure 8. Threats and failures promote to change the behavior

The tendency that students of third-year are more able to change their own behavior compared with results of first-year respondents is stated. Results of first-year future seafarers are worse across the graph. Positive answers of third-year students are dominated at variants-categories *very strongly* and *strongly*. Answers of first-year students express more desperation at categories *rather weakly* and *weakly*. Results showed an advantage of the third-year future seafarers' position. So, it is possible to note that they are able better to change their own behavior, experiencing threats and failures, compared with first-year respondents.

Psychoanalytical researches revealed that higher-year students, being more motivated, are more successfully able to apply the psychic self-regulation. However, lower-year students feel weaker and are less happy with their future profession because they choose a career by experiencing some psychological compensation [18]. So, a serious and directional support for their self-searching in general and professional self-creation is important at maritime studies.

It is studied how maritime students are able to engage in adequate activities that return a sense of the satisfaction when somebody or a group of people wish to damage them. Their abilities to change their own behavior in cases of social threats are stated (Figure 9).

It is found that third-year respondents by experiencing a social threat are better able to engage in adequate activities. Categories *strong* and *rather strong* are dominated in their answers. Number of third-year students (35 %) who demonstrated a strong position is only two percentage points lower than first-year students (37 %). Only first-year future seafarers showed *weak* (6 %) and *very weak* (8 %) abilities to engage in adequate activities by experiencing a social threat. So, it is possible to state that maritime students of both groups by experiencing a social threat are able to engage in adequate activities. However, data of third-year respondents is a little better.

Social problems at work of seafarers are frequent because a monotony, loneliness, social isolation, long-term being in the close-group and other negative conditions. So, possible correlations of future seafarers' abilities to engage in adequate activities by experiencing a social threat with other components are examined. A positive and statistically significant average strength correlation (r = 0,320; p < 0,01) is stated only with one parameter. It reveals the abilities to experience a satisfaction by engaging in everyday activities.

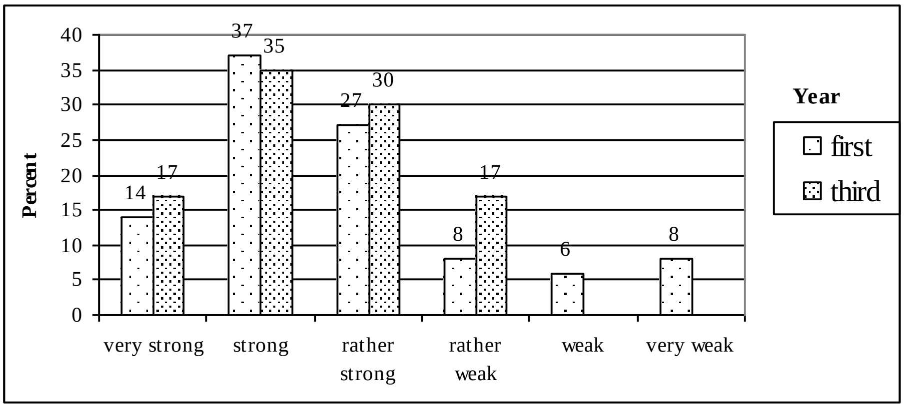

Figure 9. Abilities to engage in adequate activities at social-threat conditions

This correlation is as a valuable reference to a possible tendency. When future seafarers more often experience an internal satisfaction everyday, then it is a greater chance that mentioned satisfaction becomes to their positive preparedness for socially complicate relationships between seafarers at work. Other researchers stated the significance of the positive preparedness for a psychic self-regulation in future [6]. Researches [3; 10; 17] showed that more intensive development of students' abilities of their self-regulation by applying psychologically and educationally traditional and modern technologies could help youth achieve better results of the self-regulation, especially at cognitive level of internalization of the values and through a relatively short period of time. These scientific experiences of the improvement of psychic self-regulation abilities) could be applied for the preparation of seafarers.

Conclusions

1. Definition of the psychic self-regulation conception orients to a purposefully psychological regulation of an individual's own activity from the point of view of providence, performance and reflection. It is meaningful to different a self-control as a more static process, which is characterized by function of the self-discipline and so called a "numbness effect", genesis of which is associated with a naturally defensive reaction to the set of stimuli, and self-regulation as a dynamic, creative and flexible process, which is characterized by long-term adaptation at the level of the personality's integration.

2. Sufficiently positive indicators characterize a psychic self-regulation expression of future seafarers in everyday situations. Results of their successful behavior in everyday activities are acceptable. The position of the majority of the maritime students' physical and psychical satisfaction is positive. Respondents communicate with the people important for them well enough. However, third-year future seafarers communicate a little better. Positive emotions of physic and psychic satisfaction can help maritime students communicate more successfully.

3. A positive feeling characterizes a state of the future seafarers' self-regulation in significant situations, especially of third-year students when they must implement their meaningful desires. Abilities of universal efforts more characterize first-year maritime students. They more use their own abilities of the self-control. Abilities of the self-regulation are used less when their long-term welfare is very important. Third-year students with their own behavior seek more intensively and purposefully their most important objectives in life.

4. Positive results of future seafarers' abilities to change attitudes characterize a psychic self-regulation expression of them in extreme situations. These abilities are associated with abilities to connect different areas of their life, change behavior and test new ways of behavior, and flexibly communicate by seeking purposes. Third-year students by experiencing a failure and social threat can better change their own behavior and engage in adequate activities.

Results of expression of the future seafarers' psychic self-regulation approve the need of an educational support to them. This support must be maintained as early as possible. The components of the educational support to future seafarers are as follows:

- Learning to separate the self-regulation that is characterized by long-term significance and self-control;
- Effective development of the valuable maritime self-concept;
- Purposeful learning to experience an everyday satisfaction, related to a maritime profession;
- Perception of a significance of everyday activities that stimulates positive emotions;
- Development of abilities of a positive communication by preparation of seafarers.

References

1. Aramavičiūtė, V. Auklėjimas ir dvasinė asmenybės branda. Vilnius: Gimtasis žodis, 2005.
2. Bloor, M., Thomas, M., Lane, A.D. Health risks in the global shipping industry. Health Risk & Society, 2, 2000, p.p. 329-340.
3. Faux, R.B. Zur Nutzung von Inhaltsanalysen und Interviews in der pädagogisch-psychologischen Forschung – ein empirisches Beispiel. Qualitative social research. Berlin: Freie Universität Berlin, 2000.
4. Forstmeier, S., Rüddel, H. Zur Überlegenheit von Selbstregulation über Selbstkontrolle in Psychotherapie und psychosomatischer Rehabilitation. Verhaltenstherapie, 15, 2005, S. 158-166.
5. Grakauskas, Ž. Stresas ir elgesio savireguliacija: teorinės sąveikos problemos. Psichologija, 29, 2004, p.p. 74-87.
6. Grossarth-Maticek, R. Systemische Epidemiologie und präventive Verhaltensmedizin chronischer Erkrankungen. Berlin: Walter de Gruyter, 1999.
7. STCW Manila seafarer training amendments enter into force on 1 January 2012. International Maritime Organization. 2011. Available (accessed on 16.12.2012): http://www.imo.org
8. Kalvaitienė, G. Jūreivystės studentų profesinės karjeros savivaldos gebėjimų ugdymo prielaidos. Profesinis rengimas: tyrimai ir realijos, 19, 2010, p.p. 60-71.
9. Kirliauskienė, R. Muzikos mokytojo savireguliacija. Vilnius: Vilniaus pedagoginio universiteto leidykla, 2005.
10. Kosinar, J. Körperbasierte Selbstregulation – Basis für die Ausbildung von Kernkompetenzen im Lehrberuf. Zeitschrift zu Theorie und Praxis erziehungs-wissenschaftlicher Forschung, 22 (3), 2008, S. 409-429.
11. Lileikis, S. Valdymo psichologija: nuo altruizmo iki savireguliacijos. Klaipėda: Klaipėdos universiteto leidykla, 2008.
12. Lileikis, S. Jūreivystės studentų vertybinis santykis su jūra: fenomenologiniai kontūrai. Acta paedagogica Vilnensia, 24, 2010, p.p. 39-49.
13. Lileikis, S. Kultūrinės ir psichosocialinės jūrinės edukacijos metodologiniai metmenys. Klaipėda: Klaipėdos universiteto leidykla, 2011.
14. Mather, C. Sweatships: What it is really like to work on cruise ships. London: International Transport Workers Federation, 2003.
15. Melchart, D., Wagner, H. Naturheilverfahren. Grundlagen einer autoregulativen Therapie. Stuttgart: Schattauer, 1993.
16. Rapolienė, L., Sąlyga, J. Psichoemocinis stresas jūrininko darbe ir jo mažinimo galimybės. Sveikatos mokslai, 22 (3), 2012, p.p. 83-87.
17. Schmitz, B. Self-Monitoring zur Unterstützung des Transfers einer Schulung in Selbstregulation für Studierende. Zeitschrift für Pädagogische Psychologie, 15 (3/4), 2001, S. 181-197.
18. Trettin, J. Satzung der Gesellschaft zur Förderung der Selbstregulation. Köln: Gesellschaft zur Förderung der Selbstregulation, 2003.
19. Zimmerman, B.J. Attaining self-regulation: a social cognitive perspective. Handbook of Self-Regulation. San Diego: Academic Press, 2000, p.p. 13-39.
20. Žukauskienė, L., Viršilas, V. Lietuvos jūrininkų saviugdos poreikiai XXI a. pradžioje: vertybinis aspektas. Pedagogika, 80, 2005, p.p. 57-62.
21. Морская индустрия, транспорт и логистика в странах региона Балтийского моря: новые вызовы и ответы. Калининград: Балтийская Государственная Академия Рыбопромыслового Флота, 2011.

REGARDING STATE OF BUBBLE ENVIRONMENT AND SPEED OF SOUND WAVES IN SEA WATER

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Abstract
Dependence of speed of small perturbations propagation on gas volume content is researched. Influence of surface tension on sound speed is considered. Two-temperature model with two pressures describing dynamics of insoluble gas bubble for check of reliability and conditions of applicability of equation of bubble liquid state is applied.
Keywords: *bubbles, gas - liquid mixture, gas, liquid, volume gas content, surface tension, state equation.*

Introduction

Reasons of attenuation of sound waves in sea are not confined just by viscosity, heat conduction, relaxation (molecular) processes that is absorption. In such heterogeneous environment as sea water a significant reason of attenuation is wave scattering by heterogeneities deconcentrated in the water column. A special role here belongs to such scatterers as gas bubbles.

Dispersion of sound wave by heterogeneities of environment depends on form and sizes of heterogeneities, compressibility and density of their substance (accordingly, on wave resistance). If compressibility and density are the same as in environment, heterogeneities will not cause dispersion irrespective of their sizes and form. Otherwise, dispersion will be observed this way or another. Gas bubble is not heterogeneity which differs from water by density and compressibility. Therefore, it will create dispersion due to forward variations relative to water and due to pulsations in water. Bubble vibrations under the influence of the forces of falling of sound wave are forced vibrations which amplitude depends significantly on correlation of falling wave frequency and proper frequency of bubble radical vibrations.

For the reason that bubbles with diameters in hundredth fractions of centimeter are capable to exist in sea water over long period of time, waves with frequencies in tens of kilohertz could experience abnormal scattering (and consequently attenuation) in sea that confirmed by practical observations too. For example, navigation echo sounders with operating frequency of about 50kHz on vessel reverse when water under hull is strongly saturated with gas bubbles refused to measure even small depths and echo sounders with operating frequency of more than 200kHz do not experience such effect. Evidently, anomalously great attenuation of sounding signals happened at frequencies about 50kHz caused by resonance scattering on bubbles.

Sound attenuation on gas bubbles is aggravated also by the fact that they not only scatter but also absorb a part of sound wave energy. And this absorption happens more strongly just at resonance frequency. While consideration of the law of sound waves attenuation in sea there was stated that irrespective of causes resulting in attenuation, amplitude or intensity of wave decreases under exponential law.

With increase of water temperature, sound speed grows both at the expense of specific volume increase and decrease of compressibility coefficient. Therefore, influence of temperature to sound speed is the greatest in comparison with other factors. Subject to change of water salinity a specific volume and compressibility coefficient change as well. But corrections to sound speed due to these changes have various marks. Therefore, influence of salinity change to sound speed is less than temperature influence.

Description of research

Under definition, a square of sound speed is determined under formula:

$$C^2 = \frac{dp}{d\rho} \tag{1}$$

Let us accept equation of bubble liquid state as [1]

$$\frac{p}{p_0} = \frac{\alpha_{20}}{\rho_0/\rho - \alpha_{10}} \tag{2}$$

Then,

$$C = \frac{p}{\rho} \cdot \sqrt{\frac{\rho_0}{\alpha_{20} p_0}} \approx \frac{p}{\rho} \cdot \sqrt{\frac{\alpha_{10}\rho_{10}^0}{\alpha_{20} p_0}}, C_0 = \sqrt{\frac{p_0}{\alpha_{20}\rho_0}} \tag{3}$$

Here and further lower indexes 1 and 2 concern relatively to parameters of liquid and gas, index 0 – to initial values of parameters; p and ρ - pressure and density of bubble mixture relatively, α - volume content of phases.

There was noted above that sound speed is a significant characteristic of compressible flow. Sound speed coincides with spreading speed of small disturbances in compressed motionless environment. Indeed, subject to small deviations of pressure δ_p and density δ_ρ from their equilibrium values p_0 and ρ_0

$$p \approx p_0 + \delta_p, \; \rho \approx \rho_0 + \delta_\rho \tag{4}$$

from equation (2) we will get that

$$1 + \frac{\delta_p}{p_0} \approx \alpha_{20} \frac{1 + \delta_\rho / \rho_0}{\alpha_{20} - \alpha_{10}\delta_\rho} \approx 1 + \frac{\delta_\rho}{\alpha_{20}\rho_0} \text{ или } \frac{\delta_p}{\delta_\rho} \approx \frac{p_0}{\alpha_{20}\rho_0} = C_0^2$$

Finite disturbances (shock waves) spread with speeds more than sound speed.

Equation of bubble liquid state subject to carrying liquid is recorded as [5; 7]:

$$\frac{\rho}{\rho_0} = \frac{\frac{p}{p_0} + C}{1 + C\left(\alpha_{10} + \alpha_{20}\frac{p_0}{p}\right)}, \; C = \frac{c_1^{\,2}\rho_{10}^{\circ}}{p_0} - 1 \tag{5}$$

Subject to linearization (4) in Equation (5) we will get expression for sound speed in bubble liquid with a glance to carrying phase compressibility:

$$\frac{\delta_p}{\delta_\rho} \approx \frac{p_0}{\rho_0} \cdot \frac{C_1^2\rho_{10}^0 / p_0}{\alpha_{10} + \alpha_{20}C_1^2\rho_{10}^0 / p_0} \text{ или } C_0 = \sqrt{\frac{p_0}{\rho_0} \cdot \frac{C_1^2\rho_{10}^0 / p_0}{\alpha_{10} + \alpha_{20}C_1^2\rho_{10}^0 / p_0}} \tag{6}$$

It is evident that subject to $C_1 \to \infty$ Formula (6) turns into (3). One more equation of bubble liquid state subject to surface tension (Laplas pressure $2\sigma / R$) without consideration of carrying phase compressibility has the appearance [2; 5; 7]:

$$\frac{p}{p_0} = \frac{\alpha_{20}(1+S)\rho / \rho_0}{1 - \alpha_{10}\rho / \rho_0} - S \cdot \sqrt[3]{\frac{\alpha_{20}\rho / \rho_0}{1 - \alpha_{10}\rho / \rho_0}} \tag{7}$$

Linearization of Equation (7) under Formula (4) would result in expression for sound speed in bubble liquid subject to surface tension:

$$\frac{\delta_p}{\delta_\rho} \approx \frac{p_0}{\alpha_{20}\rho_0}\cdot\frac{3+2S}{3} \text{ или } C_0 = \sqrt{\frac{p_0}{\alpha_{20}\rho_0}\cdot\frac{3+2S}{3}} \qquad (8)$$

It is evident that subject to $S \to 0$ Formula (8) turns in (3).

Dependence of sound speed on gas volume content obtained under Formula (8) is stated in Figure 1. Similar dependence with no account taken of surface tension (Formula (3) is stated by a dotted line.

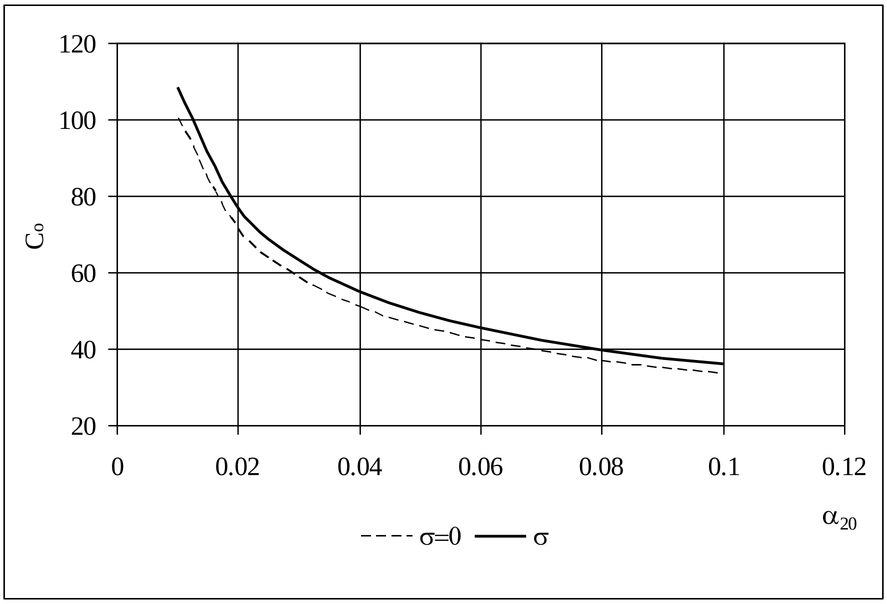

Figure 1. Dependence of sound speed on gas volume content.

As it is obvious from Figure 1, surface tension results in pressure increase and decrease of mixture density and accordingly, under (3) in increase of sound speed.

Let us follow dependence of average pressure of gas-liquid mixture $p/p_0 \approx (1-\alpha_2)(p_2/p_0 - 2\sigma/p_0R)$ on density $\rho/\rho_0 \approx (1-\alpha_2)/(1-\alpha_{20})$. In dimensionless form $P \approx (1-\alpha_2)(P_2 - S/Y_1)$ ($P = p/p_0$, $P_2 = p_2/p_0$, $Y_1 = R/R_0$) on $\Re = \rho/\rho_0 \approx (1-\alpha_2)/(1-\alpha_{20}).Y_1 = R/R_0$, $S = \dfrac{2\sigma}{R_0 p_0}$.

Let us apply cell model [1] for assignment of volume gas content (Figure 2).

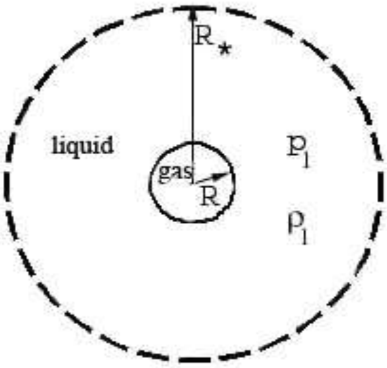

Figure 2. Cell of liquid with bubble.

Volume gas content α_2 is equal to ratio of total volume of gas to volume of whole liquid, therefore we will get:

$$\alpha_2 = \frac{V_{газа}}{V_{смеси}} = \left(\frac{R}{R_*}\right)^3 = \alpha_{20}\left(\frac{R}{R_0}\right)^3 = \alpha_{20} Y_1^3, \quad \alpha_{20} = \left(\frac{R_0}{R_*}\right)^3, \qquad (9)$$

where radius of equivalent cell around bubble [5; 7] is marked through R_*. Expression for average value of liquid pressure in cell volume was obtained in [5; 7]:

$$p_1 = p_2 - \frac{2\sigma}{R} - 4\mu_1 \frac{\dot{R}}{R} - \rho_1^0 \times$$
$$\times \left[(1-\varphi_1) R \ddot{R} + \frac{3}{2}(1-\varphi_2) \dot{R}^2 \right], \qquad (10)$$
$$\varphi_1 = \frac{3}{2} \frac{\alpha_2^{1/3} - \alpha_2}{1-\alpha_2}, \; \varphi_2 = \frac{\alpha_2^{1/3}(\alpha_2 + 2) - 3\alpha_2}{1-\alpha_2}$$

For definition of unknown Y_1, P_2 let us copy out system of equations in dimensionless type within two-temperature model with two pressures describing dynamics of insoluble gas bubble in liquid [3-6,8]:

$$\frac{d\theta}{d\tau} = \frac{3\theta}{Y_1 P_2}\left[\gamma(1+S)G - (\gamma-1)P_2 \dot{Y}_1\right] \qquad (11)$$

$$\frac{dP_2}{d\tau} = \frac{3\gamma}{Y_1}\left[(1+S)G - P_2 \dot{Y}_1\right] \qquad (12)$$

$$\frac{dY_1}{d\tau} = Y_2$$
$$\frac{dY_2}{d\tau} = -\frac{3}{2} \cdot \frac{Y_2^2}{Y_1} + \frac{P_2 - P_c - S/Y_1}{Y_1} \cdot Pe_2^2 - L \cdot \frac{Y_2}{Y_1^2} \qquad (13)$$

$$G = sign(1-\theta) \cdot \sqrt{\frac{3(\gamma-1)\theta}{Y_1}\left|\dot{Y}_1(1-\theta)\right|}, \; Y_1 = R/R_0, \; P_2 = p_2/p_0, \; P_c = p_c/p_0,$$

$$\theta = T_2/T_0, \; Y_2 = \dot{R}/u_0, \; \tau = t/t_0, \; u_0 = R_0/t_0,$$

$$t_0 = R_0^2/a_2, \; Pe_2 = \frac{R_0}{a_2}\sqrt{\frac{p_0}{\rho_1^0}}, \; S = 2\sigma/R_0 p_0, \; L = 4\nu_1/a_2,$$

$a_2 = \dfrac{\lambda_2}{\rho_{20} c_{p2}}$ - gas thermo conductivity

Here, $\gamma = c_{p2}/c_{V2}$ is adiabatic index.

In equations system (11)-(13) Nusselt parameter is set in a form obtained in the paper [5; 7]:

$$Nu_2 = \sqrt{\frac{12(\gamma-1)TR}{a_2}\left|\frac{\dot{R}}{T_0 - T_2}\right|}$$

(11)-(13) equations system is a closed equations system describing dynamics and heat exchange of insoluble gas bubble with liquid. Subject to $\tau = 0$: $\theta = 1$, $P_2 = 1 + S$, $Y_1 = 1$, $Y_2 = 0$.

We will get Koshi problem for differential equations system (11) - (13).

Bubble dynamics subject to solubility of gas in liquid is considered in [3; 4; 6; 8].

Let us consider a problem of bubble radial movement occurring as a result of instantaneous pressure in liquid subject to $\tau = 0$ at a distance of bubble from p_0 to p_c $\Delta p = p_c - p_0$.

Let us write (11)-(13) equations system in finite differences by marking through h an integration step through time and respective values of variables in points of division of period will be marked as P_{2i}, θ_i, Y_{1i} and Y_{2i}. Then, we will get:

$$\theta_0 = 1,\ P_{20} = 1 + S,\ Y_{10} = 1,\ Y_{20} = 0. \tag{14}$$

$$\theta_i = \theta_{i-1} + \frac{3\theta_{i-1} h}{Y_{1i-1} P_{2i-1}} \times \left[\gamma(1+S)G_{i-1} - (\gamma - 1)P_{2i-1}Y_{2i-1}\right] \qquad i = 1,2,\ldots \tag{15}$$

$$G_{i-1} = sign(1-\theta_{i-1}) \times$$

$$P_{2i} = P_{2i-1} + \frac{3\gamma h}{Y_{1i-1}}\left[(1+S)G_{i-1} - P_{2i-1}Y_{2i-1}\right] \times \sqrt{\frac{3(\gamma-1)\theta_{i-1}}{Y_{1i-1}}\left|Y_{2i-1}(1-\theta_{i-1})\right|} \tag{16}$$

$$i = 1,2,\ldots$$

$$Y_{1i} = Y_{i1-1} + hY_{i2-1}$$

$$Y_{2i} = Y_{2i-1} - \frac{3h}{2}\cdot\frac{Y_{2i-1}^2}{Y_{1i-1}} + \frac{P_{2i-1} - P_c - S/Y_{1i-1}}{Y_{1i-1}}\cdot Pe_2^2 h - L\cdot\frac{hY_{2i-1}}{Y_{1i-1}^2} \tag{17}$$

Required thermal physic characteristics of air and water subject to atmospheric pressure $p_0 = 10^5\, н/м^2$ and room temperature $T_0 = 293^0 K$ will be considered equal to [1]:

$$\rho_1^0 = 963\frac{кг}{м^3},\ \sigma = 0{,}06\frac{н}{м},\ \mu_1 = 2{,}7\cdot 10^{-4}\frac{н\cdot сек}{м},\ \nu_1 = \mu_1/\rho_1^0 = 3\cdot 10^{-7}\frac{м^2}{сек}$$

$$c_{p2} = 1000\frac{дж}{кг\cdot град},\ c_{V2} = 714{,}3\frac{дж}{кг\cdot град},\ \lambda_2 = 0{,}0262\frac{вт}{м\cdot град},$$

$$\rho_{20} = 1{,}16\frac{кг}{м^3},\ \gamma = 1{,}34,\ a_2 = 2{,}26\cdot 10^{-5}\frac{м^2}{сек},\ L = 4\nu_1/a_2 = 5{,}3\cdot 10^{-2},$$

$$Pe_2 = \frac{R_0}{a_2}\sqrt{\frac{p_0}{\rho_1^0}} = 4{,}6\cdot 10^5 R_0.$$

Conservation degree of gas mass in m_2 bubble was account control:

$$\frac{d}{dt}\left(\frac{4}{3}\pi R^3 \rho_2^0\right) = 0 \text{ or } \frac{Y_1^3 P_2}{\theta} = 1 + S \tag{18}$$

Choice of step of finite-differential grating h was selected from condition of execution accuracy of term (18) and was considered equal to $h = 0{,}001$. In all calculations this condition was carried out with exactness up to 1%.

Dependencies of dimensionless radius of air bubble (curve 1), air pressure in bubble (curve 3) and gas temperature (curve 2) on dimensionless time are shown in Figure 3 when pressure in water increased by surge subject to room temperature $T_0 = 293^0 K$ from $p_0 = 1ат$ to $p_c = 1{,}5ат$. Initial radius of motionless bubble was accepted equal to 10mkm and initial radial speed of pulsation speed was accepted equal to zero.

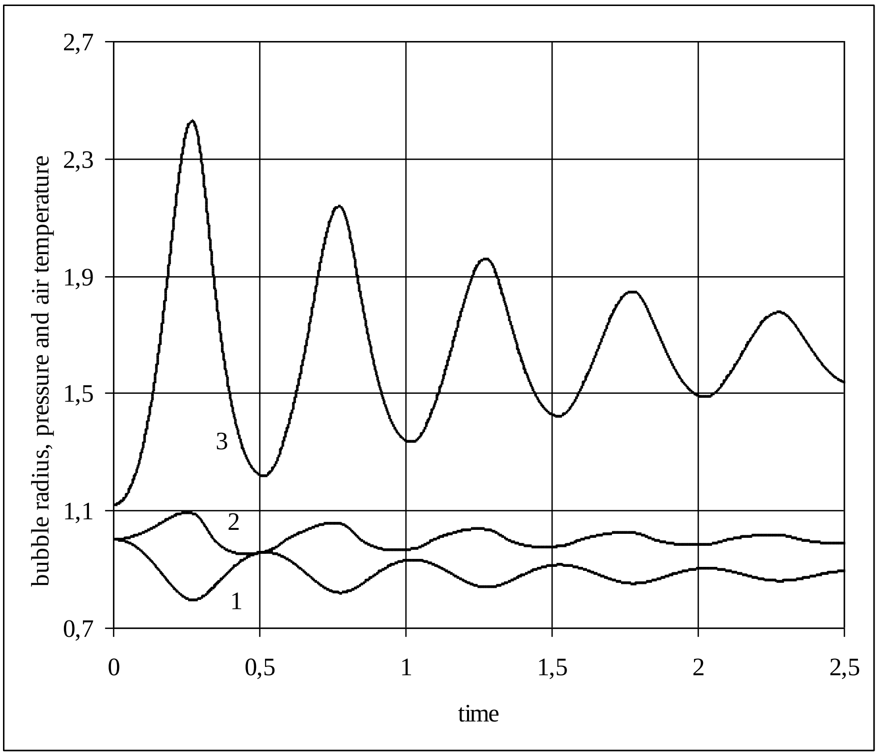

Figure 3. Dependencies of air bubble radius, pressure and air temperature in bubble on time while pressure increase in liquid.

Similar dependencies are shown in Figure 4 for a case when pressure in water decreased by surge subject to room temperature $T_0 = 293^0 K$ from $p_0 = 1am$ to $p_c = 0{,}7am$.

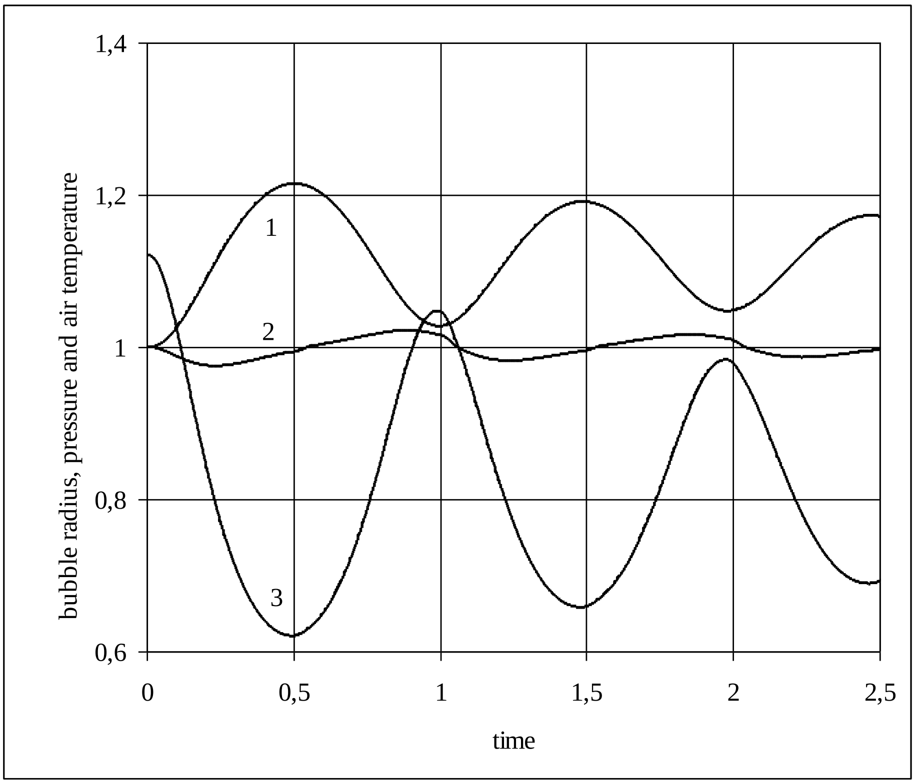

Figure 4. Dependencies of air bubble radius, pressure and air temperature in bubble on time while pressure decrease in liquid.

Let us compare results with equation of gas-liquid mixture state with incompressible carrying phase subject to surface tension:

$$\frac{p}{p_0} = \frac{\alpha_{20}(1+S)\rho/\rho_0}{1-\alpha_{10}\rho/\rho_0} - S \cdot \sqrt[3]{\frac{\alpha_{20}\rho/\rho_0}{1-\alpha_{10}\rho/\rho_0}} \qquad (19)$$

Results of calculations under Formula (19) (curves 2) are shown in Figure 5 and 6 for variants shown in Figures 3 and 4. Curves behavior shows that calculations in present paper are conformed quite well to R.I. Nigmatulin's formula [5] (curve 1).

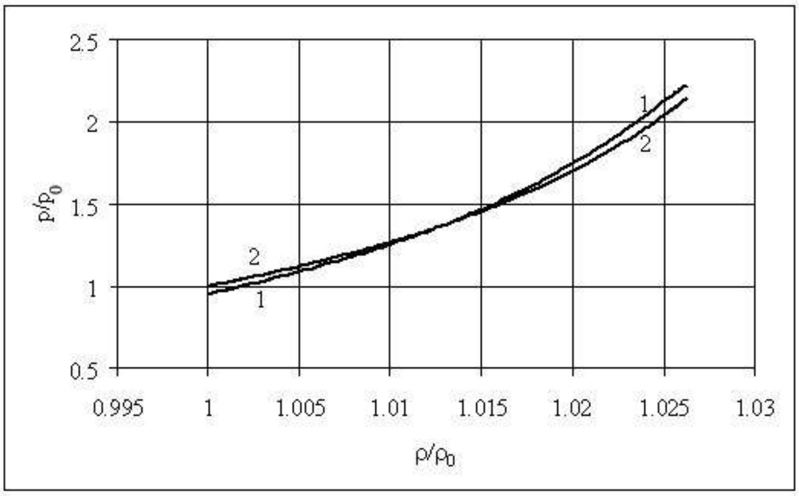

Figure 5. Comparison of calculations results with R.I. Nigmatulin's state equation.

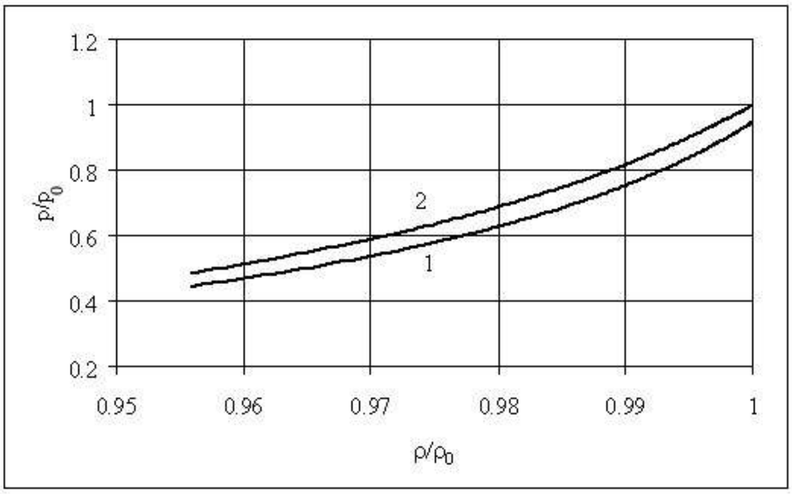

Figure 6. Comparison of calculations results with R.I. Nigmatulin's state equation.

Conclusions

The results of calculations show that equation of bubble liquid state proposed by R. I. Nigmatulin describes proper a state of gas-liquid mixture in a wide range of liquid pressure.

References

1. Варгафтик, Н.Б. Справочник по теплофизическим свойствам газов и жидкостей. М.: Наука, 1972.

2. Губайдуллин, А.А. Введение в волновую динамику газожидкостных сред. Учебное пособие. Тюмень: ТюмГНГУ, 2006, 86 с.

3. Нагиев, Ф.Б. Нелинейные колебания растворимых газовых пузырьков в жидкости. Изв. АН Аз.ССР, сер.ф.-тех и мат. наук, № 1, 1985, стр. 136-140.

4. Нагиев, Ф.Б. Декременты затухания колебаний растворимых газовых пузырьков, радиально пульсирующих в жидкости. Изв. АН Аз.ССР, сер.физ.-тех и матем наук, № 4, 1984, стр. 125-130.

5. Нигматулин, Р.И. Основы механики гетерогенных сред. М., Наука, 1978.

6. Хабеев, Н.С., Нагиев, Ф.Б. Динамика растворимых газовых пузырьков. Известия АН СССР, МЖГ, № 6, 1985, стр. 52-59.

7. Nigmatulin, R.I. Transaction of TDMMM (operative information). Tyumen, 1990, 86 p.

8. Nigmatulin, R.I., Khabeev, N.S., Nagiyev, F.B. Dynamics, heat-mass transfer of vapor-gas bubbles in a liquid. Printed in Great Britain. Inter. J. Heat and Mass Transfer. Vol.24(6), 1981, pp. 1033-1044.

ASSESSMENT OF CRUISE SHIPPING TRENDS IN KLAIPEDA AND RIGA PORTS

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Abstract
This article analyzes cruise shipping sector in Klaipeda and Riga seaports, examines the factors influencing the number of ships visiting ports and arriving cruise ship passengers. The results showed that the Riga seaport is more visited by cruise ships because of more developed tourism industry, which effectively tailored promotional measures and arranged most popular recreational areas. The Klaipeda Seaport cruise shipping sector which is analysed within a 12 years period shows that it has been established that the cruise shipping as a branch of the tourism industry is at the stage of development, there is a lack of recreational areas and services in Klaipeda and Klaipeda region, lack of public services for the tourism sector.
Keywords: *cruise shipping, tourism, attractions, cruise ship, the Baltic Sea.*

Introduction

Travel and tourism are highly information-intensive, and the onslaught of online and offline information sources has complicated the brand-building process significantly. The cruise industry in general appears to be in better shape financially than most of the industrial world's national economies [14]. One of the most developing tourism types in recent decade is cruise shipping and related activities. First class boat passengers were travelling by ships depending on financial situation, so the lower class passengers were not included in travelling with posh trips, but the highest class passengers journey equalled to a luxury cruise travel and entertainment abundance [13]. Over time, boats for target trips have been simplified, liner shipping lines were formed whose primary purpose was to provide maritime transport services for passengers, vehicles and other wheeled goods entering the ship [1]. Cruise shipping has become a separate branch of shipping, fully attributed to the tourism industry, as the main difference from the liner-it's a journey with no particular destination, including recreational travel type, whose main purpose is leisure, short excursions in port cities, capitals and other various locations [7].

Cruise ship tourism has become one of the fastest growing segments of the global tourism industry and is a central facet of the industry in various regions [5]. Natural conditions and sufficiently formed short cruise seasons are not particularly favourable for Baltic Sea Cruise Industry. The cruise shipping route attitude of the Baltic Sea region, is even during the warm season not characterizes by a small number of non-transiting ports and the number of cruise ships. It is therefore interesting to analyze the Klaipeda and Riga seaport cruise shipping peculiarity because it´s being almost the same cruise shipping natural conditions ports the number of serviced vessels is different, so the other natural causes operate cruise ports in these specifics [15].

Research subject – a number of cruise vessels accepted or calling in seaport.

Research aim is to investigate and compare the cruise indicators of Klaipeda and Riga ports.

Research tasks:

1) perform the Baltic Sea cruise market review.
2) identify the main reasons to take Riga sea port to serve larger cruise ship traffic.
3) identify the main reasons which allow Riga sea port to serve larger cruise ship traffic.
4) rate Klaipeda Seaport cruise prospects for the Baltic Sea.

Research methods are literature analysis, summary, statistical analysis and forecasting, modelling.

Cruise shipping assessment of the Baltic Sea

A cruise ship is a passenger ship type, which is designed for long-distance trips. Cruise ships have the opportunity not only to travel a long route, but passengers take up a variety of activities and entertainment on board [11]. The most common destination is a not certain route - sailing and return to the same port. Meanwhile, they are different from the ocean liner, which are used for passengers and onward transport from one point to another [5]. Cruise ships are usually full of comfort and entertainment; this means the restaurants, cafes, nightclubs, spa, swimming pools, sports clubs and recreational climbing wall, golf, tennis fields and casinos [4]. Cruise lines continue to adapt to new technology with virtually all major cruise lines offering Internet access and Wi-Fi capability and many offering guests an opportunity to make and receive cell phone calls aboard ship [7].

Cruises have become one of the most important types of tourism - it is estimated that in 2011 this service was used worldwide by about 19 million passengers, releasing almost 30 billion U.S. dollars. The world's biggest cruise ship company is Royal Caribbean International - MS Oasis of the Seas and MS Allure of the Seas. "Currently, the biggest cruise ships are used on routes to the Caribbean, Alaska and the Mexican coast. The major cruise lines are moving cautiously to fully restore or expand local capacity and say they are keeping a close eye on the pace of tourism growth [6].

Figure 1. Cruise ships on shipping routes in the Baltic Sea [13]

While analyzing cruise market in the Baltic Sea region, it can be seen that in this sea, where the weather conditions most of the year is not conducive to cruise shipping, there are already established and used to Cruise roads (Figure 1). The analysis of the Baltic coastal ports and cruise ships coming to roads can be discerned little and a lot of connections with ports. Kiel, Copenhagen, Visby, Stockholm, Hanko, Helsinki, St. Petersburg, Tallinn, Roomsaare, Riga, Klaipeda, Gdansk sea ports are one way cruise with ports and Tallinn, which looks in cruise shipping map like a central point, which turns five cruise routes (Figure 1).

While analyzing Klaipeda and Riga ports cruise specifics, it should be noted that in Riga, capital of Latvia, that itself is an industrial and service centre, sailing cruise ships along the way have the opportunity to visit the wonderful Parnu and Roomsaare areas and recreational areas, while voyage to the port of Klaipeda, on the way the islands and the adjacent ports are not formed, so there is no small recreational services in Klaipeda are needed.

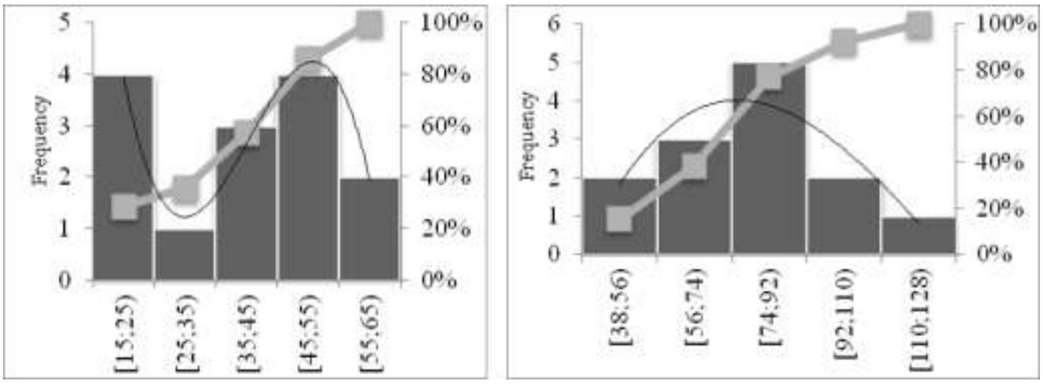
Klaipeda and Riga ports cruise shipping evolution during the period 2000 to 2012

Analyzing the 2000 - 2012 period, it was found during this period that Riga independent port totally served 1,024 cruise ships and Klaipeda seaport - 529 cruise ships, which is almost twice less. According, to the cruise shipping in the Baltic Sea region as well as the global cruise industry, development trends over the period, the lowest cruise industry rates were recorded in 2000 year after the end of the cruise shipping season: 15 cruise ships visited Klaipeda at this period and the Riga port supported more than 2 times bigger amount of ships - 38 ships throughout the season. During the entire 12 year period Riga port supported the biggest amount of cruise ships and it was in 2003 when the number of served cruise ships at

Riga port reached 121 ships and it was a record-breaking number of cruise ships that entered the Riga port. The biggest number of served cruise ships in Klaipeda national seaport was twice lower and reached 65 ships in 2007.

At the 2000 - 2012 period the average number of served vessels during the season in Riga port reached 79 ships, Klaipeda state seaport 48 % less, on the average this makes 41 serviced cruise ship in the season. Accounting both comparable port cruise shipping indicators distribution by statistical frequency histogram we can maintain that the Riga port is most likely smaller than the average serviced the cruise ships number, equal to 79 ships a year, indicators (left asymmetry exists) and Klaipeda State Seaport the coming period probably will be served by an average of less than 40 cruise ships quantity (left asymmetry). We can maintain that the coming period we cannot very significant changes in the cruise neither in Riga or Klaipeda ports [9].

It is typical in the tourism sector that the cruise shipping rate is not stable. Notable stability has cruise shipping at Klaipeda State Seaport because the number of served ships, although build-more intensive than Riga port, avoids major indicators decline in the analysis period [1]. The very most significant decrease in the number of served ships in the Klaipeda State Seaport was recorded in 2006 and 2011, when the number of served ships in one season decreased by 9 vessels (-20 %). In the same 2006, the number of served cruise ships in the port of Riga fell by 29 %.



a) b)

Figure 2. The number of served cruise ships statistical distribution during the period 2000 to 2012 at Klaipeda State (a) and Riga free (b) ports.

The analysis of the target cruise port development prospects, you can see Riga port cruise rates almost twice slower growth than Klaipeda State Seaport indicators: Riga port on average services by one cruise ship more and Klaipeda port – 2 ships more (Figure 3).

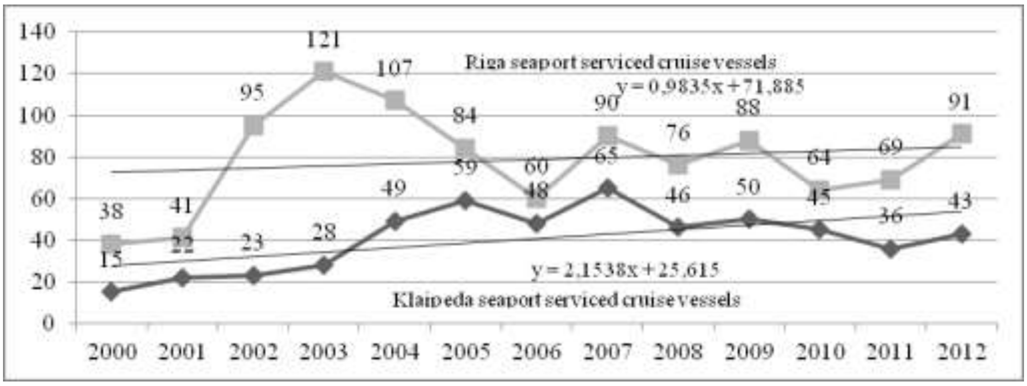


Figure 3. Klaipeda and Riga ports serviced vessel number dynamics in 2000-2012 year period.

If the economical market events and in the Baltic Sea region in future periods would remain adequate for the analyzed period in respect of economic processes and their development trends, this cruise ports indicators aligned only after 39 years and on average both ports would reach 110 ships within one cruise ship season witch in Riga State port would be 9 % lower than the recorded result for the entire period [2] (Figure 3).

In order to justify formulated cruise shipping development of Klaipeda and Riga ports trends it is required to identify main factors which had a strong impact on the cruise ports indicators variation. First of all, it should be emphasized that the Riga port starting from 2001 cruise shipping rates increase intensively, in 2002 we can observe a 132 % annual increase in the number of serviced vessels, later, in 2003 the annual rate increases another 27 %. Such changes could be leaded because other companies signed a cooperation agreement with Riga seaport cruise shipping area. Later, in 2004, when the Baltic States joined the European Union a cruise ship number in the port of Riga decline (by about 21 % annually) could lead to increased competition, which was opened parallel to the neighbouring ports in one and the same competitive global market. Although the long-term Seaport has not formed a sufficient competition in Riga Seaport cruise shipping, but eventually cruise indicators seaport began to improve, what leaded to the fact that Klaipeda Seaport accident rate was reduced and managed coastal recreational area inclusive of the EU period.

Cruise shipping sector, as the other with the use of the economic situation and consumer related transport service sectors, in 2008-2010 period declined, but it was not significant: the port of Riga was observed in only one season, and was 27 %. Klaipeda seaport serviced cruise ships decline was recorded in two seasons, an average of 15 % annually. Already since 2011 cruise shipping indicators in both ports started to increase and in 2012 end Riga port recorded 91 accepted vessels per season and in Klaipeda seaport this indicator at the same time amounted to 43 vessels.

Klaipeda and Riga Sea ports infrastructure and superstructure element comparison

With reference to cruise market in the Baltic Sea analysis, it can be said that in order to find out the major cruise shipping influencing factors it can be analyzed by the following main factors: infrastructure and superstructure, tax policy and the port fees, recreational areas and tourism development in the region.

Each port and its access is primarily characterized by means of port infrastructure and superstructure elements, which shows not only the attractiveness of the port capacity, but reveals the state government approach to maritime transport system, and the issue in question and maritime tourism and development.

The total area of the port of Riga - 2531.5 ha, and two years ago Riga City Council passed a resolution to allow the port to use another 1732 acres. The port has 114 berths in service with an overall length - 13.1 km. Open the port area covers 1.78 million square meters, warehouse - 180 000 square meters. Port's tanks capacity are- 309 500 square meters, refrigerators – 31.750 tons. Currently, the port of Riga has about 150 cranes. In 2000, the vessel's maximum draft wharves was 11 m, the port channel - 14 m, but the port is continuously deepened and it is planned that in the future Riga port depth will be 15-16 meters. The port can access 225 m long vessels.

Table 1. Comparison of infrastructure elements at Klaipeda and Riga seaports [8; 14]

Elements	Klaipeda State Sea port	Riga Sea port
Harbor, he	498	1 962
Quay number, units	152	114
Quay length, km	24,9	13,1
Open storage area, sq. m	950 920	1 780 000
Warehouses, sq. m	160 628	180 000
Reservoirs capacity, cubic m	970 000	309 500
The port can serve ships up to maximum length, m	275	225

Meanwhile, the Klaipeda port from other ports is notable not only for its unique geographical position, but also a unique design. Protective breakwaters and other hydro facilities are berths and marinas layouts and applications. Exclusive Klaipeda port feature is the sea gate construction.

Port infrastructure elements comparison suggests that the Riga seaport ahead Klaipeda seaport by depth (depth of Klaipeda port 13 meters), also it doesn't have advances port, wave-protected marine waters, which is common in many ports of the world.

To Klaipeda channel and port ships enter and leave through the straight line located in the north-west. This design fully protects the port harbor of wave radiation. During the storm strong waves are felt even at the Dane river (about 5 km from the sea gate), in addition Klaipeda is the most incident-port in the world. It is dotted with a number of the wrecks. Berth at the port of Klaipeda is very difficult. Even highly experienced captains mooring work leave to the pilots, not to mention the captain's ability to work on ferries between Klaipeda and Neringa. During the day mooring principle can change 20 times.

Competitiveness of the port, as well as cruise ship conditions in the port waters and territory has a significant impact on the adequacy of the port and the applicable charges and the tax system, which in turn depends on the country conducted tax policy.

Riga tax breaks, on 12 April 2000 Latvian Parliament adopted the Riga Free Port Act, under which companies operating in the port area were provided with tax relief. Following this resolution before the end of the period (2012 year) Riga port is set to zero customs duties, excise, property, value-added and corporate income tax rates. It is planned that a charge port companies will not pay until 2017, while the total investment will pay off. In view of the Latvia Parliament exemption for the port, large and yet completely untapped territory, planned huge investments, Riga port managers have every reason to cherish great ambition - to become a leading port in the Baltic countries. All of these benefits reduce the cost of required terminals and piers.

Another Riga city and port connection is tourists. In all three Baltic countries Latvia's capital is closest to the port, so the tourism industry in Riga city is big enough, so it allows the town to attract large flows of tourists. Seaport has a comfortable cruise ships moor for embankment, as well as equipped yacht, boat pier (wharf). It is very important that the port tourist infrastructure is integrated into the public transport system in a flexible manner so traveling tourists on cruise ships have no big traffic problems.

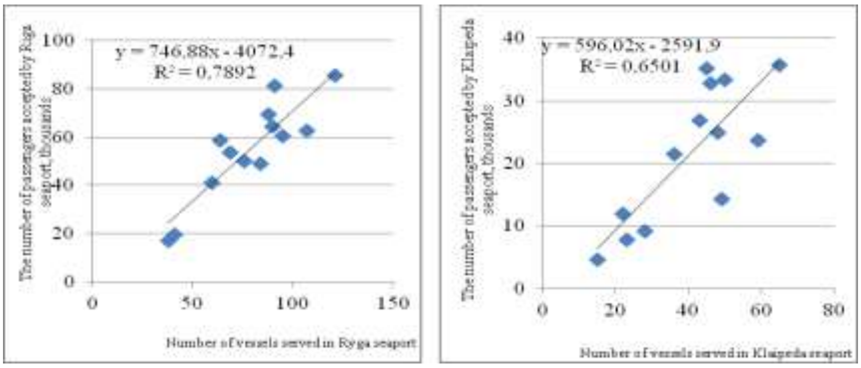
Klaipeda city is smaller, its attractiveness may already be lower simply because it is not a capital, and therefore the positive cruise industry attractiveness - enhancing measure becomes tourist recreational zones creation and arrangement, publicity, promotion and so on.

Klaipeda and Riga sea port for cruise shipping rate changes in dynamic forecast

Cruise rates are sensitive not only to macro economical, national tourism indicators, however, and port infrastructure elements, and the toll collection system changes. In the competitive international cruise industry, there are a number of factors that affect companies' performances: the general economic and business conditions, reduction in consumer demand for cruises, and changes in operating and financing costs [4].

It is natural, the expansion of airports, ports can handle the increasing number of tourists. In Klaipeda seaport a number adopted cruise ship passengers and served cruise ships linear relationship indicates that a number of vessels in Klaipeda seaport is increasing, and each arrived cruise ship is approximately carrying 597 passengers more. The cruise industry's growth is reflected in it is expanding passenger capacity [3].

Meanwhile, the Riga seaport linear number of passengers and cruise ships number dependence shows and confirms the previous conclusion that cruise ships carry 746 passengers (Figure 4).

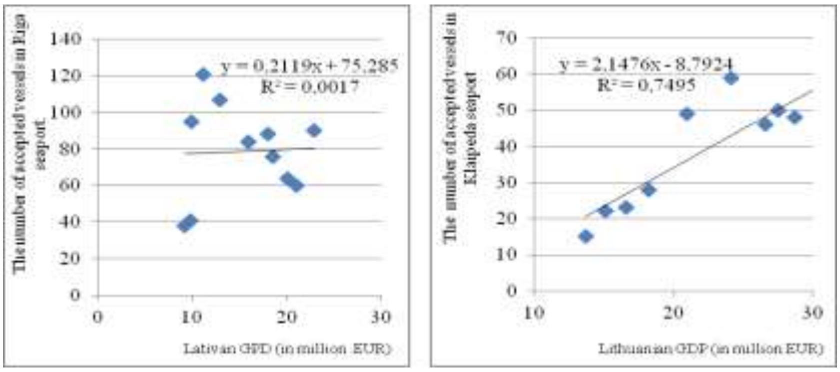


a) b)

Figure 4. Linear dependence of accepted passengers' number: at Klaipeda (a) and Riga (b) ports up to the cruise ship port number

Furthermore, a more detailed statistical indicators analysis show that to Riga port come larger cruise ships, so not only a number of served ships, but also a number of passengers in one ship in Riga port indicators are significantly better. Interestingly, however, the Riga seaport cruise rates are completely independent from an economic situation, and it shows that the cruise shipping is sufficient in dissemination terms of information about places, the region, its people, ethno-cultural traditions, and the implementation of the tourism industry development policy positively affects not only Latvia tourism, but also in cruise shipping (Figure 5).

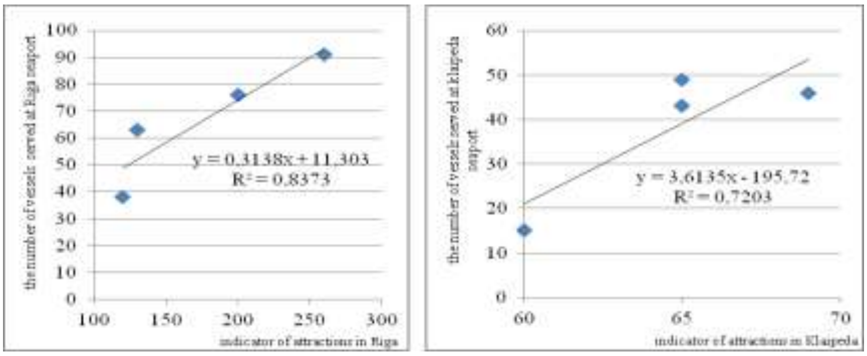
Meanwhile, the Klaipeda Seaport cruise rates strongly depend on the Lithuanian GDP dynamics because the existing state budget is balanced and the positive changes cause additional investments in port infrastructure upgrade, development of tourism industry, recreational landscape development. This shows that the tourism industry in Lithuania is in a development stage and in 2012 end is less developed than the tourism industry in Latvia. In addition, in Riga, as the advertisement of a capital as 2014 European culture capital, leads to more recreational tourism, along with cruise conditions.



a) b)

Figure 5. The linear dependence number of accepted vessels from the country's economic regression model at Klaipeda (a) and Riga (b) seaports

Following the Riga seaport cruise dependence on the number of visited places analysis, it was found that 84 % of cruise shipping by signal strength is dependent on the number of tourist attractions and recreational status in Riga and its surroundings. Applying attractions calculation and assessment methodology and statistical data to the tourism industry, in Klaipeda seaport has been established strong enough to cruise dependence on the number of places (Figure 6).



a) b)

Figure 6. The linear dependence of vessels accepted and a number of attractions in Riga (a) and Klaipeda (b) seaports

Regression analysis shows that the establishment of a local recreational area or existing arrangements for tourism purposes allows you to welcome a number of tourist coming close to 4 cruise ships Exactly the same effect has each of the cruise shipping and tourism-oriented services infrastructure integration to the port city of public service infrastructure. Thus, in order to increase the cruise seaport indicators requires sufficient investment in port infrastructure, passenger terminal facility elements of the integration of the city's public services, infrastructure and recreational areas, maintenance and promotion.

Conclusions

Klaipeda and Riga ports differ in several aspects, in particular the port types. The port of Riga is more navigable than Klaipeda, as the port of Klaipeda is one of the fatal accidents in ports in the world. It is also the port of Riga is superior to the number of places because Riga is the capital city, this attracts more tourists, while Klaipeda is difficult to compare with other cities visited by cruise ships, it is impossible because it does not have the cultural heritage. A sufficient Riga marketing strategy and the effectiveness of the measures allows you to see that the cruise shipping in Latvia, Riga port is sufficiently strongly developed, has tidied up and popularized recreational areas developed cruise shipping infrastructure and user-friendly public service sector system adapted to the tourism industry in policy implementation.

After a study of these ports, it can be said that two countries cruise rates fluctuated, were not stable during the whole period, but the Riga seaport cruise rates for the entire period was significantly higher than in Klaipeda. However, recent years have showed that the Klaipeda Seaport cruise shipping rates grow more intensively and that remains the same cruise conditions and developments in future periods, so after the 39-year-old cruise shipping development in these ports would converge.

Causal analysis showed that Klaipeda seaport, and the whole Lithuania, the tourism industry, and especially cruise shipping is evolving, so required optional port infrastructure and updating directly depends on country's economic development, material investment, but the most significant relationship was determined between the number of vessels and recreational zones of incorporation, organization and integration of services to the public tourism services in the city and the region.

References

1. Belova, J., Mickienė, R. Uosto veiklos valdymas: ekonominis aspektas. Klaipeda: Klaipedos universiteto leidykla, 2012.

2. Belova, J., Mickiene, R. Economic Efficiency Assesment Problems of Maritime Sector under Globalization Conditions. In: Transport Means. Proceedings of the 12th International Conference (Kaunas, Lithuania, October 23-24, 2008, Kaunas University of technology), 2008, pp. 75-77.

3. Belova, J., Mickienė, R. The Efficiency Formation Problems of Maritime Sector Companies under Crisis Conditions. Human resources - the main factor of regional development. No. 3. Klaipėda: Klaipėdos universiteto leidykla, 2010, pp. 320-324.

4. Caiazza, R. Strategies and Financial Instruments for Facing Main Risks in Cruise Industry. Business Review, Vol. 11, Issue 8, 2012, pp. 1081-1087.

5. Clancy, M. Shape up or ship out: the power and politics of cruise itinerary development. Globalizations, Vol. 5, Issue 3, 2008, pp. 405-418.

6. Finn, K. Straipsnio pavadinimas. New Orleans Magazine, Vol. 41, Issue 9, 2007, pp. 32-33.

7. Gulliksen**,** V. Cruise industry. Society, Vol. 45, Issue 4, 2008, pp. 342-344.

8. Klaipeda seaport statistics. Klaipeda port autorithy’s website. Available (accessed on 05.03.2013): http://www.portofklaipeda.lt/statistika

9. Klaipėdos uosto plėtra ir vis dar neišnaudotos galimybės (Development of Klaipeda seaport and capacities). Available (accessed on 16.03.2013): http://www.technologijos.lt/n/technologijos/laivai/S-20947/straipsnis/Klaipedos-uosto-pletra-ir-vis-dar-neisnaudotos-galimybes?l=2&p=1

10. Latvian statistics department data base. Available (accessed on 16.03.2013): http://www.csb.gov.lv/en/dati/statistics-database-30501.html

11. Lemmetyinen, A., Frank, M. Building a brand identity in a network of Cruise Baltic's destinations: A multi-authoring approach. Journal of Brand Management, Vol. 17, Issue 7, 2010, pp. 519-531.

12. Lithuanian Statistics Department data base. Available (accessed on 16.03.2013): http://www.statgov.lt/database

13. Miller, K. R. Cruise market assessment. Travel & Tourism Market Research Handbook. 2013, pp. 239-242.

14. Riga seaport statistics. Riga seaport website. Available (accessed on 05.03.2013): http://www.rop.lv/en/

15. Vainorius, M. Rygos uostas krovos kiekiais ketina dvigubai aplenkti Klaipėdą (Riga port cargo volumes will double bypass Klaipeda). Available (accessed on 18.03.2013): http://www.ve.lt/naujienos/ekonomika/ekonomikos-naujienos/rygos-uostas-krovos-kiekiais-ketina-dvigubai-aplenkti-klaipeda-385391/

A COMPARISON OF PEAT HANDLING DYNAMICS IN KLAIPEDA AND RIGA PORTS

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Abstract
Peat (as bulk cargo) flows and handling dynamics trends can be seen in the Baltic Sea ports - Klaipeda and Riga. As the peat resources in the Baltic States are sufficient and fill the market, large quantities are exported. Lithuania not only has a good geographical position, but also a well-developed road infrastructure between Lithuania and neighbouring countries which do not have access to the sea. These advantages create a favourable condition to travel considerable number of peat through Lithuania.

Keywords: *peat, handling, bulk, terminal, transit.*

Introduction

In the rapidly developing world of technology an intensive decline in various petroleum products and other popular fuel materials is visible, as their cost is growing very quickly. “Masterforex-V Academy” predicts that within the next 30-50 years the world of liquid cargo, consisting of oil, its products and liquefied petroleum gas, will fall by nearly 75 %. Declines in oil and petroleum products as well as liquefied gas emissions around the world were influenced by growing population, which at present seeks around 7 billion. There are attempts to explore for an alternative ways to replace it. Peat is one of these substances, which may partially replace the current energy source in state’s agricultural system. Before peat falls into the hands of the customers it has to go through a long process: it has to be mined, processed, loaded, transported, and stored. Scientists say that peat can significantly reduce the increase in heating prices, create jobs and stimulate export and import development. KTU (Kaunas University of Technology) researchers estimate that peat of Lithuania could heat houses for up to 80 years through an effective use and create up to 10 % all the required heat energy for the houses.

Peat, as an alternative fuel, demand shows the ports handling dynamics, which directly depends on the resources within the particular geographical location, the quantity of production, logistics, technology, and port infrastructure. As a general, when the price of any good or services rises the quantity demanded will fall [5]. Due to these factors it is important to investigate how the demand for peat reflects the specialization of ports and future prospects of peat handling. In order to assess the competitive position of the port of Klaipeda in the peat market, this work will compare two ports, the Lithuanian port of Klaipeda and the largest seaport in Latvia - Riga. The selected research object is a peat handling.

Research purpose is to evaluate Klaipeda seaport peat prospects and compares them with the Riga’s port indicators.

Research objectives:

- describe the peat transport logistic chain;
- compare Klaipeda’s and Riga’s seaport infrastructure elements;
- analyse peat dynamics for the years 2005 - 2012 and propose future trends.

Research methods are comparison of descriptive statistics indicators, correlation analysis, time series analysis, and regression models. All figures were calculated using MS Excel and its addendum Analysis ToolPak. The 2005 – 2012 peat-term statistical indicators were used in the study.

Peat transportation logistic chain

Peat is an organic combustible sedimentary rock, formed from remains of swamp vegetation which mineralization is sped up by an excess of water and oxygen deficiency. Natural peat according to the structure is divided into mats: (small fragmented) and amorphous (well decomposed). Different forming conditions divide peat into types - (lowland, bogs and intermediate) and subtypes (garter, bare marsh). Peat formation process is very slow.

Only up to a 1 mm thick layer of peat are formed over the year. In Lithuania turf covers 6.4 % of the country's area, in Latvia - 10.7 %, Belarus - 11.56 %, Estonia – 22 %, Finland – 33 %. In case of favourable conditions, over a long geological period, peat naturally turns into lignite and later turns into a coal. Peat is useful, because it is used for fuel, in agriculture for litter and when turf is over rotten - to fertilize soils.

Despite the fact that Lithuania has less resources of the peat than Latvia, Klaipeda’s port handles more. This has a major impact on intensive transit cargo flows from Belarus. From a handling perspective, peat is classified into bulk peat and packed peat. To keep safety of goods, it has to be packed according to certain instructions. In case of a mishap, all necessary expenses will have to be covered by the insurance company [15]. Homogeneous bulk cargoes are carried by a fleet of large bulk carriers operating between terminals designed to mechanize cargo handling [13]. Type of transported peat determines peat handling terminal type that should be used during transportation. Packed and pressed turf is usually loaded in a general cargo terminal, and bulk-on a bulk and dry bulk cargo terminals (Figure 1).

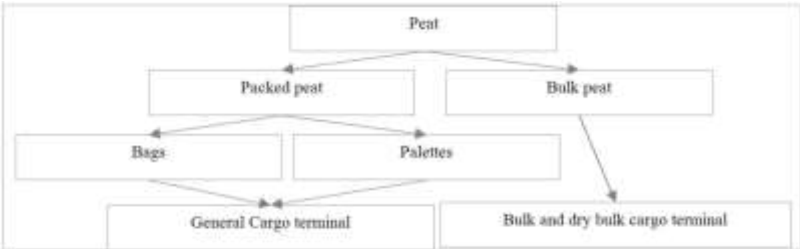


Figure 1. Peat cargo terminal selection

Klaipeda’s seaport loads peat which is obtained from Lithuania, imported and by transit road transported from Belarus. Transit route from Belarus bypasses Riga ‘seaport, so Riga’s seaport general and bulk and bulk cargo terminals are mostly loaded with the peat which is extracted in Latvia. Another essential difference in the way peat is transported in Lithuania and Latvia is that the largest part of Lithuania’s peat is transported by cars whereas in Latvia-by railway (in Riga about 80% of peat is transported by rail).

Peat’s popularity as an alternative energy resource can be explained by the relatively low prices (Figure 2). Compared with the LPG price, turf costs six times cheaper so operating costs of peat heated dwellings and industrial buildings can be up to six times lower only by energy resources.

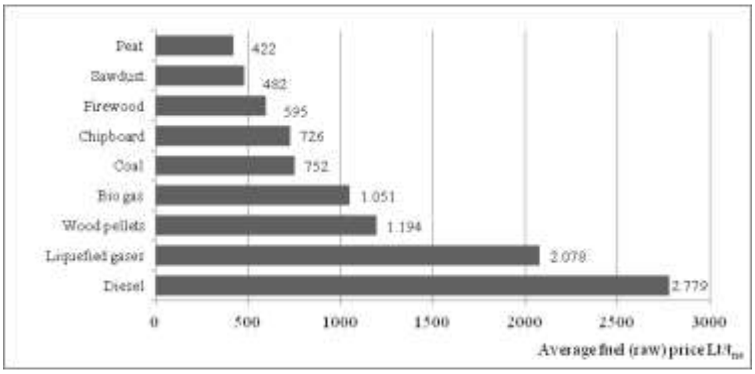


*Figure 2.*Alternative energy prices

Peat is the type of natural resource which doesn’t need a very complex technology in order to be extracted and processed; however, it has its own characteristics. Dry bulk cargoes can be handled as a continuous process by pouring the cargo into the ship and discharged using continuous unloaders, such a bucket conveyors or conveyor spirals feeding a conveyor belt system on the terminal [1].

From the extraction site, after treatment, depending on their functional purpose, peat is transported by land to the main storage. The user of transportation has a wide range of services at his or her disposal, all revolving around the five basic modes (water, rail, truck, `air and pipeline) [11]. The peat transport logistics chain is provided in. In order to keep the chain flexible, it need to be cared by the following factors: customer power; quality ; inventory level; landed cost of the final product; sharing risk; long-term agreements [7]. Once the major scheduled and unscheduled maintenance functions that must be accomplished have been identified, the next step is to break these functions down into job operations, duties, tasks, subtasks, and task elements [2]. It can be seen opposite to the peat loading and transport chain, which starts in part cyclical process and ends when the turf or the particular product reaches the final user: the household, factory, agriculture company, and so on. Vehicles are especially designed for the transport of peat: transported by a special trailer with a sliding floor, from the storage places, a large part of peat is supplied by markets for consumers, on the other part of the remainder peat – loaded to maritime transport, and exported to Western Europe countries. However, the major modes of landside freight transportation for international imports and exports are rail and trucking [3].

As soon as peat reaches seaport, it is loaded on special vessels, which are designed for bulk cargo transportation. Large quantity of peat is loaded onto the maritime transport and then shipped by „dry bulk cargo" type vessels (Figure 3). A wide range of bulk commodities are carried in bulk carriers including coal, peat, ore, cement, alumina, bauxite, and mineral sand plus shipments of products such as packaged steel and timber [6]. Cargo vessels can be classified according to their hull design and construction [4]. Klaipeda port can accept this type of vessel, with a length of approximately 90 m, while the Riga port can accept up to 150 m long vessels. Klaipeda and Riga ports can accept such models of ships as Vaermoe, Asko, Lady Menna, Vind. These types of vessels can load up to 100,000 tons of bulk cargo. But it is unlikely that ship classes (and/or types) will remain static. The importance and impact of trade patterns will continuously influence ship design and capacity. Thus, there is a need for the shipping organizations and the ports to maintain a forward looking approach in so far as the ship owners will 'decide to build' and the ports be able to handle the ships [14].

Managing the turf materials and processed peat warehousing terminals optimization problems, it is necessary to reduce loading and unloading time, as well as to ensure trouble-free cargo arrival at the terminal, and leave it to the other transport systems (rail, road, inland waterways).

The term supply chain management was introduced by consultants in the early 1980s and has subsequently gained tremendous attention [11]. Until now, relationships in the supply chain have been monopolized by a linear model, one that is characterized by a one- way, fixed flow of goods and information [10]. Thus, the terminal is like a barrel in which cargo enters through holes in the barrel and through the same is removed from the terminal (Figure 3).

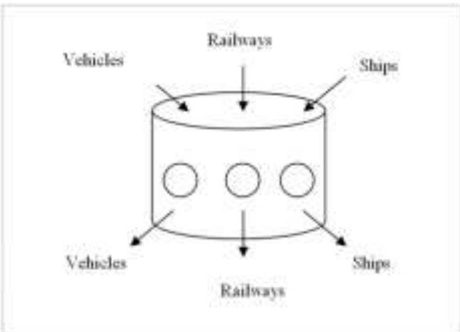


Figure 3. Dry bulk cargo area of peat logistical scheme

It should be kept in mind that the bulk (which includes the peat) handling, storage and transportation technology determines cargo's physical properties: density, humidity, caking, resistance, effects on human health [9]. JSC MABRE LPC is engaged with raw turf materials handling in Klaipeda's port, this is the longest operating terminal which handles peat. The study leads to another terminal, which is involved in transhipment of the turf - JSC Western Stevedoring. Currently, Klaipeda port has three terminals, which are engaged with turf and their raw materials transhipment. Riga harbour currently has four terminals, which are engaged with peat, but the number of terminals in the port of Riga has changed several times. In 2010 Riga's seaport had up to seven terminals, which were engaged with, but in 2011 the number of terminals dropped - just five left.

Peat is stored in open type storage warehouses. For each charge of vehicles, two relocations are considered: the storage from a transfer (quay, rail ramp and truck yard) into a storage location and the retrieval from a storage location to transfer point [8]. The total amount of stored peat depends on kind of turf species, because different turf types require different aisles and separations. Peat loading terminal is specialized not only in peat handling, but also in other bulk cargo. Turf covers approximately half of the terminal - 0.5 hectares on average 20,000 cubic metres of turf, enough to load two ships. So load layout as close to the quay allows avoiding accidental stops of ship loading operations. Both analysed ports has a quite comfortably furnished bulk and general cargo terminals in which it is convenient to load and unload cargo into different vehicles.

Comparison of infrastructure elements in Klaipeda and Riga sea ports

Klaipeda's seaport - ice-free deep-water port, situated along Klaipeda Strait. About 7000 ships from 50 different countries visit this port every year. Free port of Riga - the Latvian port on the Baltic Sea, which lies on the Gulf of Riga, at the mouth of the Dauguva estuary.

Although the port handling values are significantly different (Table 1), their numerical draft depths values are similar. The difference is not big, but Riga's seaport can receive ships with greater drafts, it's one of the reasons why the total of Riga port handling is significantly higher than Klaipeda's port's general cargo rates.

Table 1. Comparison of infrastructure elements Klaipeda and Riga sea ports

Ports	Harbour area	The water area	Draught depth	Entrance channel depth
Klaipeda	498 ha	629 ha	13-14 m	14,5 m
Riga	1962 ha	4386 ha	14 - 15 m	15,5 m

Port of Klaipeda has five bulk terminals, from which three carry peat handling operations, while the Riga port has four terminals, which are engaged in the transhipment of peat (Figure 4). Even though the Riga's seaport was ahead with these parameters comparing with the port of Klaipeda, Klaipeda port in a common peat handling has bigger amounts during the period 2005-2012 (for 48 %). Such a gap in peat handling can be explained by the fact, that Klaipeda's seaport runs one of the main peat cargo transit route, which bypasses Riga.

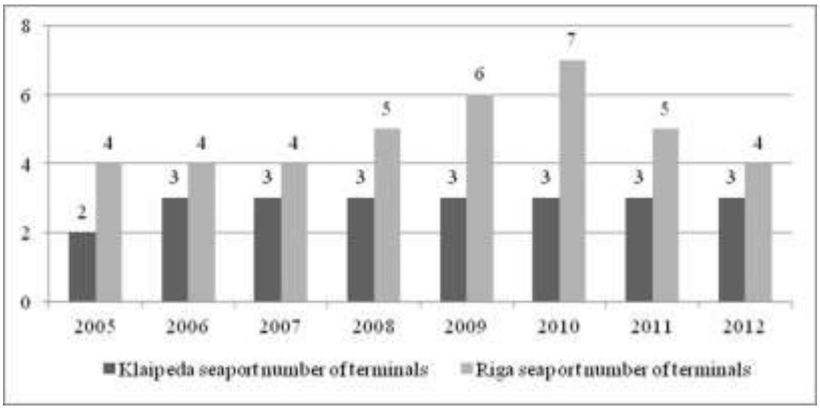


Figure 4. Dry bulk cargo area of peat logistical scheme

Comparing the connections of Klaipeda and Riga seaports with other maritime countries, we cannot notice any significant differences. Both ports cooperate with countries with well-developed agriculture, like Denmark, Germany, Great Britain, Finland, Sweden, and Holland, Belgium. Also, both ports cooperate with each other. Either analysed port terminals territory and water area requirements of International Ship and Port Security Code events (European Parliament and of the Council) were implemented.

Klaipeda seaport infrastructure is better than the Latvian's capital port. Klaipeda is the only port in Lithuania so it receives huge funding from the state budget, as well as from the European Union. We cannot say that about the biggest port of Latvia, because Latvia also has another two large ports

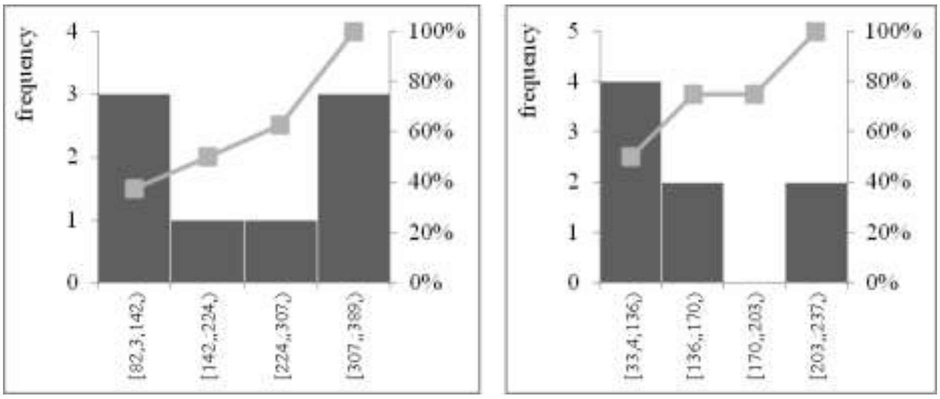
(Ventspils and Liepaja), in addition to the ports of Latvia, it has seven smaller ports with a relatively high proportion of marine trade, care for the surrounding regions of the fishing business, and input to the Latvian economy. Another reason why the Latvian capital port is not allocated with high level of funding is that the largest state funding goes to the city architecture care in order to increase the flow of tourists.

Peat handling indicators in Klaipeda State Sea Port and the port of Riga

Peat handling indicators of both Riga and Klaipeda ports were analysed in eight-year period. The largest peat handling in Klaipeda port was 382 thousand tons 2009, while Riga's seaport peat handling peak was significantly lower - it reached 234 thousand tons in year 2008. Lowest handling of turf cargo in Klaipeda's port was recorded in year 2005 and it was only 60 thousand tons, while at the same year period, a minimum rate of Riga port reached just 104 thousand tons (figure 5).

Klaipeda seaport peat handling was not stable over the period (V_R = 143%, V_σ = 53%). Mostly recorded load factor for 3 years (2005-2007), hovered around the minimum handling characteristics, but in other three years period (2010-2012) reached the maximum values. According to the Klaipeda's port peat handling statistical indicators frequency histogram (Figure 7) and the layout of the indicators time series (Figure 8), we can make an implication that the year 2008 is turf load breakthrough year. This might have been determined by the resolution that was signed by the Lithuanian government, facilitating the movement of goods in transit through Lithuania territory in year 2007.

In Riga's port during the entire period, peat load factor was approximately around 1 % from the total bulk cargo handling dynamics, except the year 2007-2008, when the peat handling was 1.57 %. That means that the total peat dynamic patterns in Riga are related with dynamic changes in dry bulk cargoes handled by the port (Figure 5).



a) b)

Figure 5. Histograms of frequency of peat handling at Klaipeda (a) and Riga (b) ports

Klaipeda and Riga peat handling analysis indicates that both ports experienced an increase in turf handling from the beginning of the period: Klaipeda seaport peat load factor has increased over 8 years by 485 %, and an increase in Riga's port (same period) was 198 % base growth rate, indicating that the 2012 turnover is close to the maximum of 2006 year handling characteristics (Figure 8). Klaipeda Seaport peat load factor increased nearly six times, while Riga's peat handling increased twofold, when approached the initial load, which reached only 119 thousand t, what is just 2 thousand tons more than in year 2006.

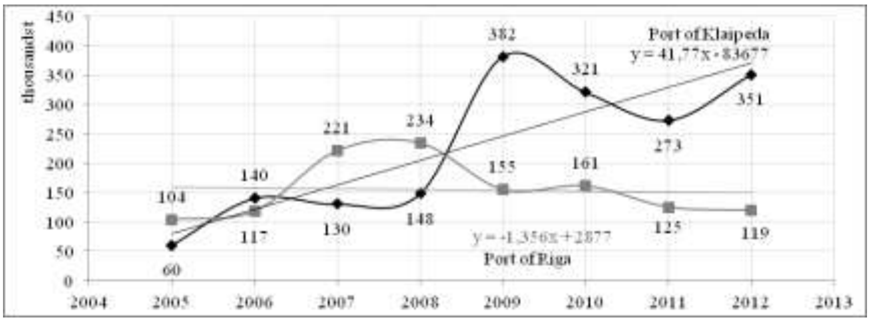
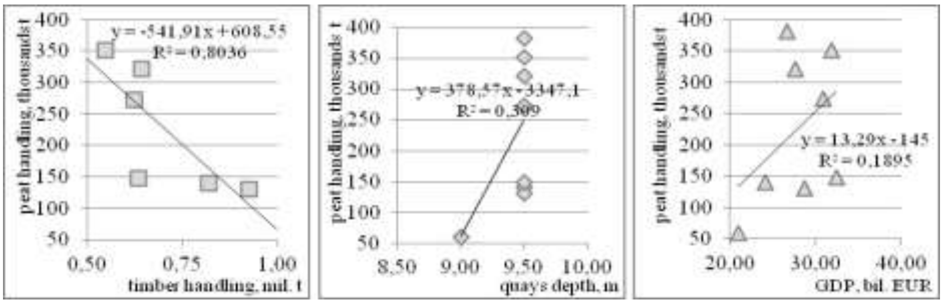


Figure 6. Dynamics of peat handling at Klaipeda and Riga ports in 2005-2012

Compared to the port of Riga, Klaipeda Seaport peat handling grows much faster, one of the key reasons is the increase of transit from Belarus through Lithuania. Lithuania and Belarus have signed a contract Belarus of cargo transit through the ports of the Republic of Lithuania, what is very useful because about 30% of Klaipeda port handled cargo is coming from Belarus.

Moreover, in the port of Klaipeda in 2006 peat handling began in the new terminal. The new terminal allowed maintaining higher level of peat loading and unloading. The new terminal influenced the period from year 2007 to 2009, when peat handling almost tripled (from 130 thousand tons to 382 thousand tons). However, while Klaipeda peat was carried out to the maximum extent, the port of Riga handled peat amount decreased. The main reason was the fact that the terminals are more focused on wood and coal handling. Peat handling volumes in Riga's port from year 2008 to 2012 halved. (from 234 thousand tons to 119 thousand tons). However, there is a high probability that the peat handling will grow in the future. Seaport peat development trends indicate that the Klaipeda seaport should handle 42 thousand t peats per year, while in Riga seaport trend is decreasing, implying that the peat decreases on average 1.35 thousand tons.

However, it is dangerous to rely on trends, because the existing macro-economic indicators and port infrastructure element changes can have an impact on peat characteristics. As shown by the analysis of Klaipeda port, peat causation has the greatest impact on wood cargo volumes decline, which suggests that the peat and timber handling in Klaipeda port uses the same terminals. In addition, a decrease in the duration of the import paperwork procedures, positively influenced peat handling statistics. Not so statistically significant, the noticeable connection between the peat handling and the larger number of terminals and depth in the terminal quays - the greater depth at the quays and larger number of terminals leads to an increase of peat handling.



a) b) c)

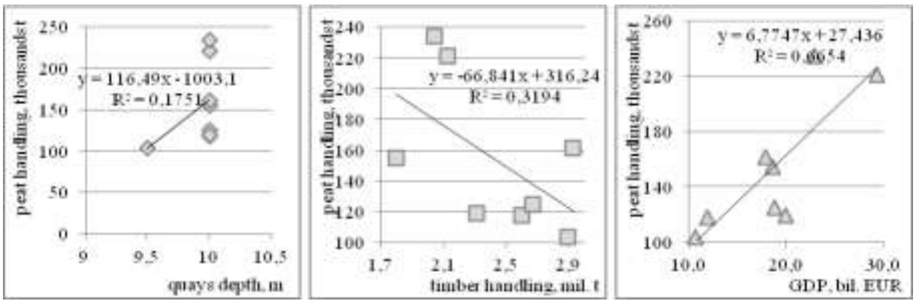
Figure 7. Klaipeda seaport peat linear dependence on:
a) timber handling; b) quays depth at the berths; c) the change in GDP

When peat and wood materials are handled in dry bulk and general cargo terminals, there is a particularly strong correlation between the timber and turf handling volumes. If the wood handling volume decreases by 1 million tons, peat handling volumes will increase to 541,91 thousand (Figure 7). However, in order to make accurate model of the peat handling volume in seaports, the multiple regression models were made, in which the major causal factors were identified such as exports of goods (x_1), imports of goods (x_2), export procedures time (x_3), exports (x_4) and imported (x_5), container price (Doll/1 TEU), timber handling volumes (x_6) and the unemployment rate (x_7), then the peat multiple linear regression model is described as follows:

$$y=1478,64-5,13x_1+3,70x_2+44,03x_3-3,14x_4+1,29x_5-0,59x_6+16,86x_7 \quad (1)$$

In accordance with model and based on the market macroeconomic projections for the period 2013-2016, we can simulate peat handling situation. Predicted that the country's unemployment rate will reach 11.5 % in 2013, in 2014 - 10 %, and the export and import rates will not have major changes, if the unexpected changes does not happen in a political environment, a substantial increase in volumes of peat handling, reaching 328 thousand tons can be expected. However, without the improvement of the infrastructure it would be difficult to expect larger handling volumes. To illustrate, increasing the depth of the terminal quays from 9.5 to 10.5 m., allows us to expect ~1 % larger cargo volumes increase. However, according to all the above mentioned factors and further reducing the export price to $750, which is $150 higher than in Latvia, it is possible to reach 537 thousand t annual peat handling results plus to climb a couple positions in the World Bank carried out studies, to improve the indicator in Lithuania's business environment.

Through development of multiple regression models, it was found that the peat handling used terminal number, and the depths at the quays are not the main peat positively acting factors. If the country's GDP rises by 1 billion EUR, then peat rates are likely to increase only by 6.77 thousand tons. Analysed time period to evaluate the reliability of linear dependence on factors such as number of terminals and the depth at the quays was too short, but these factors also have a linear relationship with the peat handling indicators: peat growth directly affects timber cargo drop and coal cargo volumes growth and increase in depth at the quays (Figure 8).



a) b) c)

Figure 8. Latvian maritime peat handling indicator regression models
a) depends on timber handling; b) depends on quays; c) depends on GPD

In order to accurately assess the potential peat handling trends of the Riga sea port, four multiple regression models were made, which will allow a more precise definition of peat loading rates in future periods.

Riga Seaport peat load factor depends on many factors such as the number of import documents (x_1), import procedures time (x_2), the export price (for 1 TEU) (x_3), quays depth (x_4), timber handling volume (x_5) , the country's GDP (x_6), the country's unemployment rate (x_7).

$$y=-26115,99+89,43x_1+52,81x_2+0,20x_3+2475,25x_4+53,05x_5+2,91x_6+4,47x_7 \quad (2)$$

Based on the model (2), and according to the market macroeconomic forecasts, predicted for 2013, by 5 % with annual GDP growth and reduction of unemployment to 10.8%, we can possible predict the volume of peat handling in Riga port will decline and in 2013 cargo volumes will be almost 118 thousand tons. Positive peat handling trends can be predicted only if export price total increase of $600 per 1 TEU and $655 per 1 TEU and then, if macroeconomic indicators are forecasted properly, peat handling indicators will remain at least stable.

Conclusions

One of the reasons explaining the reduction in Riga's port peat handling is that the port of Riga dry bulk cargo terminal mostly loads carbon. Riga port annually handles around five times more carbon than the peat; coal transportation makes 40% total Riga's seaport handling. And one of the main factors for Klaipeda seaport, which lets increase the volume of peat handling, is a peat transit route through the Belorussia and the transit path through Lithuanian roads and Klaipeda port.

The descriptive statistical analysis set, that the likely turnover in future periods in Klaipeda port will reach more than 226 thousand t. This number was confirmed by evaluated trend, which showed that average annual increase in Klaipeda's peat handling is 41,77 thousand tons in period 2013-2016 and according to the descriptive statistics indicators, Riga's seaport peat handling rates will be lower than 152 thousand t., as confirmed by the declining average of 1.36 thousand tons annually of peat handling dynamics.

Causal analysis showed that the Riga's seaport peat load factor most strongly and significantly depend on a country's GDP, which means economic situation in the country, while the Klaipeda port peat loading dynamics inverse proportion depends on timber handling dynamics.

Multiple linear regression models show that the handling volume tenses of peat will increase in Riga's port in future periods, only in cases if export price increase to $700 for 1 TEU, (which would increase export prices by 16 %), peat handling volume would rise by 18 %. Such a change would jeopardize the business environment in the country. An improvement in economic conditions (GDP growth, unemployment rate decreases) should hardly affect peat handling and it should continue to decline annually by average 1 thousand tons. Only an improvement in economic conditions do not allow predicting larger peat handling results in Lithuania, but 3 % reduction of export price in addition to the improvement of the economic situation of the country, would increase the volume of peat handling by 16 %. If the quays depth is increased by 1 meter, it is possible to expect up to 18 % larger peat handling characteristics.

References

1. Alderton, P. Port management and operations. London, 2008.
2. Blanchard, B. Logistics engineering and management. New Jersey, 2004.
3. Bonacich, E. Wilson, J., B., Getting the goods. London, 2008.
4. Branch, E. Elements of shipping. London, 2007.
5. Cowie, J. The economics of transport. London, 2010.
6. Eyres, D. J. Ship Construction. Burlington , 2011.
7. Jančiauskas, B., Treigienė, D. Supply chain management. Vilnius, 2003.
8. Kim, H.K., Guther, H. Container Terminals and Cargo Systems. Berlin, 2007.
9. Mickienė, R., Belova, J. Uosto veiklos valdymas: ekonominis aspektas. Klaipėda, 2012.
10. Perret, F., Jaffeux, C. Essentials of logistics and management. Italy, 2007.
11. Ronald, H. Business logistics management. New Jersey, 1999.
12. Stock, R., Lambert, M. Strategic logistics management. Singapore , 2001.
13. Stopford, M. Maritime economics. New York, 2009.
14. Taylor, L. G. Ships and ports. Great Britain, 1991.
15. Weiss, D. Building an import export business. New Jersey, 2008.
16. Freeport of Riga authority - Statistics. http://www.rop.lv/en/about-port/statistics.html. 2012.
17. Latvijas statistika. Available: http://www.csb.gov.lv/en/statistikas-temas/transport-key-indicators-30711.html
18. Port of Klaipeda- Statistics. Available: http://www.portofklaipeda.lt/uosto-statistika
19. Statistics Lithuania. Available: http://www.stat.gov.lt/en/pages/view/?id=1349
20. Strategy of responsible peatland management. International Peat Society. Available: http://www.peatsociety.org/sites/default/files/files/srpmwebversion.pdf. 2010.

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