



MULTI-CRITERIA CARGO FORECAST ON EAST-WEST TRANSPORT CORRIDOR BETWEEN KLAIPEDA AND KARLSHAMN

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1. Introduction

Multi-criteria cargo or passenger flows forecast method include different factors, which influence on flows. Main factors, which are included in multi-criteria method are:

- Global economical situation;
- Hinterland or Country economical situation and possible changes;
- Transport system capability and its development plans;
- Countries people buying capability of the different commodity groups;
- Competitors actions and development plans;
- Factors, which has influence on cargo flows, for example fertilizers using in agriculture and its possible influence on cargo flows;
- Possible political influence on cargo flows and transport corridors;
- Possible Administrative changes and its possible influence on flows;
- Other additional factors, such as environmental cataclizmes, war actions and so on.

Multi-criteria forecast method used in many sectors and by this method could be received more accurate forecast results.

2. Theoretical basis of the multi-criteria forecast method

Multi-criteria (elastic) method could be finding in many references, but main Multi-criteria dependents could be expressed as follows [2]:

$$Q_T = (Q_0' + BT)M \quad (1)$$

Where: Q_T - forecast flow for T period;

Q_0' - flow in last statistical point;

B - forecast coefficient;

T - forecast period;

M - Multi-criteria coefficient, could be calculated as follows:

$$M = \sum (K_m F_m) \quad (2)$$

Where: K_m - weight coefficients, sum of coefficients in all cases must be 1;

F_m -factors, in point Q_0 should be equal to 1.

Factors coefficients could be calculate by matrix method if it is enough initial data, as well could be used for the finding coefficients experts or other methods. As example Ro-Ro transportation is very „sensual“ to economical, political and other changes, because Ro-Ro transportation mainly used for the final products, which request fast payment.

In case using matrix method factors weight coefficients could be calculate as follows [1, 2]:

$$K_{m1} = \begin{vmatrix} F_{m11} & F_{m21} & F_{m31} & F_{m41} \\ F_{m12} & F_{m22} & F_{m32} & F_{m42} \\ F_{m13} & F_{m23} & F_{m33} & F_{m43} \\ F_{m14} & F_{m24} & F_{m34} & F_{m44} \end{vmatrix} \quad (3)$$

$$K_{m2} = \begin{vmatrix} F_{m21} & F_{m31} & F_{m41} & F_{m11} \\ F_{m22} & F_{m32} & F_{m42} & F_{m12} \\ F_{m23} & F_{m33} & F_{m43} & F_{m13} \\ F_{m24} & F_{m34} & F_{m44} & F_{m14} \end{vmatrix} \quad (4)$$

$$K_{m3} = \begin{vmatrix} F_{m31} & F_{m41} & F_{m11} & F_{m21} \\ F_{m32} & F_{m42} & F_{m12} & F_{m22} \\ F_{m33} & F_{m43} & F_{m13} & F_{m23} \\ F_{m34} & F_{m44} & F_{m14} & F_{m24} \end{vmatrix} \quad (5)$$

$$K_{m4} = \begin{vmatrix} F_{m41} & F_{m11} & F_{m21} & F_{m31} \\ F_{m42} & F_{m12} & F_{m22} & F_{m32} \\ F_{m43} & F_{m13} & F_{m23} & F_{m33} \\ F_{m44} & F_{m14} & F_{m24} & F_{m34} \end{vmatrix} \quad (6)$$

As example factors weight coefficients for the Ro-Ro transportation on Klaipeda – Karlshamn line, received by matrix method and checked by expert method, on basis analysis Global economic situation during 30 years, Hinterland economic situation during 17 years, analysis of the transport system capacity and Competitors actions during last 20 years and development programs up to 2030 in East Baltic region, political and other tendencies during last 20 years, is taken as [1, 2, 3]:

- Global economical situation – 0.3;
- Countries (hinterland) economical and political situation – 0.25;
- Transport system capacity – 0.15;
- Competitors actions - 0.20;
- Other additional factors - 0.10.

Factors weight coefficients should be analyse for the concrete commodities, transport corridors and so on, that means should be special studies for the concrete conditions.

Factors should be calculate or evaluate on basis perspective economical Countries development programs, transport system development programs, competitors development programs, new plants constructions and so on, which has influence on Ro-Ro transportation.

3. Multi-criteria forecast method used for the EWTC II on Ro-Ro line between Klaipeda and Karlshamn

Ro – Ro transportation very much depend of the GNP and could be used regular 1:2:3, that means in case GNP chang on 1 %, change trade on 2 % and transportation request change on 3 %.

For the EWTC on Klaipeda – Karlshamn line, were calculated on basis available statistics is received results, presented in tables (start from 2012).

Table 1. Global economic situation, changes in % in 2012 - 2030.

Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
GNP changes, in %	0,2	0,5	1,0	1,3	1,4	1,5	1,7	1,7	1,6	1,5	1,0	-0,3	0,0	0,2	0,6

Years	16	17	18	19 (2030)
GNP changes, in %	0,8	0,9	1,0	1,1

Ro-Ro transportation request link with regular 1 : 2 : 3.

Table 2. Ro – Ro transportation forecast in %, depend global economical situation (for runnig year is taken as 100 %, or used coefficient 1, F_{m1}).

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ro-Ro transportation request in %,	1,6	2,1	5,1	9,0	13,2	17,7	22,8	27,9	32,7	37,2	40,2	39,3	39,3	39,9	41,7

Year	16	17	18	19 (2030)
Ro-Ro transportation request in %,	44,1	46,8	49,8	53,1

Countries (hinterland) Ro-Ro transportation request.

Table 3. Hinterland GNP forecast for the 2012 - 2030 years.

Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Hinterland GNP	0,8	1,8	3,1	3,5	3,7	4,1	4,5	4,4	3,2	2,0	-1,0	-4,5	-6,0	-1,1	0,6

Years	16	17	18	19 (2030)
Hinterland GNP	0,9	1,2	1,5	1,8

Ro – Ro transportation faktor depend Hinterland GNP situation for the forecast period.

Table 4. Ro –Ro transport factor, in %, F_{m2} ,

Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ro-Ro transportation request in %	2,4	7,8	17,1	27,6	38,7	51,0	64,5	77,7	87,3	93,3	90,3	76,8	58,8	55,5	57,3

Years	1	2	3	4
Ro-Ro transportation request in %	60,0	63,6	68,1	73,5

Transport system development programs, which link with Ro-Ro cargo transportation, depend on terminals, access to terminals and so development on planning period in Klaipeda and Karlshamn port and regions.

Table 5. Transport system development link with Ro – Ro cargo factor coefficient F_{m3} for the forecast period (2012 – 2030).

Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ro-Ro transportation	1,0	1,0	1,0	1,1	1,2	1,3	1,5	1,5	1,5	1,6	1,8	1,8	1,5	1,5	1,8

Years	16	17	18	19
Ro-Ro transportation	1,8	1,8	1,8	2,0

Competitors actions and its development programs, which can take part of the Ro-Ro cargo flow and influence on EWTC.

Table 6. Competitors influence factor F_{m4} .

Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Competitors influence	1	1	1	0,9	0,9	0,9	0,9	0,7	0,7	0,7	0,7	0,7	0,75	0,75	0,75

Years	16	17	18	19 (2030)
Competitors influence	0,75	0,75	0,7	0,7

Table 7. Other factors coefficient for forecast period (2012 – 2030) (F_{m5}).

Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Other factors	1	1	0,7	0,8	0,8	1	1	0,7	0,8	0,9	1	1	0,7	0,9	1

Years	16	17	18	19
Other factors	1	1	0,9	0,8

For the EWTC on line Klaipeda – Karlshamn multi-criteria forecast coefficient for the forecast period (M), presented in table 8.

Table 8. Multi-criteria forecast coefficient (M) calculation results.

Years	1(2012)	2	3	4	5	6	7	8
$K_{m_1} \cdot F_{m_1}$	0,3018	0,3063	0,3153	0,3270	0,3396	0,3531	0,3683	0,3837
$K_{m_2} \cdot F_{m_2}$	0,2560	0,2695	0,2928	0,3190	0,3468	0,3775	0,4112	0,4442
$K_{m_3} \cdot F_{m_3}$	0,1500	0,1500	0,1500	0,1650	0,1800	0,1950	0,2250	0,2250
$K_{m_4} \cdot F_{m_4}$	0,2000	0,2000	0,2000	0,1800	0,1800	0,1800	0,1800	0,1400
$K_{m_5} \cdot F_{m_5}$	0,1000	0,1000	0,0700	0,0800	0,0800	0,1000	0,1000	0,0700
M	1,0078	1,0258	1,0281	1,0710	1,1264	1,2056	1,2845	1,2629

Table 8 continuation.

Years	9	10	11	12	13	14	15
$K_{m_1} \cdot F_{m_1}$	0,3981	0,4116	0,4206	0,4179	0,4179	0,4197	0,4251
$K_{m_2} \cdot F_{m_2}$	0,4682	0,4832	0,4758	0,4420	0,3970	0,3888	0,3992
$K_{m_3} \cdot F_{m_3}$	0,2250	0,2400	0,2700	0,2700	0,2250	0,2250	0,2700
$K_{m_4} \cdot F_{m_4}$	0,1400	0,1400	0,1400	0,1400	0,1500	0,1500	0,1500
$K_{m_5} \cdot F_{m_5}$	0,0800	0,0900	0,1000	0,1000	0,0700	0,0900	0,1000
M	1,3113	1,3648	1,4064	1,3699	1,2599	1,2735	1,3443

Years	16	17	18	19 (2030)
$K_{m_1} \cdot F_{m_1}$	0,4323	0,4404	0,4494	0,4593
$K_{m_2} \cdot F_{m_2}$	0,4000	0,4090	0,4202	0,4338
$K_{m_3} \cdot F_{m_3}$	0,2700	0,2700	0,2700	0,3000
$K_{m_4} \cdot F_{m_4}$	0,1500	0,1500	0,1400	0,1400
$K_{m_5} \cdot F_{m_5}$	0,1000	0,1000	0,0900	0,0900
M	1,3523	1,3694	1,3696	1,4231

Multi-criteria forecast coefficient (M), presented on graphical version shown changes of the mention coefficient during next 19 years.

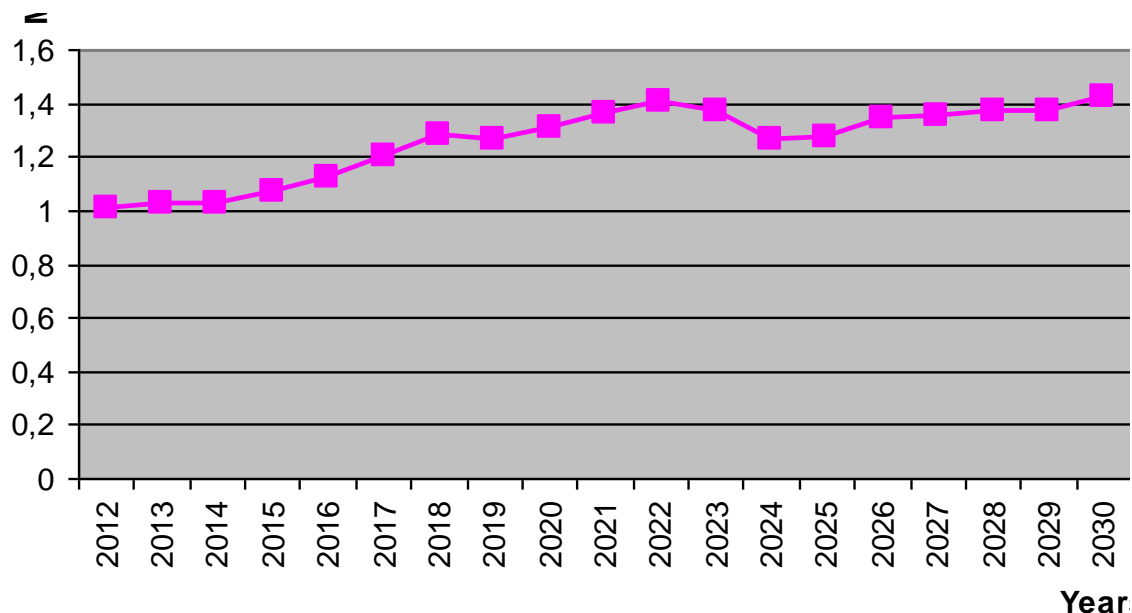


Fig. 1. Multi-criteria forecast coefficient (M) for the Ro-Ro transportation on Ro-Ro line Klaipeda – Karlshamn for the next 19 years up to 2030.

For the correct calculation it is very important statistical data basis. For the using multi-criteria forecast method it is necessary very cheerfully analyze each factor and factors weight and receiving results.

Table 9. Ro-Ro transportation statistics on EWTC during last 14 years and between Klaipeda and Karlshamn during 2006 – 2011 (Ro-Ro line was creating in 2005).

Years	2006	2007	2008	2009	2010	2011
Ro-Ro cargo units x 1000	40,3	42,8	43,6	38,3	47,7	57,3

On basis statistical data for the last 6 years are calculated: coefficient $B=1743$, Ro-Ro cargo flow in 15 years (units) should 86876 units, mathematical waiting 45015 units, forecast accuracy $e = +/- 6810$ Ro-Ro units. Variation coefficient $\delta = 15,1 \%$.

On basis multi-criteria forecast method, for the EWTC on line Klaipeda – Karlshamn received forecast results for the next 15 years, presented in table 10.

Table 10. On basis liner and multi-criteria forecast methods are received results for the EWTC corridor on line Klaipeda – Karlshamn (Ro-Ro transport units x 1000) for the next 19 years (up to 2030) (real, pessimistic and optimistic forecast).

Years	1 2012	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19 2030
Ro-Ro units,	59	61	63	65	67	69	71	73	75	77	79	81	83	85	87	89	91	93	95

receiv -ed by liner fore- cast met- hod																			
Ro- Ro units, rec- eived by multi- crite- ria met- hod	60	63	65	70	75	83	91	92	98	105	111	111	105	108	117	120	125	127	135
Pessi- mistic fore- cast	53	56	58	63	68	76	84	85	91	98	104	104	98	101	110	113	118	120	128
Opti- mis- tic fore- cast	67	70	72	77	82	90	98	99	105	112	118	118	112	115	124	127	132	134	142

Transport units x 1000

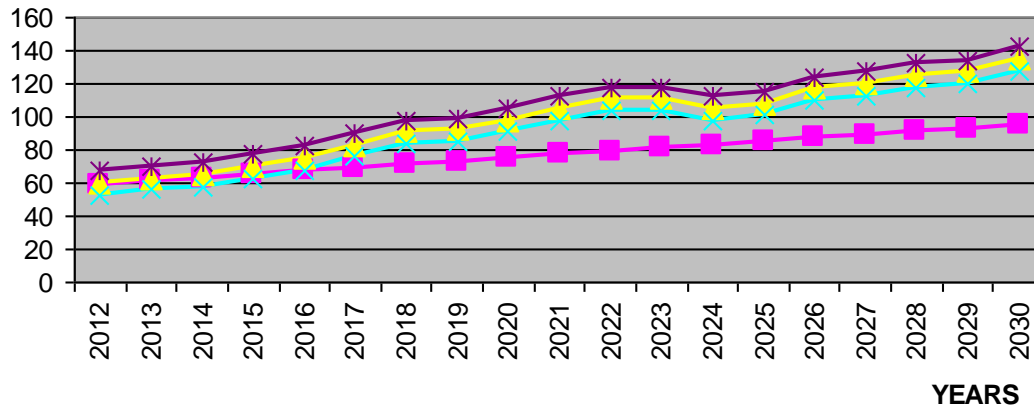


Fig. 2. Liner (red line) and multi-criteria (yellow line) Ro-Ro transport units on EWTC on line Klaipeda - Karlshamn forecast and forecast accuracy (limit by easy blue – pessimistic scenario and violet lines – optimistic scenario)

4. Conclusions

Presented multi-criteria forecast method and its results for the Ro-Ro shipping line Klaipeda Karshamn and testing in first 4 months 2012 shown, that method could be used in other EWTC II sections.

5. REFERENCES

1. Paulauskas, Vytautas. Logistika: monografija / Klaipėdos universitetas. Klaipėda, Klaipėdos universiteto leidykla, 2007. 256 p. ISBN: 978-9955-18-225-2. (On Lithuanian)

2. Paulauskas, Vytautas. Optimalus uostas: monografija/ Klaipėdos universitetas. Klaipėda, Klaipėdos universiteto leidykla, 2011. 320 p. ISBN: 978-9955-18-571-0. (On Lithuanian)

3. Paulauskas, Vytautas. Oversize transport in the South Baltic. The Lithuania case. Baltic Transport Journal No 5, 2010 (37). Gdynia, Poland ISSN: 1733 – 6732, 2010, p. 32 – 33.