

VILNIUS GEDIMINAS TECHNICAL UNIVERSITY

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**IMPACT OF CARGO FLOWS
ON PORT DEVELOPMENT**

Summary of Doctoral Dissertation
Technological Sciences, Transport Engineering (03T)

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Introduction

Cargo flows are essential to every port's operation and are subject to the influences by multiple internal and external factors. Depending on those factors, the situation in cargo market varies – cargo flows fluctuate, some decline and instead new ones are formed.

In port development, it is of utmost importance to take into consideration the cargo flow variation. This would enable to evaluate the need for investment. Transport investments, the seaports actually, usually are tremendous and pay off on long-term schedule. Given the insufficient investment, the transport system will fail its efficient cargo processing thus causing huge delays of ships, railway and road transports. Excessive investment would mean vast funds needlessly frozen that may never return and should rather be administered for other fields.

Therefore forecasting of cargo flows remains a most important issue in port development substantiation, on which depends the choice of development strategy and possibility to evaluate their consequences and find out the best solution.

Relevance of the Problem. Substantiation of port development is related to the accurate cargo flow forecasting. The key problem is that mathematical statistic forecasting methods that are apt to transfer the trends of past into future, are found incapable of assessment of a potential impact from certain factors on the cargo flows. It is therefore necessary to establish how to forecast cargo flows with evaluation of certain factors, that might cause considerable impact on ports or port environment (restriction of a certain cargo flow, construction of new ports etc.).

The Purpose of the Dissertation is to analyze and specify the capability of cargo flow forecasting in ports, through assessment and modelling the distribution of cargo flows throughout competitor ports, by considering certain factors that might cause considerable changes into ports or port environment.

Key Tasks of the Work:

- to generalize the quantitative and structural changes of cargo flows on the Eastern Baltic ports, in order to establish reasons for cargo flow changes;
- to analyze the reasons of cargo flow distribution throughout competitor ports in order to determine the objective factors.
- to carry out a research of possibilities of port complex assessment to be applied in cargo flow forecast;
- to carry out a theoretical research on cargo flow forecasts to be used for substantiation of port development;
- to model the cargo flows throughout the Eastern Baltic ports, while considering certain factors (restriction of a certain cargo flow, construction of new ports etc).

Scientific Novelty. Specified cargo flow forecasting and its application in port development substantiation by taking into consideration the impact of certain factors that might cause considerable impact on ports or port environment. Specified methodology of modelling of cargo flow distribution across competitor ports.

Main Statements of the Dissertation:

- the results of assessment of cargo flow variation on the Eastern Baltic ports;
- the components of port complex assessment that are to determine the selected efficiency criteria;
- the methodology of cargo flow forecast for substantiation of port development.

Methods of Investigation: Statistical analysis and forecasting methods and method of complex analysis have been applied in the course of investigation.

Structure of the work. The work consists of the introduction, 5 chapters, conclusions, list of literature sources and 8 supplements. The work has been issued on 120 pages, including 17 tables and 26 figures.

Approbation of results. Main principles of the dissertation are approbated in 3 scientific conferences and 8 scientific published works.

1. Survey and analysis of the literary sources

The summarizing of results of scientific research works leads to following conclusions:

- the issues of port development modelling and optimization have been thoroughly discussed by either Lithuanian and foreign researchers. However for proper employment of these methods multiple initial data are required whose accuracy determines the final results.

- the initial data for port development are the existing and forecasted cargo flows. A lot of studies dedicated to cargo flow forecasts and their reliability have been based on the mathematical statistic forecasting methodology. These methods transfer the past trends into future, and enable forecasting under constant unchanging conditions.

- foreign studies emphasize that under rigid competition, market situation can change very rapidly, and therefore the forecasts obtained through mathematical statistic methodology will thus be inaccurate and wry.

Hence the scientific issue shows up – on how to forecast the cargo flows by taking into consideration the impact of certain events that might cause considerable effect on ports or port environment.

2. Cargo flow analysis on the Eastern Baltic

Over the last decade, the gross cargo flow has been steadily increasing even under the great economic recession periods, i.e. in 1991-1993 after collapse of the Soviet economy, and in 1998-1999 during the economic crisis in Russia.

Some ports feature different nature of cargo flow variation. It should be taken into account that flow decline in some ports have not been accidental:

- in 2001 Klaipeda Port saw a considerable drop in metal flow due to two external factors: increased railway rates for Russian-made metals and import restrictions of Russian-made metals into USA;

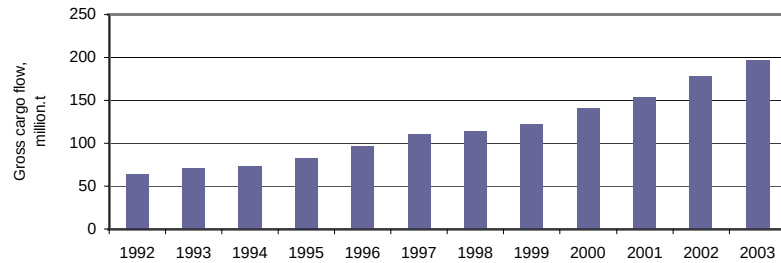


Fig. 2.1. Gross cargo flow through the Eastern Baltic ports

- in 2002, 2003 Ventspils Port suffered a considerable drop of cargo flow due to suspended oil piping. The official reason for the termination of oil supply was a reorganization of oil piping into port of Primorsk.
- In 2003 Tallinn Port experienced flow decrease due to ice-hindered navigation.

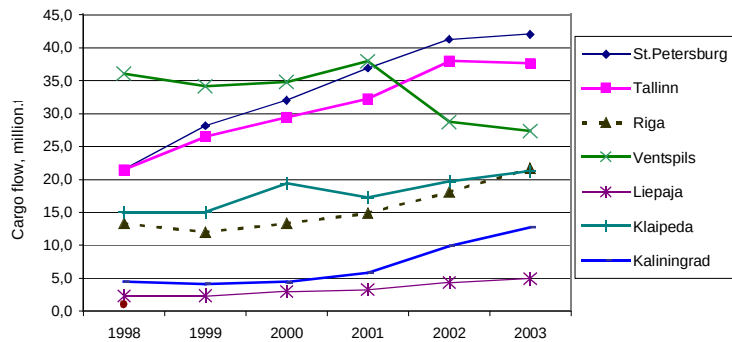


Fig. 2.2. Cargo flows through various ports

We could thus single out these common principles:

- under normal situation, the flows tend to continuously change;

- external factors in port environment cause sudden changes;
- there is no direct subjection between port characteristics and cargo flows.

3. Methods of cargo flow analysis in ports

Factors to impact the cargo flow

A customer, while choosing one or another port is merely seeking the most favorable option that can be named as the selected efficiency criterion. Mostly efficiency criteria are featured as the gross costs of a logistic system. Other criteria like shortest delivery time or accuracy to a fixed schedule are taken as main criterion only in specific cases.

We shall analyze an example of how cargo flows are affected by berthing draft - one of the key characteristics of the port. To simplify, we can assume that a single subject coordinates the whole process from sender to recipient.

To a client, the port draft matters as much as it affects the gross costs of the logistic system. In this case, the bigger ships are operated, the lower freight costs are incurred. However once the shipment is made in small consignments on low-drafted vessels, the port draft in general will be of no concern to the client.

In summary of above we can maintain that any characteristic of a port or port environment matters to the client to that extent as to how much it affects the selected efficiency criterion.

When investigating the influence of the factors toward the efficiency, we have to deal with a problem that many values such like freight costs or cargo rate are merely either negotiable or confidential. The latter indices are very convenient for practical uses yet are of little value for research that is based on objective and available data.

The above factors more or less are influenced by objective quantitative characteristics of ports and port environment. For instance, transport cost has to be proportionate in respect to transport distance, since all the expenditure and costs involved depend on the distance.

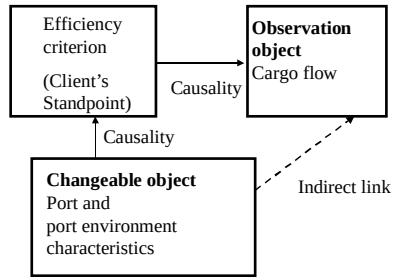


Fig. 3.1. Cargo flows as interlinked with internal and external factors

Delivery time is affected by the distance, number of border-crossings en route etc. We shall refer to these objective and uniformly determined data (total distance, number of border-crossings) as basic characteristics that we will use for to establish a complex port assessment model.

Table 3.1. Comparison of efficiency and port assessment criteria

Criteria	Advantages	Drawbacks
Selected efficiency criteria	Reflect the causality in respect to the cargo flows	Exact (often confidential) data required
Port assessment criteria	Available and objective data are used	Reflect indirect relation to cargo flows

Basic data and values are to comply with the following requirements:

- basic characteristics have to be uniformly determined in quantitative terms and publicly accessible;
- basic characteristics have to make influence on the selected efficiency coefficient.

So that to enable assessment of a port in respect to the rival ports, the entire route has to be considered: hinterland, port and overseas regions.

assessment, or by investigating the influence of basic data onto the selected efficiency.

For different cargo, specific basic characteristics will be different. In oil transit, for instance, the port draft parameter is of immense importance, whereas for small container vessels (on the Baltic) it is of minor consequence.

Cargo flow forecasting model

Taking for instance the value of cargo flow from t_0 to t_1 that is equal to function $Q = f_1(t)$. Cargo flow analysis for the period of time $t_1 - t_2$ is based on this function. Yet at the moment of time t_2 a certain change takes place (a rival port opens, improved parameters of the port under research).

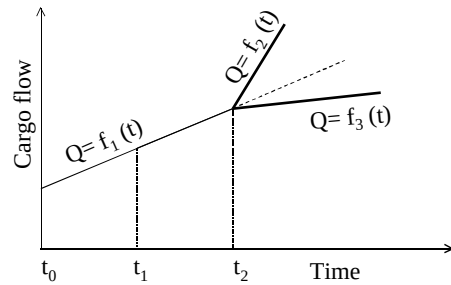


Fig. 4.1. Cargo flow forecast inadequacy under a changing situation

Then the situation afterwards (time t_2) becomes unpredictable, because function $Q = f_1(t)$ is no longer valid (due to the changed situation), meanwhile another regressive model cannot be built up as there are no background data.

Many a researcher introduces optimistic scenario to reflect improvement in situation, and pessimistic scenario for the deterioration. Such an assumption can be followed for assessment of changes caused by unpredicted circumstances. Yet this fails to reveal the gist of the process itself.

The general demand of transport depends on the external factors to which ports have no affect. Therefore, cargo flow increase or decrease at a port, under the same level of foreign trade, is possible only by re-distribution of cargo flows among the ports.

So the rival ports form a system where change in a single component parameter, many other parameters are due to change. Furthermore, the objects like railway, shipping lines that interact with rival ports' system components are of considerable importance. Such objects are considered to be the environment of the system, or in our case – port environment.

We can assume that cargo flow variation at certain ports is proportionate to a certain derivative value that contains the whole of port and port environment data, that we relatively name u . It will mean the impact of port and port environment in respect of the efficiency and will be equaled to the complex port assessment value. Then a specific cargo flow in the region can be determined as below:

$$\begin{cases} \Delta Q_i = u_i \Delta Q \\ \sum u_i = 1 \end{cases} \quad (4.4)$$

The forecast algorithm is as follows:

- forecast of a gross flow for a certain cargo in the region;
- selection of complex port assessment criteria;
- determination of complex port assessment criteria weight coefficients;
- complex port assessment under current situation and comparison with actual cargo flow changes;
- complex port assessment under a changing situation;
- forecast on cargo flow distribution throughout separate ports in accordance with complex port assessment.

The model offered can be used for substantiation of the port development. In this event it is important to forecast the expected flow variation that determines change of terminal revenues and port dues.

The above model reliability can be evaluated in three phases.

1. The inadequacy of the gross cargo flow forecast:

$$Q = f_Q(t) + e_1 \quad (4.5)$$

where $f_Q(t)$ - cargo flow dependence on time function (trend);

e_1 - error of the gross flow forecast assessing the effect of stochastic factor. This random variable is evaluated according to the statistic values of data available;

2. The inadequacy of forecast of the gross flow distribution throughout separate ports:

$$Q_i = Q f_{ui}(t) + e_2 \quad (4.6)$$

where $f_{ui}(t)$ - a separate port's value of complex port evaluation figure dependence on time function;

e_2 - error of the gross flow distribution inadequacy to the complex port assessment parameter.

This error occurs because the complex port assessment model either has not covered all of the factors or has made a wrong assessment of a specific factor influence on the complex port assessment criteria. This random variable is calculated based on the statistic data available.

3. The inadequacy of assessment of a specific factor influence on cargo flow:

$$Q_i = Q f_{ui}(t) + e_2 + e_3 \quad (4.7)$$

where e_3 - the error of a specific factor influence on the cargo flow.

This error occurs when modeling changes in port or port environment and separate component's impact on the efficiency criteria has been miscalculated. In this case we cannot calculate the

statistic data of the error since there are no background parameters, i.e. random value is indeterminate.

Hence the importance of the weight coefficients of port complex assessment components shows up. They account for the reliability of the results obtained and the possibilities of employment of the whole model. This indeterminacy can thus be decreased by means of additional research on the modelled factor.

Assessment of cargo flow impact on port development

Port facilities can be evaluated in terms of several aspects:

1. Economical. Each terminal features an appropriate economically optimum cargo traffic. If the cargo flow is either very low or very high, the economic result can be negative, though technologically the terminal is capable of operations.

2. Navigational. With the excessive cargo flow it is impossible to ensure the shipping safety and well-timed operations, in particular on those routes that contain locks or complicated shipping channels. Such situation has occurred on the Black Sea following the imposed restrictions to oil tanker traffic at night through the straits. Although the Black Sea ports maintained a sufficient cargo flow and port capacities in reserve. Yet the navigational throughput would hinder the growth of handling rates.

3. Capacity of inland transport network. The worldwide experience shows that some ports can survive only through redistribution of cargo flows, i.e. only by re-loading goods on the basis ship to ship. However on the eastern Baltic ports almost entire cargo flow has been on the inland transport to ship model and vice versa. Inland transport networks that service ports are of the limited throughput capacity. That can limit the throughput of the entire port.

4. Cargo handling potential of the port terminals. This aspect is introduced on a wider scale. The productivity of port terminals is conditioned by the following factors:

- berth throughput capacity;
- storage facilities;
- inland transport servicing facilities.

In view of optimization thereof, the above factors feature different potentials.

Berth throughput capacity is determined by the ship size it can accommodate and cargo handling facilities available, i.e. berth throughput is subject to the impact of the most expensive elements of port infrastructure and superstructure whose adjustment imply high-cost and long term issues, and sometimes is utterly impossible.

Quays are one of the most expensive items within port infrastructure therefore their optimization and utmost capacity implementation may lead to a maximum effect.

Storage facilities are determined by the storage capacity and store equipment available. There is vast potential for adjustment and renovation here. It is possible to carry out a quantitative enlargement of storage facilities through expansion of storing space at the account of reserve territories, by removing the unnecessary premises and a qualitative expansion through optimizing the cargo distribution within a terminal.

Inland transport servicing facilities are based on the available equipment that in terms of price in comparison to other terminal issues is relatively low, and the throughput of access roads.

Based on the above conditions, we build a terminal optimization model:

$$Q_{exem} \leq Q_{max} = Q_{quay} \leq Q_{stor} \leq Q_{inl} \quad (4.8)$$

where Q_{exem} - examinee capacity of the terminal;

Q_{max} - maximum capacity of the terminal;

Q_{quay} - quay facilities throughput;

Q_{stor} - storage facilities;

Q_{inl} - inland transport processing facilities.

If the terminal does not meet the model condition, its optimization is expedient in order to achieve the utmost throughput and attract maximum cargo transit at the least investment:

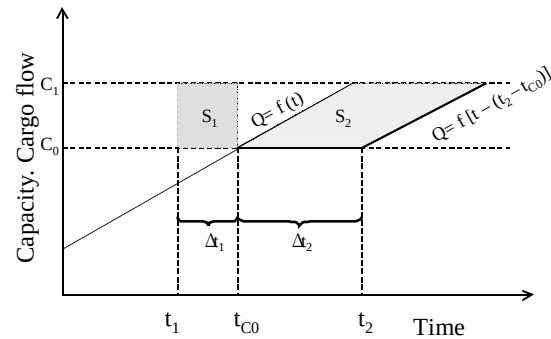


Fig. 4.2. Assessment of time factor in port development

Terminal capacity at the initial moment of time is C_0 . Through further development or optimization of the terminal it is possible to increase the terminal capacity by C_1 . If they have failed to foresee a potential need for terminal expansion in due time, it is likely that at a certain moment of time t_{co} cargo flow will level up with designed capacity of the terminal. Then the cargo flow will be suspended until the terminal capacities are renewed. Terminal capacity adjustment takes place for a particular period which involves research, investigation, design and reconstruction with eventual implementation into operation.

When the reconstruction is overdue:

- we shall encounter the shortage of capacity what will lead to part of cargo transits left unprocessed;
- excess cargo flow will stream through competitor ports and will be hard to return.

When the reconstruction is premature we shall operate with excess capacity that were not necessary (effect of frozen investment for some period of time).

Thus port development investigation is not limited to setting the required capacities alone. One of the critical issues in port development

is the minimization of time gap between the implementation of new facilities and the moment of time when they are actually needed.

5. Cargo flow influence on port development analysis

Application of port complex assessment model

Complex port assessment model covers the following factors:

Port infrastructure parameters (draft along the specialized quays) reflect the sizes of ships that can be employed for transport of a specific cargo. Use of larger vessels enables the decrease in shipment rate (per cargo unit) thus enabling to reduce the gross costs of the logistic system.

On the Baltic, small sized container vessels are employed that can be processed at any port, thus this parameter is not important. In oil product transportation, possibly larger ships are used thus the port infrastructure parameters are of immense importance. In fertilizer market, beside the huge cargo batches there are multiple medium-sized batches that are delivered to European ports, thus for these cargoes a port parameter is less important than for oil products.

Distances to the overseas destination ports reflect the delivery term of cargo by ship, freightage rate, and limitation in view of liner shipping schedules. The importance of this factor is minimized by the following circumstances that container carriers on the Eastern Baltic call at several ports in turn. Time factor is not that important for mass cargoes, except those events that the consignments are transported to relatively adjacent European ports on small or medium sized vessels (what is very characteristic of fertilizer transport).

The probability of freezing reflects the possibility of navigational hindrance due to ice condition. Basically, the freezing ports employ icebreakers that primarily tend to service liner ships, therefore navigational hindrances happen only subject to adverse meteorological conditions. Jet icebreaker assistance means extra expense to the shipping company.

This parameter of port is essential to linear shipping where the accuracy to the schedule is of special importance and for oil and oil product market where in the cold seasons of the year is maximum demand for oil product terminal load. Besides navigational hindrances can trigger chain reaction: after the tanks it terminal are full it is impossible to discharge railway tanks where oil products can get frozen and congeal which will affect the discharge later. Railway operator cannot accept the carriages due to the excess number of rail tanks yet undischarged. The refinery cannot deliver the product for due to shortage of empty tanks. The refinery is compelled to cut the production output.

The market size of any country reflects the import and export potential of that country. This characteristic is very influential in respect of consumer goods to be carried by containerships and ro-ro. Yet it has no impact on oil product and fertilizer transits.

The potential of mass cargoes is determined by major plants and factories in the country. In general, the basic parameter is to be considered the annual export rates.

The distance to the major foreign industrial or consumer centers account for the delivery time and costs. In this study we consider Moscow as major consumer center, while the plants in Russia and Byelorussia are treated as major production centers.

Number of border checks implies the chances that the cargos delivery will be delayed mainly due to the problems at border points.

The traffic amount over the last years has reflected the entire complex of factors (loading rate, formality arrangement efficiency etc.), that are taken into consideration by cargo owner or his representative (cargo forwarder) when choosing a transport route for his cargo. This can be named as indirect expert assessment.

Moreover in most cases the new cargo shipments will be very likely transported by cargo owner through the routes already known. Thus in container and fertilizer deliveries this parameter is of high importance.

Oil product shipments in term of technological aspect are considerably simpler so quality factors here are of minor importance.

The chosen weight coefficients of complex port assessment are proportional to the transport costs under different stages of transport process.

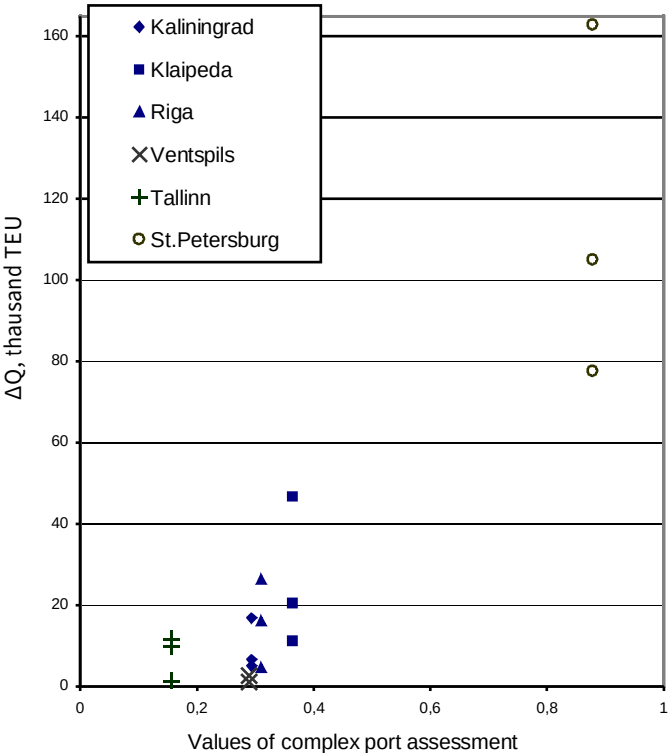


Fig. 5.1. Values of complex port assessment and actual containerized cargo flow variation

Following the complex port assessment in respect of diversity of cargoes: liquids (oil products), bulk cargo (fertilizer), general cargo (containers) it has been ascertained that in containerized cargo there exists a strong subjection between the complex port assessment values and cargo flow variation (correlation factor 0,89). In oil products, the direct dependence between the complex port assessment values and cargo flow variation is fairly weak (correlation factors respectively 0,24 and 0,25).

The following key reasons as having preconditioned the results have been established:

In container market, small shipments prevail therefore the choice of ports is rather a stochastic process, i.e. the clients tend to pick a concrete port more often when the efficiency value or efficiency-related complex port assessment value is higher.

At the initial and final stage of combined transportation, containers are basically delivered by road transport. Due to the huge competition between the carriers, the transport cost is proportional to the actual rates of shipment therefore they can be conveyed in objective criteria (delivery distance etc.).

Mass cargo market is rather closed with a small number of commodity shippers and receivers, so even a solution of a single party involved can change the situation substantially.

Railways that are mostly operated by monopolist companies ship mass cargoes, and their rates hardly reflect the costs for a particular shipment. Such factors like discounts to large-scale clients, capital integration etc., are proven to be of major influence which cannot be rated through complex port assessment scale.

The offered model is applicable to small-batched shipments mostly carried by road. Such normally are container and ro-ro cargo deliveries. The model however does not apply to mass cargo shipments that are delivered to port by railway.

Forecasting of cargo flows

The efficiency of the forecast as produced by the author by 42% exceeds the prognosis obtained by direct application of the regressive

model in respect of Klaipeda seaport container flow data. The complex port assessment research shows Klaipeda to be a best-prospected port for the intended increase of container traffic. This has been sustained by latest data from the recent years: in 2002 container flow through Klaipeda port has increased by 45%, and in 2003 – by even 65%. So this optimistic prognosis is rather evidential.

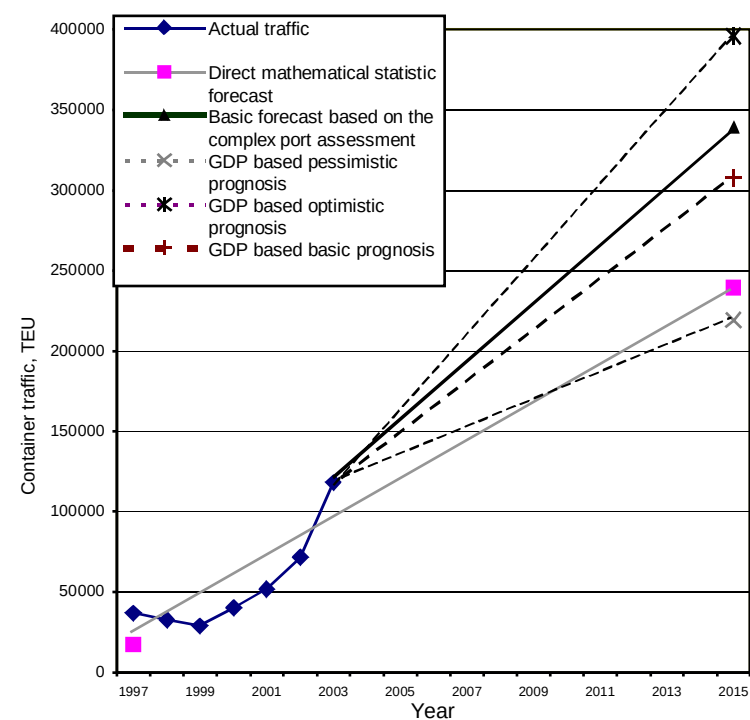


Fig. 5.2. Forecasts achieved through different methods

The basic prognosis of the considered forecasting method is close to the basic prognosis made by researches who used other forecasting model. The forecast is based on the correlation of container traffic with GDP value per capita. Difference is 10%.

Modeling of change in port environment

Containers are one of the best – prospected cargoes whose traffic rates are booming very rapidly. Therefore the shortage of facilities is anticipated. For this reason new container terminals are planed on the Eastern Baltic. We are evaluating a possible impact of new ports into the container traffic. When modeling the parameters of new terminals, we consider the values close to those actually planed on the Baltic.

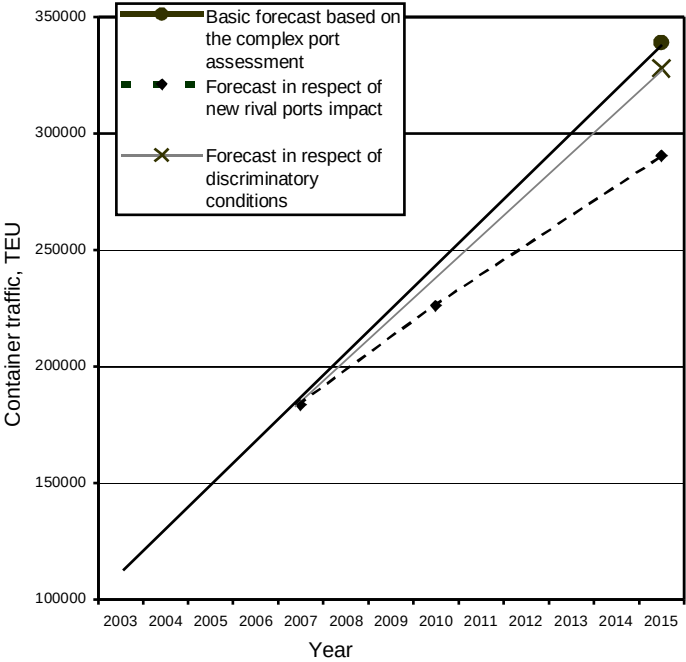


Fig. 5.3. Impact of different factors on container traffic

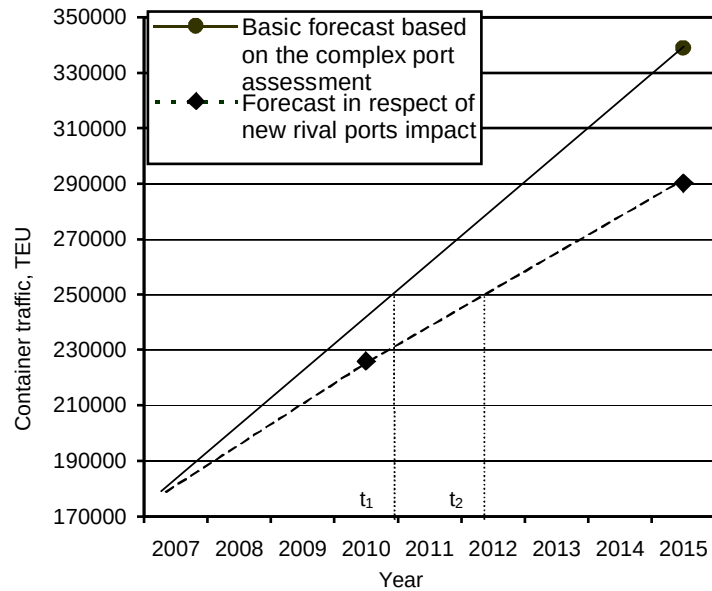


Fig. 5.4. Assessment of new ports impact on port development

Usually the restriction on cargo transit from a certain country of origin is effected through the increase in transport rate or by implementing special customs regulations. Therefore the Russia related cargo traffic limitation into the Baltic ports is modelling by means of increased values of appropriate factor.

The results of the prognosis show that new ports will likely takeover a part of the flow however the result of their complex assessment is lower than that of the existing ports. Given the fact that major container lines have already established routes, new ports are considered only if they feature significant advantages.

Taking into account the construction of new ports on the Baltic, Klaipeda container terminal expansion should be postponed for another eighteen months at least thus enabling to avoid unnecessary premature investments.

Conclusions

1. The research of cargo flow on the Eastern Baltic ports has established that both separate ports and separate cargo flows tend to be subject to different variation schemes. Immense impact on the cargo flows has come from a variety of external political and economical factors.

2. The customer's choice for cargo shipping through certain port is determined by the selected efficiency criteria (which in most cases is the total costs of the logistic system). It has been proven in the dissertation that there is an indirect link between the port and port environment characteristics and cargo flow.

3. The dissertation has proven it possible to choose such objective quantitative components for complex port assessment that would impact the efficiency criteria, i.e. there is causality between the port and port environment characteristics and the efficiency criteria. The direct research of the selected efficiency criteria are limited to the extent that the required data like freight cost, cargo rate etc. are often either negotiable or confidential.

4. The model proposed in the dissertation is based on the established link between the complex port assessment value and cargo flow, i.e. the cargo flow distribution throughout the rival ports is proportionate to the efficiency values and consequently to complex port assessment values.

5. It has been ascertained that for containerized cargo there exists a strong subjection between the complex port assessment values and cargo flow variation (correlation factor 0,89). For oil products and fertilizers, the dependence between the complex port assessment values and cargo flow variation is fairly weak (correlation factors respectively 0,24 and 0,25).

6. The analysis of the conformability of the complex port assessment values to container flows variation has established that in container market, small-sized shipments prevail therefore the choice of ports is rather a stochastic process, i.e. the clients tend to pick a

concrete port more often when the efficiency value or efficiency-related complex port assessment value is higher.

7. The analysis of the imbalance between the complex port assessment values to mass cargoes (oil product and fertiliser) flows variation has established that mass cargo market is rather closed with a small number of commodity shippers and receivers, so even a solution of a single party involved can change the situation substantially. Further, such factors like discounts to large-scale clients, capital integration etc., are proven to be of major influence which cannot be rated through complex port assessment scale.

8. The forecasting methodology as introduced herein can be applied in forecasting of container transits through the Eastern Baltic ports. The accuracy of the methodology has been approbated through comparison to the results of prognosis made by other researches where they used GDP and container flow correlation method. It has been ascertain that the difference between the basic forecast results is only 10%.

9. The forecasting methodology has been applied for the specification of the demand for further development of Klaipeda container terminals facilities. It has been provided that due to the impact of new rival ports the demand for Klaipeda container terminal expansion and new investments is to be postponed for another eighteen months at least. The flow forecast model as produced in the study following its due adoption in future, may be applied not in ports alone, yet on rival-port scale and road transport routes.

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KROVINIŲ SRAUTŲ ĮTAKA UOSTŲ PLĖTRAI

Uostų veiklos pagrindas yra krovinių srautai, kuriems turi įtakos daugybė vidinių ir išorinių veiksnių. Priklausomai nuo jų, situacija krovinių rinkoje kinta — kinta krovinių srautai, vieni nutrūksta, jų vietoje formuojasi nauji.

Vykdant uostų plėtrą, svarbu atsižvelgti į krovinių srautų pokyčius. Tai įgalintų teisingai įvertinti investicijų poreikį. Investicijos į transporto sektorių, konkrečiai į jūrų uostus, yra ypač didelės ir atsiperka per ilgą laiko tarpą. Esant nepakankamoms investicijoms, transporto sistema negalės efektyviai apdoroti krovinių srautų, susidarys laivų, vagonų, automobilių transporto prastovos. Per didelės investicijos — tai be tikslo išaldytos didelės lėšos, kurios neaišku kada atsipirks ir galėtų būti panaudotos kitose srityse.

Taigi krovinių srautų prognozės sudarymas yra vienas svarbiausių uostų plėtros pagrindimo uždavinių, nuo kurio priklauso plėtros varianto pasirinkimas, galimybė paskaičiuoti jų padarinius ir rasti geriausią variantą.

Problemos aktualumas. Uostų plėtros pagrindimas siejamas su tiksliais krovinių srautų prognozėmis. Egzistuoja problema, kad matematiniai statistiniai prognozavimo metodai, perkeliantys praeities tendencijas į ateitį, neviseiškai įvertina atskirų įvykių galimą poveikį krovinių srautams. Todėl būtina ištirti, kaip prognozuoti krovinių srautus, įvertinant atskirus įvykius, galinčius sukelti pokyčius uoste ar uostų aplinkoje (tam tikro krovinių srauto apribojimas, naujų uostų statyba ir pan.).

Disertacijos tikslas — ištirti ir patikslinti krovinių srautų uostuose prognozavimo galimybes, tiriant ir modeliuojant krovinių srautų pasiskirstymą konkuruojančiuose uostuose, įvertinant atskirus įvykius, galinčius sukelti žymius pokyčius uostuose ar uostų aplinkoje.

Pagrindiniai darbo uždaviniai:

- apibendrinti kiekybinius ir struktūrinius krovinių srautų pokyčius Baltijos jūros rytinės pakrantės uostuose, siekiant nustatyti krovinių srautų kitimo priežastis;
- ištirti, kokios priežastys turi įtakos krovinių srautų pasiskirstymui konkuruojančiuose uostuose, siekiant nustatyti objektyvius veiksnius;
- ištirti uostų kompleksinio įvertinimo panaudojimo galimybes krovinių srautams prognozuoti;
- atlikti krovinių srautų prognozių panaudojimo uostų plėtros pagrindimui teorinį tyrimą;
- sumodeliuoti krovinių srautus rytinės Baltijos jūros pakrantės uostuose, įvertinant atskirus įvykius (tam tikro krovinių srauto apribojimas, naujų uostų statyba ir pan.).

Darbo mokslinis naujumas:

Patikslintas krovinių srautų prognozavimas ir jo panaudojimas uostų plėtrai pagrįsti, įvertinant atskirų įvykių, galinčių sukelti pokyčius uostuose ar uostų aplinkoje, poveikį. Patikslinta krovinių srautų pasiskirstymo konkuruojančiuose uostuose modeliavimo metodika.

Disertacijoje ginamos nuostatos:

- krovinių srautų pokyčių Baltijos jūros rytinės pakrantės uostuose vertinimo rezultatai;
- uostų kompleksinio įvertinimo komponentai, išreiškiantys pasirinktą naudingumo kriterijų;
- krovinių srautų prognozavimo uostų plėtrai pagrįsti metodika.

Darbas atliktas naudojant šiuos metodus: statistinės analizės ir prognozavimo metodus, kompleksinės analizės metodą.

Darbo aprobavimas. Pagrindiniai disertacijos teiginiai aprobuoti 3 mokslinėse konferencijose ir paskelbti 8 publikacijose.

Disertacijos apimtis ir struktūra. Disertaciją sudaro: įvadas, penki skyriai, svarbiausios išvados, literatūros sąrašas, priedai. Disertacijos tekstą sudaro 120 lapų. Darbe yra 26 paveikslai, 17 lentelių ir 8 priedai.

Išvados:

1. Išnagrinėjus krovinių srautus Baltijos jūros rytinės pakrantės uostuose, nustatyta, kad tiek atskirų uostų, tiek atskirų krovinių srautai turi skirtingas kitimo tendencijas. Didelį poveikį srautams turėjo atskiri išoriniai politiniai ir ekonominiai veiksniai.

2. Kliento pasirinkimą gabenti krovinį per vieną ar kitą uostą lemia pasirinktas naudingumo kriterijus (daugeliu atveju naudingumo kriterijus yra bendrieji logistinės sistemos kaštai). Disertacijoje įrodyta, kad egzistuoja netiesioginis ryšys tarp uosto ir uosto aplinkos charakteristikų ir krovinių srautų.

3. Disertacijoje įrodyta, kad galima parinkti tokius objektyvius kiekybinius kompleksinio uostų įvertinimo komponentus, kurie turi įtakos naudingumo kriterijui, t.y. egzistuoja priežastinis ryšys tarp uosto ir uosto aplinkos charakteristikų ir naudingumo kriterijaus. Tiesioginiai pasirinkto naudingumo kriterijaus moksliniai tyrimai yra apriboti tuo, kad reikalingi duomenys, tokie kaip gabenimo kaina, krovinio kaina ir pan., dažnai būna sutartiniai ar konfidencialūs.

4. Disertacijoje pasiūlytas autoriaus sukurtas prognozavimo modelis remiasi nustatytu ryšiu tarp uostų kompleksinio įvertinimo kriterijaus ir krovinių srautų, t.y. krovinių srautai tarp konkuruojančių uostų pasiskirsto proporcingai naudingumo kriterijaus reikšmėms, o kartu ir kompleksinio uostų įvertinimo reikšmėms.

5. Nustatyta, kad egzistuoja stipri konteinerizuotų krovinių srautų priklausomybė nuo kompleksinio uostų įvertinimo reikšmių (koreliacijos koeficientas 0,89). Naftos produktų ir trąšų priklausomybė nuo kompleksinio uostų įvertinimo koeficiento reikšmių yra labai silpna (koreliacijos koeficientai yra atitinkamai 0,24 ir 0,25).

6. Ištyrus konteinerizuotų krovinių kompleksinio uosto įvertinimo reikšmių ir faktinių konteinerizuotų krovinių srautų pokyčių atitikimo

priežastis, nustatyta, kad konteinerizuotų krovinių rinkoje vyrauja smulkios siuntos, todėl uostų pasirinkimas artimas tikimybiniam procesui, t.y. klientai tuo dažniau pasirenka konkretų uostą, kuo didesnė yra naudingumo kriterijaus reikšmė ar jį atspindinti kompleksinio uostų įvertinimo reikšmė.

7. Ištyrus masinių krovinių (naftos produktų ir trąšų) kompleksinio uosto įvertinimo reikšmių ir faktinių srautų pokyčių neatitikimo priežastis, nustatyta, kad masinių krovinių rinka yra uždara su nedideliu skaičiumi produkcijos siuntėjų ir gavėjų, todėl net vieno dalyvio sprendimas gali iš esmės pakeisti situaciją. Nustatyta, kad didelę įtaką turi tokie veiksniai, kaip nuolaidos stambiams klientams, kapitalo integracija ir pan., kurių neįmanoma išreikšti uostų kompleksinio įvertinimo komponentais.

8. Sukurta prognozavimo metodika tinka rytinės Baltijos jūros pakrantės uostų konteinerių srautams prognozuoti. Metodikos tikslumas patvirtintas lyginant rezultatus su kitų tyrėjų prognoze, kuri remiasi BVP ir konteinerių srauto koreliacija. Nustatyta, kad gauti bazinių prognozių rezultatai skiriasi tik 10 %.

9. Pasiūlyta prognozavimo metodika panaudota Klaipėdos uosto konteinerių terminalų pajėgumų plėtros poreikiui patikslinti. Nustatyta, kad dėl naujų konkuruojančių uostų poveikio papildomų konteinerių terminalų pajėgumų ir investicijų poreikis nusikeltų pusantrų metų. Pasiūlytas srautų prognozavimo modelis, atitinkamai adaptavus atėityje, gali būti taikomas ne tik uostams, bet ir konkuruojantiems uostams bei sausumos transporto maršrutams.

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