Olli-Pekka Hilmola (editor)

SECOND RESEARCH MEETING HELD AT MOSCOW - STRATEGIC ROLE OF LOGISTICS AND SUPPLY CHAIN MANAGEMENT

LAPPEENRANTA
UNIVERSITY OF TECHNOLOGY

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Olli-Pekka Hilmola (editor)

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Foreword

In the beginning of June 2006 we held the First International Railway Seminar during Innorail days in Kouvola, Finland. As autumn proceeded further on, I had discussions with my colleagues here in Finland as well as in Russia, and the number of people saw the need for the second meeting among researchers concerning the field of logistics and supply chain management. As we take special characteristics from this region into account, such issues as border crossing (EU/Russian border), railways, information systems, efficient transportation mode selections and supply chain management are together establishing the base for operations.

I shall use this opportunity to give sincere thanks for all of the authors from their contributions in this volume – I do hope that discussions during seminar will improve our research works even further. This edited book is without a doubt valuable source for different stakeholder groups (students, managers, directors, governmental officials and researchers); this has been proven with the interest towards our June 2006 research meeting edited volume, since until today this book has been downloaded from kouvola.lut.fi website by approx. 500 times.

We would like to express our gratitude for the city of Kouvola, Finland giving us an opportunity to arrange this second international research meeting concurrently with the annual Innorail Seminar. As our meeting is held at the facilities of prestigious academic institution, which Moscow State University of Railway Transport (MIIT) surely do represents, we would like to express our sincere appreciation for this university giving us needed research meeting venue. We do hope that this second seminar strengthens our research collaboration, and fosters sustainable logistics development in the area.

In Kouvola, Finland October 2006,

Olli-Pekka Hilmola

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Rolling Highway as Ivangorod-Narva Border Crossing Solution

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Abstract

This paper studies the need for a rolling highway border-crossing solution between Ivangorod, Russian Federation and Narva, Estonia (EU). It analyses the reasons for the rolling highway to be the most viable solution for solving the prevailing issues at the above mentioned border crossing point. The research demonstrates that an intermodal transport system, such as a rolling highway, has considerable long-term competitive advantages over the alternative border crossing restructuring projects.

Keywords: border crossing, rolling highway, intermodal, truck, railway, bridge, transit traffic, E20

1. Introduction

Historically, Narva has been known as a traditional centre of international trade. The waterway along the Narva River was established already during the Viking times (5th to 9th century) and it formed one branch of the famous Baltic-Mediterranean waterway that the ancient Russian manuscripts refer to as the 'Route from Varangian to Greece.' The use of the waterway through the Gulf of Finland boomed in the 9th-10th century.

At the crossing point of the Narva River (Figure 1) a trade settlement was established in the 13th century, and in 1345, due to the privileges of King Valdemar IV Attredag of Denmark it became a town. That is birth story of the city of Narva. Medieval Narva played a big role in the Baltic trade system born under the aegis of the Hanseatic League and the Teutonic Order.

From the end of the 15th century, after the Novgorod Republic was joined to Moscow, Novgorod lost its historic role as the intermediary of the economic ties between Russia and Europe to Narva. In the second half of the 16th century, during the Livonian War, Russian Czar Ivan the Terrible conquered Narva, and for the next 20 years the town became the predominant centre for sea trade for Russia.

The new and most important era of prosperity in Narva's history was under the reign of the Swedish Kingdom. That period is regarded as the 'Golden Era' of Narva. Those

days routes through Narva not only connected the Baltics with Russia but also with Persia and Transcaucasia.

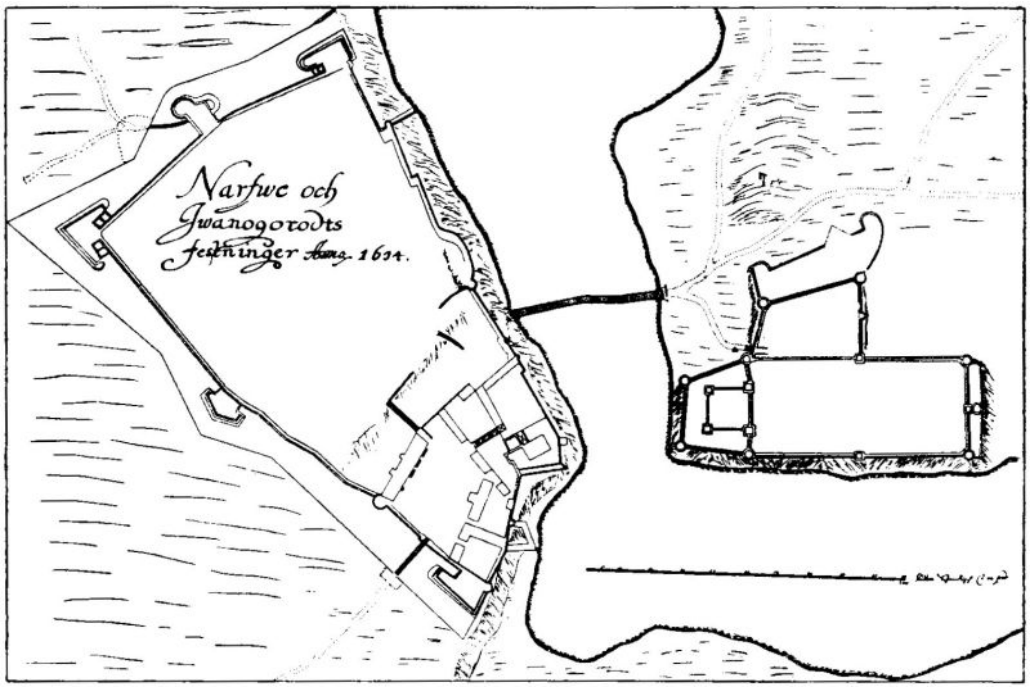

Figure 1. Map of Narva-Ivangorod border-crossing from 1634. (Source: www.narvaplan.ee)

Narva's role as one of Russia's most prominent sea ports started to diminish with the building of the city and the port of St. Petersburg in the 18th century. Estonia's independence in 1991 brought about a critical change. As the Narva River once again became the borderline between two different economic territories it regained its former importance as the transit gate for international trade.

In recent years, Russia's economy has had an average annual increase of 7%. That trend is reflected in the rapid growth of Russia's purchasing power and consumption, in result of which Russia is receiving an increasing flow of transit traffic. In the Baltic region it is mostly reflected in the constant increase in transporting cars, building materials, consumer electronics and FMCG (Fast Moving Consumer Goods). A large share of these goods is transported to Russia by road. Based on Finnish statistics, up to 93% of all eastbound transit traffic via Finland is road transport based (Märkälä, Jumpponen, 2006).

In the Estonian corridor, the relation in eastbound transit flow is similar and the domination of road transport is significant. What makes it different from the Finnish experience is the large share of vehicles registered in the European Union in addition to Russian and Estonian transit companies. The most frequent are trucks registered in Lithuania, Latvia, Poland, and Holland. That trend puts increasing pressure on the Russia-Estonia border crossing points, the most heavily used of which is the Narva-Ivangorod crossing. After Estonia joining the EU in 2004 the rate of border crossing at the Narva-Ivangorod crossing point abruptly increased by 40% (Figure 2).

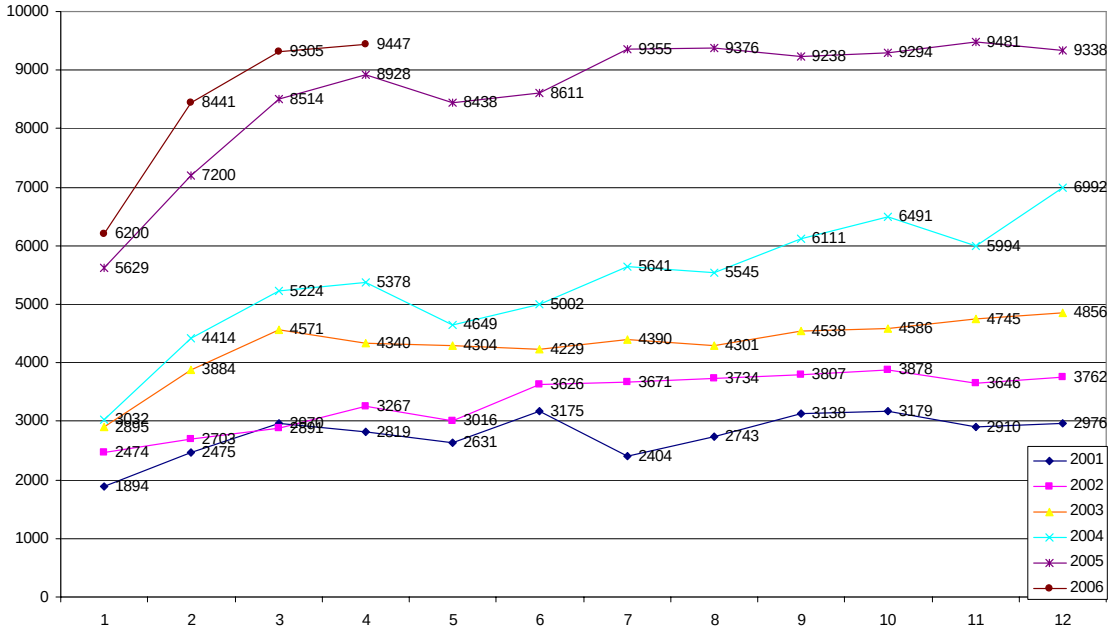

Figure 2. Border crossing dynamics of Ivangorod- Narva road, 2001-2006, east- and westbound border-crossings per month. (Estonian Tax and Customs Board, 2006).

The existing Ivangorod-Narva border crossing point over the Narva River bridge on Route E20 (Figure 1), is about to reach its maximum capacity. The present capacity is up to 350 trucks in 24 hours. In the worst case scenario it takes an eastbound truck up to 120 hours to cross the border. The predominant factors in the border-crossing point's capacity and efficiency are:

- Limitations of Russian Customs and the high number of departments on the border;

- Share of carriers from other countries in Estonia-Russia road border crossing points;
- Border crossing capacity of other countries bordering Russia;
- Operation of other transit channels (transit to Russia via Byelorussia);
- Single line-up or non-sorting of vehicles (Estonian Tax and Customs Board, 2006).

It is clear that the location of the more than 800-year-old border bridge in the center of town does not meet the needs of intensity and rapid volume growth of the present-day road transit between the EU and Russia. At the same time, finding a new and more suitable location for the border crossing point is not an easy task. The Narva River, the existing infrastructure, environmental issues and city planning on both sides of the border put strict restrictions on building a new road bridge and possible relocation of the border crossing point for heavy road traffic.

2. Possible standard solutions

In 2005, the governments of Estonia and Russia established a committee to investigate the location of the new road bridge and border crossing point. On January 26, 2006, a work group meeting consisting of Estonian and Russian delegations to discuss the future bridge took place in Narva. The Estonian delegation was lead by Andres Tint, Vice-Chancellor of the Ministry of Economic Affairs and Communication. The Russian delegation was headed up by Oleg Lomanov, the Deputy Director of the Office of National Policy on Road Economy, Car and City Passenger Transport of the Ministry of Transportation of the Russian Federation. As a result of the meeting the parties agreed upon a Protocol of Intention. According to the document, the first step in the project of renewing the border crossing point on the Narva River is to put together a technical-economic rationale (Smirnov, 2006). Under consideration are the following three options, all of which have considerable weaknesses and none of which entirely solve the problem:

- Reconstructing and continuing to use the existing bridge;

- Establishing a new border bridge with accompanying infrastructure in Riigiküla, 8 km to the North-West of Narva;
- Establishing a new road bridge immediately next to the railway bridge based on the Soviet Ivangorod-Narva general plan.

2.1. Continuing to use the existing bridge

The border between the Russian Federation and the European Union on Route E20 Tallinn-St. Petersburg is the Narva River. Border crossing is over the bridge located in the hearts of the city centers of Narva and Ivangorod. The location of the bridge is historical, in actuality the towns were built, during centuries, around the bridge. Such a location is acceptable for small cars and buses; however, it does not fit the needs of rapidly growing cross-border truck traffic. It is the most efficient border crossing point between Russia and Estonia with a crossing capacity of approximately one-third higher than that of the other two road crossing points: Kunitshnaja Gora-Koidula and Shumilkino-Luhamaa (Figures 3 and 4).

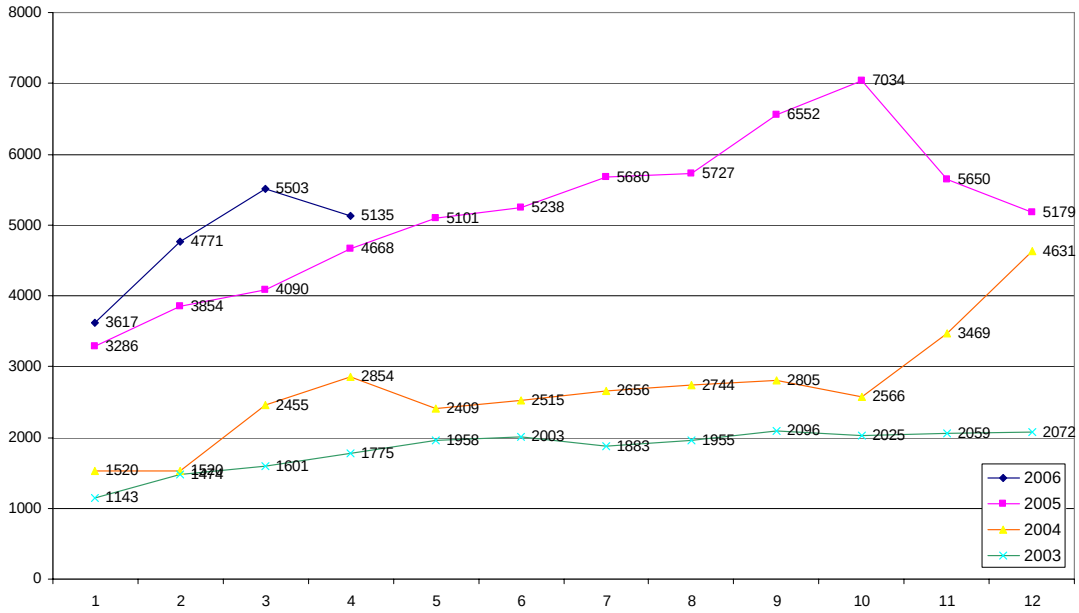

Figure 3. Dynamics of the Kunitshnaja Gora-Koidula road border crossing point, 2003-2006, east- and westbound border crossings per month. (Estonian Tax and Customs Board, 2006).

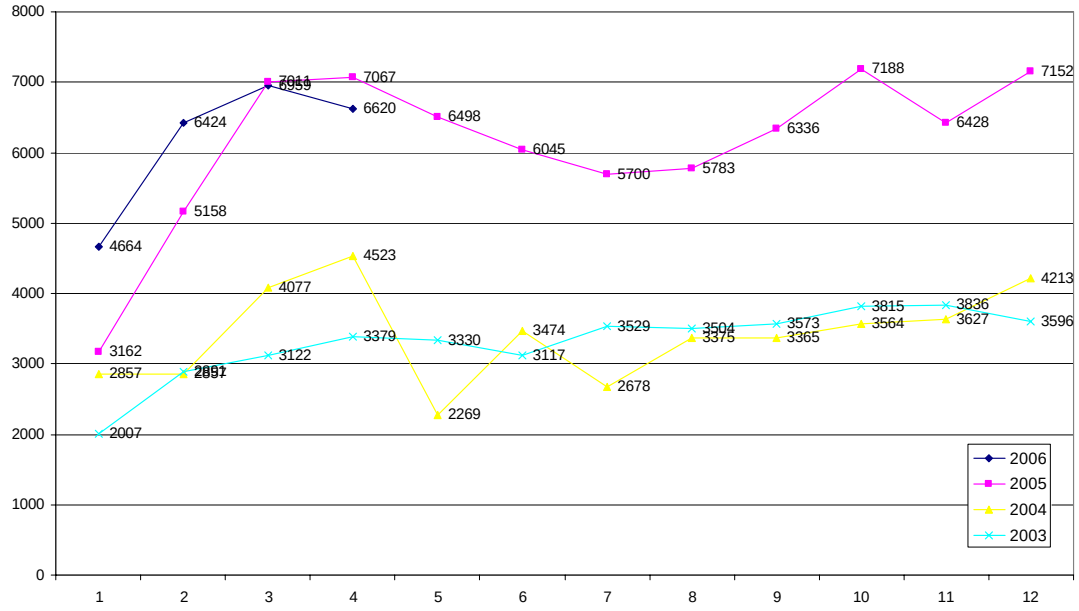

Figure 4. Dynamics of the Shumilkino-Luhamaa road border crossing point, 2003-2006, east- and westbound border crossings per month. (Estonian Tax and Customs Board, 2006).

The existing Ivangorod-Narva border crossing point is about to reach its capacity limitation. The present capacity is up to 350 trucks in 24 hours (east- and westbound). The minimal time needed for a truck to pass the Customs on the Estonian side is six minutes (Estonian Tax and Customs Board, 2006). That means that in ideal conditions one border point lane can clear up to 10 trucks an hour. The theoretical capacity can be calculated by multiplying that figure with the number of lanes at the customs zone. There are two eastbound and two westbound control lanes for heavy traffic in the customs zones. Ideally, that calculation means 240 vehicles per 24 hrs per lane. That, however, is not a realistic picture. In the worst case scenario it can take an eastbound truck up to 120 hours to cross the border. For example, in August 2006 the border point's eastbound capacity was only eight trucks in 24 hrs.

Stopping trucks heading for Russia on the bridge for preliminary check inevitably creates a bottle-neck. Thus, currently it is not the bridge itself posing the problem but the usage methods of it. By reorganizing customs procedures on crossing by the Russian side it would be possible to increase the computational processing capacity at the present Ivangorod-Narva Route E20 border crossing point to 480 trucks in 24 hrs (bringing the

combined east- and westbound processing up to 960 trucks). It can thus be deduced that the peak performance of the current border point is at most 73%. The growth dynamics of transport volumes demonstrates that achieving the maximum processing capacity would help win time but it would not be a sufficient long-term solution.

Based on the Russia-bound road transit statistics of the Finnish Customs, the average annual transit volume increase is 13% (Finnish Customs, 2006). Kilpeläinen demonstrates correlations between Russian import and the volume in eastbound transit traffic via Finland (Kilpeläinen, 2004). Based on that, prognosis can be made for demand-based pressure to double border crossing capacity by 2012, reaching capacity limitation at Ivangorod-Narva border-crossing point by 2014 at the latest. By reorganizing processes to allow for close-ideal conditions, efficiency required by demand could be achieved.

The pre-requisite here would be to establish a common border crossing point and to introduce electronic border crossing technology to reduce the average time spent on processing a truck to six minutes. Unfortunately, in reality it is a highly unlikely development. Also, this scenario does not allow for reserve to further increase capacity of the border crossing point.

2.2. New road bridge and border crossing point in Riigiküla

The second option under consideration is establishing a new bridge in Riigiküla, situated 8 km North-West of the existing road bridge, towards the sea. The first important downside of this option is the lack of infrastructure on the Russian side (Figure 5). This option also conflicts with the principles of sustainable development of heavily populated areas. Based on the expert evaluation of Teet Saarepera, the chairman of the board of The State Resources Centre - the leading Estonian real estate company specializing in developing logistics parks - a border-crossing point cannot be built in residential or recreational areas.

Looking at the city plans of Narva and Ivangorod it is clear that the towns were divided in two halves in planning. To the north of the railway lies the residential area, to the south the industrial area. The town plans are balanced. The industrial area of Narva

has plenty of resources for further development. All main infrastructures, including gas, water, and electric lines are in place. The road network shows foresight in it being over-dimensioned.

The reserve land for residential building is to the north of the Narva city limit, in the direction of Narva-Jõesuu (Figure 5). The entire world favors the city plan featuring a high-rise *City* surrounded by low-rise suburbs. There is no basis to belief that Narva's development will be any different. The bank of the Narva River and the proximity of the sea turn the area between Narva and Narva-Jõesuu into a unique residential and recreational area. That area represents the most valuable residential development ground. In the coming decades, Narva and Narva-Jõesuu will likely blend together into one unit. This logic does not allow for intensive transit traffic and the inevitable concurrent environmental pollution to cut through the most valuable residential building area (Saarepera, 2005).

Figure 5. Possible location for the new road bridge and border crossing point in Riigiküla. (Source: Eesti Maa-amet, 2006)

No project to develop infrastructure is guaranteed to succeed if in preparing and contracting them, the principles of sustainable development and environmental protection have not been considered. Estonia passed the Sustainable Development Act that singularly declares that the purpose of sustainable use of natural environment and natural resources is to guarantee a satisfactory living environment as well as the resources necessary for economic development without significantly damaging the natural environment and by maintaining natural variety. The Act also states that the freedom to develop property and practice enterprise-related activity can be limited based on the need to protect the environment - the common property of humankind and national wealth (Sustainable Development Act of the Republic of Estonia, 1995).

Planning activities that spread across the national border or could significantly alter natural environment is handled in international cooperation. That means that when it comes to the issue of the border bridge, the Estonian environmentalists will form a common front with their Russian colleagues. To ignore their instructions or to be in conflict with the principles of sustainable development can lead to unwanted results.

It is the rule of thumb for the environmentalists to avoid, if at all possible, the building of additional transportation infrastructure, i.e. first and foremost the roads and railroads but also bridges and ports. Within the bounds of possibility, the existing infrastructure should be used and the capacity of it should be increased by reorganizing its processes. Building infrastructure is considered environmental pollution (Lahtvee, 2005).

In addition to economic, political, environmental and road construction related problems one more aspect needs to be considered when discussing building a new bridge outside of the city limits of Ivangorod and Narva – that is the aspect of social problems. There are many known instances of towns having virtually died out by re-routing traffic past the town instead of through it. For both Narva and Ivangorod, transit traffic was the primary reason for establishing the town, and has been an important source of income for centuries. It is hard to predict the possible socio-political repercussions of liquidating the Ivangorod-Narva border crossing point and guiding traffic past the cities.

2.3. New road bridge and border crossing point south of Narva railway bridge

The third standard solution proposes building a new road bridge immediately to the south of the existing railway bridge (Figure 5). That corresponds with the Soviet-era joint general plan for Ivangorod-Narva. The plan proposes building the new road immediately next to the railway. In Narva, there is also a reserve to accommodate the road under the bridge and sidewalk crossing the railway. It is theoretically possible to create customs zones on either side of the Narva River that would be three to five times larger than the existing zones (depending on the extent of demolishing and reconstruction work required). The Soviet-era general plan could not have planned for bigger areas than that as at the time, planning a border crossing bridge was not in scope.

Research conducted in 2005 by the author of this paper established that the third alternative meets the following criteria:

a) The route from Narva city limit on Route E20 to the planned new bridge would be harmless to the inhabitants and the surrounding environment;

b) The route would not clog traffic in the main streets of the city not interfere with public transport;

c) The route would utilize existing roads and streets to the maximum;

d) It would guarantee good accessibility to Narva's Industrial Park;

e) It would create synergy by integrating road and railroad border crossing points.

Building a new road bridge to the south of the railway bridge and new parts to Route E20 that would pass through the traditional industrial areas of Narva and Ivangorod fosters inclusion of new investments, establishing new logistics parks and therefore creating jobs in both cities. It would also make sense from the point of city logistics as the existing local workforce commonly uses light and public transport.

The main downside of this scenario is the complicated engineer-technological solution of the new bridge as, similar to the existing railway bridge, it would need to reach across the two forks of the Narva River, Juri Gagarin Street in Ivangorod and Kalda Street in Narva. Further research is warranted to determine whether the investment

required for this solution would be justified by the acquired increase of border crossing capacity.

3. Rolling highway as the Ivangorod-Narva border crossing solution

Rolling highway is a specific form of intermodal transport where complete truck-combinations are driven on board of low-built railway platforms. Today, this method is used to overcome physical barriers such as the Alps and the English Channel, but as many of the costs - such as capital cost for the truck and salary of the driver - remain to be borne by the haulers, it is not regarded as a large-scale future solution for European intermodalism. The low net to tare ratio is another restraining factor (Woxenius, 1998).

In the context of Ivangorod-Narva border crossing, we are also looking at a physical barrier - the Narva River and the peculiarities in the city plans that in long range would not allow to further extend the customs zones located immediately on the banks of the river. If the inspection of the trucks were removed from the physical border to the industrial areas that would accommodate for broadening the customs zone, it would complicate controlling the transit of trucks through the city from the check point to the border bridge and vice versa. To eliminate straying from the course and stopping, all vehicles would need to be convoyed.

Rolling highway solution allows:

- To use the existing railway bridge for border crossing of trucks;
- To relocate the customs zones away from the physical border to the industrial zones of Narva and Ivangorod where there is enough reserve land to broaden the control zones dozens of times which in long-term perspective will be necessary;
- To deliver trucks without stopping on train platforms via the railway bridge from the EU customs zone directly into the customs zone of the Russian Federation which guarantees safe transit even if the customs zones are several kilometers away from the physical border. Trucks will not have the opportunity to leave the platform. It is also impossible to add or remove anything from the trucks during the crossing;

- To integrate customs zones and loading and unloading terminals with the parking lot for trucks waiting to cross the border (Figure 8).

The practice of a designated waiting area for border crossing has been in use in Narva since 2000. For that purpose a 4,700 m2 paved and fenced area that offers the drivers elementary hygienic conditions was built. The waiting area is operated by Transservice-N, a company owned in part by the City of Narva. It includes a café, currency exchange, customs brokerage and declaring company as well as a hotel. There have been several disputes over financing the maintenance of the waiting area; however, by now no one is negating its necessity. It allows the drivers to wait to cross the border while resting without the constant need to move along in the line. Tachographs remain clean and the drivers can sleep without interruption.

The benefit of the waiting area to the city of Narva is apparent. Trucks are directed four at a time to the border based on order number, just as the previous trucks have left. There is an efficient radio communication between the waiting area and the border. Thus, the constant line-up of trucks blocking the city streets with its inevitable pollution due to the lack of hygienic conditions available to truckers has been eliminated. The waiting area can accommodate up to 150 trucks which by now is no longer sufficient. During peak periods there are over 500 trucks waiting to cross from Narva to Ivangorod. At the same time, the total time to cross the border in the southern border crossing points may be shorter but despite that the truckers prefer to cross at Narva due to the humane conditions created for them at the waiting area.

The arrows in Figure 6 represent outbound traffic. Inbound traffic passes through the unloading site (3) and the customs zone (4). Similarly integrated terminals need to be located on both sides of the border. Their exact locations and layout will be determined by the characteristics of the building plots. Basing on the goal of increasing the capacity for border-crossing by twenty times it would, in ideal circumstances, mean the capacity of processing 9,600 trucks in 24 hrs one way and up to 19,200 trucks in both directions. To achieve this, the customs zones will need to have 40 parallel lanes in each direction. Let it be noted here that the border crossing of 9,600 trucks per 24 hrs on the rubber wheels would mean an average bridge crossing of 7 trucks a minute in each direction.

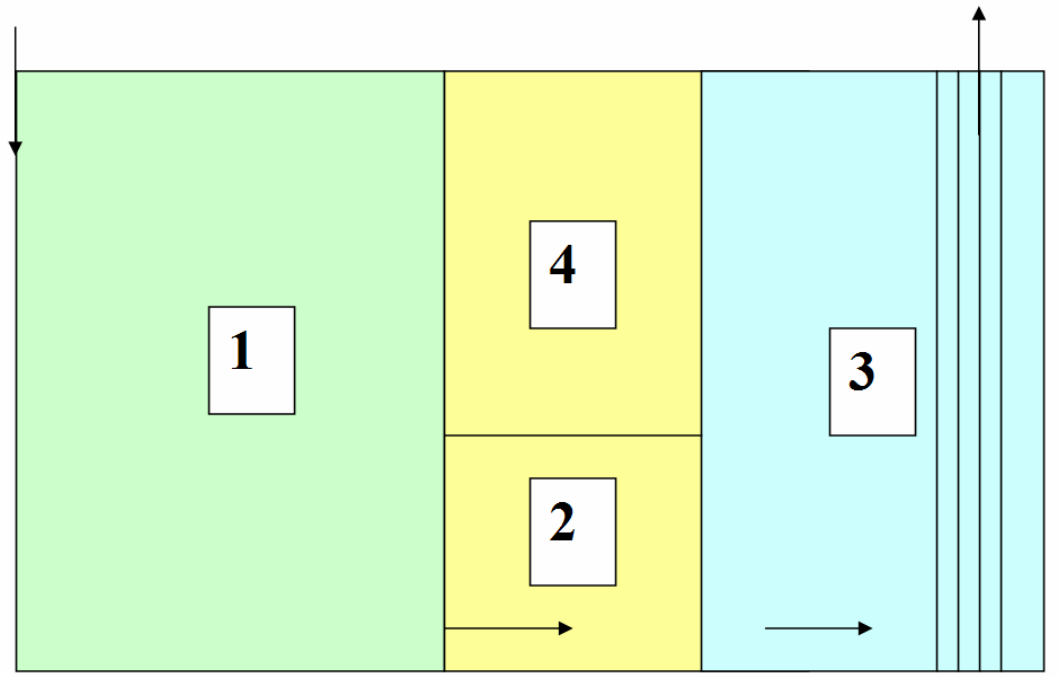

Figure 6. Integrated terminal with truck waiting area (1), customs zones (2; 4) and rolling highway loading and unloading site (3)

From this we can deduct that up to 400 trucks enter both terminals' rolling highway loading zones from the customs zone, and at the same time the same number of trucks is unloaded from the railway platforms arriving from the other side of the border. Using trains consisting of 100 platforms, the departure interval between shuttle trains needs to be 15 minutes.

Based on the distance between the terminals, speed limits, loading and vehicle securing technologies used, and the potentials in railway resources one can determine the necessary number of trains, dimensions of the terminals, workforce and technical means, extent of investments and operating costs, and calculate the profitability of the project. The parameters listed are the object of further research and preparation of the Ivangorod-Narva rolling highway model.

4. Conclusions

The location of the Ivangorod-Narva Route E20 road bridge is historic. It is more than 800 years old, and both cities were erected around the Narva River border crossing point. Currently, the road transit volumes between the EU and Russia are demonstrating an average annual growth trend of 13%. The volume of crossing the Narva River bridge increased suddenly by 40% with Estonia joining the EU and the next quantum leap can be predicted in connection with the development of the Sillamäe Port. Counted arguments support the claim that the current technological organization of the border crossing via the old bridge will soon not be able to satisfy growing demand.

Currently, the border crossing is at times operating at 73% of its full capacity. By reorganizing processes it would be possible to increase it to 100%; however, that would not be a long-term solution. Also, the location of the bridge in the hearts of the city centers is not appropriate for intensive heavy traffic. Increasing the flow of traffic on the existing route would bring with it decreased quality of life.

Of the standard alternative options the most viable is building a new road border bridge to the south of the existing railway bridge. The location of the bridge and the border crossing points within the limits of Narva and Ivangorod fosters inclusion of new investments, building of new logistics parks, and creating jobs in both cities. It would also make sense from the point of city logistics as the existing local workforce commonly uses light and public transport. The main downside of this scenario is the complicated engineer-technological solution of the new bridge as similar to the existing railway bridge the new one would need to reach across the two forks of the Narva River. This scenario also has physical restrictions in building customs zones on the banks of the Narva River and therefore does not offer a permanent solution to the border crossing problem.

Rolling highway is a solution that allows expansion outside of the limitations of the standard solutions and to increase the processing capacity of the border-crossing point 20 times without building an additional bridge. To accommodate that, waiting areas with parking lots and customs zones integrated with low-built railway platform loading and unloading terminals need to be built in the industrial areas of both Narva and Ivangorod.

The terminals will be connected by up to 100-platform shuttle trains that will depart from each side every 15 minutes and use the existing railway bridge to cross the Narva River.

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A Historical Note: Transportation Relationship Development between Russia and Finland

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Traditionally Finland is known as the great trading post. Russia occupies 7% of the outer trade after the crisis of 1998 the trade turnover of Russia and Finland has decreased, but from 1999 the Russian export began to increase in all spheres of goods.

In the structure of export of Russian Federation to Finland the following goods prevail: black oil and oil products, machines and equipment, timber, chemical products and black metals. Russia imports machines, equipment, paper and carton, paints and lacquers, foodstuff from Finland.

In 2002 outer trading turnover of Russia and Finland made up 4,4 billions of dollars. According to expert rates, the increase of the trade amount can increase to 7-10 billions of dollars per year.

According to the resolution of the council of Ministers of the Russian Empire of February, 24, 1869 on the crossection of the railway and the borderline between the Russian Empire and Finland the Sestroretsk border post was founded. The post was obliged to examine Finnish goods and passengers luggage on the stations between the border and Saint-Petersburg. This work has to be done every day and night.

In the «Petersburg Newspaper» of August, 10, 1904 the following information appeared: “The Finnish Government of Railroad begins to connect Finnish and Empire roads by the railroad branch. The way is figured out. The direction has been fixed. The branch begins on the Vyborgskaya side near the Kulikovo field and goes to the bank of the Neva-river. ” One of the members of the Northern railroad Committee informed that: “this direction satisfies economical requirements of the bread trade. The total volume of trade of different goods varies from 40 to 45 millions of rubles. The future branch can count on the big flood of passengers also from outskirts of Saint-Petersburg”

After the customs had been founded and branch built, the operation system began to be modernized. In the first volume of “Railroad Stations” by S.D. Karejsha, 1917, the first technological process between the stations was viewed. The condition of the transported goods had to be examined, the number of the trains going to the foreign railroad had to be controlled. S.D. Karejsha offered to build special roads for the trains which would cross the border and would be examined there.

Firstly they had to be sorted according to the categories and directions on the native station and then on the foreign station. The main problem was timing. The trains stayed there for too long and became the obstacles on the way of the other trains. To solve this problem the agreement was signed according to which one of the stations would be used as common and its owner, the railroad, would be involved into the whole process giving its own locomotives and servants for that procedure. In the middle of the 30ies of the last century professor V.N. Obraztsov in “Station and Junction” introduced the new term “boarding station”.

The main principles of such boarding station have been retained until today. In 1995 the national net of the Finnish railroads was transferred into the limited company, consisting of 22 companies, which form the modern structure of the “Finnish railroad” Group. After Finland became a part of European Union, the borderline have become the internationalization factor in the sphere of goods and passengers for Russia.

Definitely the peculiarities of the transportation and economical development depend on the conditions of transportation of outer trade goods and transportation infrastructure of both countries.

The development of telematics in the sphere of transportation conduction of outer trade goods has become very important for providing competitiveness and reliability of transportations were introduced, which increased the quality of the border control of goods a lot.

Apart from the enormous progress which has been reached from the times of the border station foundation, still there are some unsolved questions. On some stations there still exists a problem of train uncoupling, which brings to train delays.

One of the mail goals is the creation of the electronic document turnover in export-import operations and introducing the automatized control system of the border station.

The amount of existing problems brings to the further research and examination of the peculiarities of organization and finding the new forms of cooperation. Both common railroad track and long cooperation between Russia and Finland definitely are favorable factors for the future expansion of transportation and economical cooperation.

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The Real Price for Container Transportation between Asia and Europe

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Abstract

Favourable geographical location grants Russia with an excellent possibility to benefit from transit cargo transportation between Asia and Europe. However, so far Russia has not been able to utilize this possibility. Russian Railways failed to offer a viable alternative to the all-water route. This paper analyses the main factors influencing the competitiveness of railways in comparison with sea transport in Eurasian transit transportation. The main goal of the research is to determine the strong sides of rail transportation in order to find out the niche for its future development.

Keywords: Railways, container transportation, Finland, Sweden, China, Russia

1. Introduction

The importance of Russia as transit territory for Europe-Asia cargo transportation is being widely discussed lately. However, Russian Railways have failed to attract a significant volume of transit cargo. For example, the trade between China and Europe is booming, but the cargo is mainly transported by sea. The insufficiency of the infrastructure and the deficit of rolling stock are often mentioned as reasons for a poor performance of Russian Railways. However, the main factor negatively influencing the transit of containers via the Trans-Siberian Railway is Russian tariff policy. As a result of the last significant increase in transportation tariffs, the Trans-Siberian Railway's transit traffic between the Far-East and Finland declined about 90 %. Was that transit "real transit" or "grey import" is another question.

The study accepts that the main reason for the low cargo flow through Russia is the high price in rail transportation when compared with sea transportation. Transporting of one freight container (20') between Asia and Europe by rail costs about USD 3 000 - 3 700, when sea transport costs only USD 1 200 - 1 700. At the same time, rail transport has one advantage, which the sea transport is not able to beat. This is the shorter time needed for transportation. When shipping different items between continents in fully

loaded containers, the shipping costs are usually extremely low per item. And more expensive products (e.g. mobile phones) have a very low transportation costs if compared with their value. The study argues that when taking into account the price erosion and inventory holding costs, the time spent in transportation plays a major role. Thus it appears that for the transportation of some products between Europe and Asia it is cheaper to use "more expensive" rail transport.

2. Trade turnover between China and its partners in Europe: case of Finland and Sweden

2.1. China's main trade partners in Europe

Since 2004, European Union (EU) tops the list of China's main trade partners. The trade turnover between EU and China is constantly growing. During the last five years, the average annual growth rate for EU's import from China was about 18%, while for export it was about 14%. However, the contribution of different EU-members to the bilateral trade between EU and China is not the same.

Table 1. Trade turnover between China and its main partners in Europe in 2005, million USD (EUROSTAT, Customs of the People's Republic of China).

Partner	Total turnover	Growth 2005/2004 (%)	Exports	Growth 2005/2004 (%)	Imports	Growth 2005/2004 (%)	Share in China-EU turnover (%)
Central Europe							
Germany	63 252	16,9	30 724	1,2	32 528	36,9	29,1
Netherlands	28 803	34	2 926	-1,5	25 877	39,7	13,3
Great Britain	24 503	24,2	5 526	16,1	18 977	26,8	11,3
France	20 649	17,5	9 009	17,8	11 640	17,3	9,5
Belgium	11 745	25,2	4 005	13,8	7 740	32,1	5,4
Denmark	3 985	26,4	1 196	-0,8	2 789	43,3	1,8
Poland	3 153	35,3	557	14,4	2 596	40,8	1,5
Hungary	2 859	-8,6	366	-23,1	2 493	-5,9	1,3
Austria	2 492	8,8	1 609	6,6	883	13,1	1,1
Czech Republic	2 039	13,7	372	-15,9	1 667	23,4	0,9
Northern Europe							
Finland	6 254	13,4	2 628	-13	3 626	45,4	2,9
Sweden	5 699	9,6	3 122	-6,5	2 577	38,6	2,6
Norway	2 466	1,6	1 144	-18,2	1 322	28,5	-

Germany, the most populated country of EU, is the leading trade partner for China. It is followed by Netherlands and the Great Britain, which shares in overall EU-China trade are more than two times smaller than Germany's. The shares of 12 European Union members and Norway are showed in the following Table 1.

As it can be seen from Table 1, the share of Finland in EU-China trade turnover is only 2.9 %. However, if compare Finland's trade turnover per capita with e.g. Germany and the Great Britain, it becomes clear that China is more important partner for Finland than for two trade leaders, but not that important like it is for Netherlands.

Only two countries, Austria and Sweden, are exporting to China more than importing from there. E.g. Netherlands is importing from China about ten times that amount it is exporting. In general, the EU-China trade is in imbalance and the imbalance tends to increase when imports from China are increasing faster than exports.

2.2. Trade between Finland and China

During the last ten years the trade between Finland and China increased more than five times (see Figure 1). Especially the import from China has increased steadily and the amount of import is nowadays about two times higher than the amount of export. The trade balance was positive for Finland during the 90's and up to 2002, but since that the value of the imports has exceeded the value of the exports.

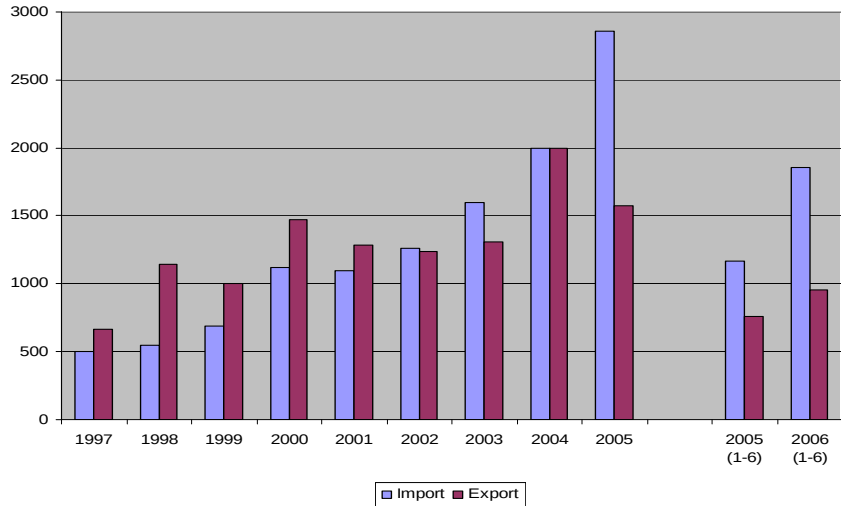

Figure 1. Trade turnover between Finland and China during the years 1997 - 2006, EUR million. Source: Finnish National Board of Customs

Nowadays Finnish export to China consists of a large amount of general industrial machines and special industrial machines (see Table 2), which are mainly exported because of the investments made by Finnish companies to China (e.g. investments in the forest industry). As during the last years the amount of those investments varies very much from year to year, the amount of Finnish exports to China follows the similar path jumping up and down. At the same time, Finnish import from China is constantly growing.

Table 2. Top-15 product groups in Sino-Finnish trade. Source: UNCTAD/WTO

Rank	Import from China	Share	Export to China	Share
1	Telecomm. and sound equipment	31.15 %	Telecomm. and sound equipment	28.98 %
2	Office machines	20.23 %	Iron and steel	11.59 %
3	Electrical machinery, apparatus and appliances	16.27 %	General industrial machines	10.52 %
4	Clothing and accessories	5.16 %	Special industrial machines	9.40 %
5	Metals manufactures, n.e.s.	4.44 %	Electrical machinery, apparatus and appliances	8.34 %
6	Miscellaneous manuf. goods, n.e.s.	3.99 %	Power generating machines	5.24 %
7	General industrial machines	3.06 %	Paper, paperboard, etc.	5.06 %
8	Textile yarn, fabric, etc.	2.31 %	Scientific equipment, etc.	2.41 %
9	Scientific equipment, etc.	1.44 %	Non-ferrous metals'	1.83 %
10	Footwear	1.16 %	Pulp and waste paper	1.83 %
11	Prefabricated buildings, fittings, etc.	1.15 %	Hides, skins, furskins, raw	1.57 %
12	Road vehicles	0.96 %	Miscellaneous manuf. goods, n.e.s.	1.19 %
13	Special industrial machines	0.90 %	Organic chemicals	1.07 %
14	Non-ferrous metals'	0.86 %	Crude fertilizer mineral	1.02 %
15	Other transport equipment	0.76 %	Metals manufactures, n.e.s.	0.98 %
	Top-15's share in the total import	*93.84 %*	*Top-15's share in the total export*	*91.01 %*

Telecommunication and sound equipment is in the top position both in Finnish export and import from China. The share of the mobile phones in total exports to China as for the first six months of 2006 was EUR 165 million (export price quoted FOB, Free on Board). The value of the export almost doubled from the last year. The quantity of the exported mobile phones increased from less than 660 thousand mobile phones to more than 1.6 million mobile phones (about 320 TEUs if loaded in containers) and the average value decreased from EUR 113 to less than EUR 102. During the same time, components for different telephone and radio sets were exported for a value of more than EUR 40 million.

Production of forest industry represents the traditional Finnish exports. However, in case of China it is forced to the background by products of metal industry. One reason for

this may be the relatively low price and the relatively high transportation costs of forest products. Concerning its exports, Finland had and somehow still has the same problem as e.g. Russia do, namely the low value of exports per weight. If we look at the export price of e.g. pulp and paper, round wood and crude oil per their weight or volume, the price is very low compared with high extent of value added products, e.g. mobile phones and DVD-players.

However, the export of the Finnish forest industry to China increased during the first six months of 2006 remarkably. The value of the exported paper and board was EUR 49 million that is more than one third higher than a year ago. The export of the paper pulp was 2.5 times higher than year ago and reached EUR 41 million. Partly the increase of the export of the forest industry is due to the industrial conflict in May-June of 2005, because of which caused the value of export in 2005 was lower than usually.

2.3. The trade between Sweden and China

The structure of Swedish trade with China is given in Table 3.

Table 3. Top-15 product groups in Sino-Swedish trade. Source: UNCTAD/WTO

Rank	Import from China	Share	Export to China	Share
1	Telecomm. and sound equipment	19,86 %	Telecomm. and sound equipment	14,43 %
2	Clothing and accessories	15,11 %	General industrial machines	14,04 %
3	Electrical machinery, apparatus and appliances	8,54 %	Electrical machinery, apparatus and appliances	12,31 %
4	Miscellaneous manuf. goods, n.e.s.	7,49 %	Iron and steel	9,60 %
5	Metals manufactures, n.e.s.	6,69 %	Road vehicles	8,54 %
6	Furniture, bedding. etc.	5,30 %	Paper, paperboard, etc.	8,41 %
7	Other transport equipment	3,65 %	Special industrial machines	6,98 %
8	General industrial machines	3,32 %	Scientific equipment, etc.	3,93 %
9	Footwear	2,75 %	Power generating machines	3,23 %
10	Office machines	2,72 %	Pulp and waste paper	2,78 %
11	Road vehicles	2,65 %	Organic chemicals	2,65 %
12	Textile yarn, fabric, etc.	2,64 %	Metals manufactures, n.e.s.	1,72 %
13	Prefabricated buildings, fittings, etc.	2,47 %	Metalworking machinery	1,62 %
14	Non-metal mineral manufactures	1,88 %	Medicinal, pharm. products	1,36 %
15	Fish and sea products	1,32 %	Miscellaneous manuf. goods, n.e.s.	1,13 %
	Top-15's share in the total import	86,38 %	*Top-15's share in the total export*	92,73 %

Like for Finland, for Sweden too the export and import of telecommunications and sound equipment is the most important in trade with China. However, their share in Swedish export to China is somewhat two times less as in Finland.

3. Maritime and Rail Shipping costs for different goods between Asia and Europe

Nowadays, inarguable leadership in container transportation between Asia and Europe belongs to sea transport. Its current share in Eurasian transit container transportation is about 90%. It is often said that the major reason for shippers to prefer maritime transportation to other transport modes, in particular railways, is its lower shipping costs. To clarify the situation, the maritime and rail shipping costs were calculated for four different products: copying paper, mobile phone, DVD-player and pair of shoes. The former two products represent Finnish export to China, while the later two are usual import from China.

3.1. Container dimensions

It was assumed that those products are transported in a standard 20-foot dry cargo containers (can also be referred to as 1CC freight container, 20', TEU). According to international standard SFS-ISO 668, minimum internal dimensions for 20-foot container are:

Height 2.350 m
Width 2.330 m
Length 5.867 m

Thus, minimum volume for such a container is 32.125 m^3.

According to experts estimations, the rating (or the maximum gross weight) of 20-foot dry cargo container is 24 000 kg. Its maximum tare mass (or weight of empty container, including all fittings and appliances used in a particular type of container in its normal operating condition) is 2 400 kg. The payload of the container is the maximum permitted weight of payload, including the dunnage and cargo securement arrangements that are not associated with the container in its normal operating condition. Therefore, Payload = Rating - Tare Mass or 24 000 kg – 2 400 kg = 21 600 kg (Export 911).

3.2. Products' dimensions

Copying Paper

It was calculated that one package of copying paper includes: carton 220 g + wrapping paper 5 x 22 g + 2 500 sheets of paper A4 (210 x 297 mm, 80 g/m2). From this it follows that the gross weight of the package is 12.805 kg. Package dimensions are: 0.308 m x 0.219 m x 0.262 m = 0.01767242 m3

If container is fully-loaded with no space left, it can carry 1 817 packages (9 085 reams[1]) of paper, which is about 21 960 kg. Usually packages are loaded in pallets with 240 reams (48 packages) on each pallet. Therefore, the weight can be the limit in the case of transportation of copying paper. Because of the payload, container can carry only 1 686 packages of copying paper.

DVD-player

Package dimensions of DVD-player are: 0.515 m x 0.290 m x 0.130 m = 0.0194155 m3. Thus, one fully-loaded 20-foot container can carry 1 654 DVD-players.

Average weight of the DVD-player including package is 2.386 kg. So the amount of 1 654 DVD-players will together weight 3 916 kg that is less than the payload of the container. Thus, container can be loaded completely.

Mobile phone Nokia 6630

Mobile phone's box dimensions are: 0.182 x 0.188 x 0.077 = 0.002635 m3. Thus, one fully-loaded 20-foot container can carry 12 193 mobile phone' boxes.

The weight of one box, including mobile phone, charger, and other fittings, is 0.679 kg. The total weight of the fully-loaded container will be 8 279 kg. Payload here is not a restricting factor.

Pair of Shoes

For the purpose of the research altogether four boxes of shoes (two for men's shoes and two for women's shoes) were chose with random sampling and then measured. The

[1] Ream is a traditional unit of quantity used for counting sheets of paper. Ream is equal to 500 sheets.

volume of these boxes varies from 0.003692 m3 to 0.006953 m3 and the average volume is 0.005328 m3. Their weight varies from 406 g to1 135 g and the average weight is 771 g. On average, one container can carry maximum 6 029 pair of shoes that is 4 648 kg. Payload again is not a restricting factor.

3.2. Shipping costs calculations

As it can be seen from calculations presented above, the payload restricts the amount of products that can be loaded into container at a time only in case of copying paper. In the other three cases container can be fully-loaded. However, in practice, it's impossible to fill every single millimeter of container space. Besides, it would be interesting to see how the shipping costs per item change depending on the container utilization rate. Thus the calculations were made for two cases: 1) container is 100%-loaded, 2) container is 80%-loaded[2].

It was estimated, that average cost of railway transportation from a port on the east coast of China to a European port is at minimum USD 3 000 per TEU and at maximum USD 3700 per TEU. At the same time, the shipping by sea from a Chinese port to a European port costs minimum USD 1 200 per TEU and at maximum USD 1 700 per TEU (Shu, X., 1997). Those figures were used to calculate the shipping costs per item for four chosen products. The results of the calculations are given in Table 4.

[2] Although the maximum permitted weight of payload is 21 600 kg, the shipper may be prohibited to have that much payload in areas where there are legal limitations to the overall load of a vehicle. Thus, it is common to encounter a payload of 17 500 kg (or 80% of the maximum payload).

Table 4. Shipping costs for various goods. Source: authors' calculations

	Copying Paper (A4, 2500 sheets)	DVD-player	Mobile telephone	Pair of Shoes
Weight of the the Item, kg	2.561	2.386	0.679	0.771
Quantity of Items in TEU if the utilization rate is 80%	1 454	1 323	9 754	4 824
if the rate is 100 %	1686	1654	12193	6029
Maximum weight, kg	21 600	3 916	8 279	4 648
Sea transport per item, USD, if				
the Freight costs USD 1200, u.r. 80%	0,83	0,91	0,12	0,25
the Freight costs USD 1200, u.r. 100%	0,71	0,73	0,1	0,2
the Freight costs USD 1700, u.r. 80%	1,17	1,28	0,17	0,35
the Freight costs USD 1700, u.r 100%	1,01	1,03	0,14	0,28
Rail transport cost, USD, if				
the Freight costs USD 3000, u.r. 80%	2,06	2,27	0,31	0,62
the Freight costs USD 3000, u.r. 100%	1,78	1,81	0,25	0,5
the Freight costs USD 3700, u.r. 80%	2,54	2,8	0,38	0,77
the Freight costs USD 3700, u.r. 100%	2,19	2,24	0,3	0,61
Retail price per item, USD	25	99	150	99
Sea transport costs as % of retail price if				
the Freight costs USD 1200, u.r. 80%	3,3	0,92	0,08	0,25
the Freight costs USD 1200, u.r. 100%	2,85	0,73	0,07	0,2
the Freight costs USD 1700, u.r. 80%	4,68	1,3	0,12	0,36
the Freight costs USD 1700, u.r 100%	4,03	1,04	0,09	0,28
Rail transport costs as % of retail price if				
the Freight costs USD 3000, u.r. 80%	8,25	2,29	0,21	0,63
the Freight costs USD 3000, u.r. 100%	7,12	1,83	0,16	0,5
the Freight costs USD 3700, u.r. 80%	10,18	2,82	0,25	0,77
the Freight costs USD 3700, u.r. 100%	8,78	2,26	0,2	0,62

As it can be seen from Table 4, the most valuable product, i.e. mobile phone, has the lowest ratio between shipping costs and the retail price varying from 0.07 to 0.25%. It appears that the shipping costs per item are quite low when considering the retail price of the product. Copying paper has the relatively highest ratio between shipping costs and the retail price, but still it is only 7-10% in railway transportation from Europe to China. It can be noted, that the results of these calculations are quite analogous to the calculations made by Maritime International Secretariat Services Ltd. (International Chamber of Shipping).

3.4. Price erosion and its influence on shipping costs

Price erosion is a factor, which has very strong effect on electronic apparel. It has been estimated (Rantala & Hilmola, 2005) that the price erosion in electronics industry is around 20 - 35 % per annum. Also everyone who has followed during the last years the prices of mobile telephones, flat displays and televisions, DVD-players etc, has noticed

that the prices products for these products have sank sufficiently. As electronic apparel takes the leading positions in China-Europe bilateral trade, it is important to know the influence of price erosion on transportation costs of those products. It is also interesting to study how the situation changes depending on the transport mode chosen for product delivery. To clarify these issues, the price erosion for mobile phone transported from Finland to China was estimated for two cases: 1) transportation by sea, 2) transportation by railways.

According to Nokia's observations, price erosion for mobile phones is 20–30% per annum. If assume that price erosion for mobile phones is 24% and the sea transportation from Europe to China lasts 1.5 months, it appears that during the trip the value of these mobile phones declines by 24%/12 x 1.5 months = 3%. At the same time, the rail transportation through Russia lasts approximately 0.5 months and so the price erosion will be only 1%.

For a mid-range mobile telephone with export value of USD 125 (about the same as 101.5 EURO indicated above), the difference between price erosion in sea transportation and price erosion in railway transportation is USD 2.50 per each phone.

The calculations presented in a previous chapter have shown that the shipping costs of mobile phone in sea transportation are much lower than in railway transportation. However, the phones are transported by sea three times longer than by railway resulting in higher price erosion. Thus, if price erosion included, the situation with transportation costs for the phone reverse: transportation by sea is more expensive than by rail.

Assuming that in a container there are 9 754 mobile phones (80%-loaded) multiplied with USD 2.50/telephone, the price erosion for the whole container reaches USD 24 385(!). It means that while transporting one container with mobile phones by sea instead of using railways the consignee should add additional USD 24 385 to the container transportation costs. Apart from that, we should also include in this calculation inventory holding cost.

If thinking about DVD-players, their prices have decreased heavily since they were introduced back in the 90's. If we use the same parameters as we used for mobile phones and we assume that the export price for a one DVD-player is USD 50 (roughly 50% of retail price) declines by one USD. When multiplied the quantity of these DVD-players,

1 323 by USD 1/per item, we get the value for price erosion which is USD 1 323. Summarizing this and the shipping cost of USD 1 700 we get USD 3 023.

3.5. Inventory holding costs

In accordance with the conventional inventory control theory, the longer delivery time results in greater level of inventory to provide the same level of services and increases the inventory holding costs.

Copying paper and pair of shoes

When talking about copying paper and shoes the price erosion is not significant or there is no price erosion at all. If the retail price for copying paper is above mentioned USD 25 and the quantity 1 454 package, we can estimate that the export price is about USD 10 per package which totals USD 14 540. Inventory holding cost 2.5 % per month totals USD 364. If we summarize this inventory holding cost USD 364 to shipping cost USD 1 200 - 1 700, we get the total cost of USD 1 564 - 2 064, which is far less than the transportation costs if used railway (USD 3 000 - 3 700).

We also estimated that the export price for shoes is USD 20. So the inventory holding cost for one pair of shoes will be USD 0.50 Multiplying this with the quantity of shoe boxes, 4 824, we get USD 2 412.

DVD-players and mobile phones

It was estimated that the average level of inventory holding costs is about 20–40% per annum. If the inventory holding costs are accepted at the level of 30%, the inventory costs per month are 2.5%. As the difference in delivery time between sea and railway transport is one month, the transportation by sea causes an extra 2.5 % inventory holding cost. In case of mobile phone (USD 125) the additional inventory costs are USD 3.125/item. For the container with 9 754 phones it means additional USD 30 481.

If additional inventory costs are added to the expenses caused by price erosion, the overpayment for the use of sea transportation instead of railway transportation for the delivery of one container with mobile phones from Finland to China reaches USD 54 866.

Anyway, the calculation results show that the price competitiveness of the sea transport is rather arguable. In case of high value products the railway transportation can be much cheaper.

Table 6. Final transportation costs for container with mobile phones transported by sea and by railways. Source: authors' calculations

Container transportation	Transportation cost, USD	Price erosion, USD	Inventory holding costs, USD	Final transportation cost, USD
Mobile Phone (FOB price USD125)				
Sea transportation	1 200	36 578	45 722	83 500
Railway transportation	3 700	12 193	15 241	31 134
Difference	*-2 500*	*24 385*	*30 481*	***52 366***
DVD-player (FOB price USD50)				
Sea transportation	1 200	1 985	2 481	5 665
Railway transportation	3 700	662	827	5 188
Difference	*-2 500*	1 323	1 654	***477***
Pair of Shoes (FOB price USD20)				
Sea transportation	1 200	0	3 618	4 818
Railway transportation	3 700	0	1 206	4 906
Difference	*-2 500*	0	2 412	***-88***
Copying Paper (FOB price USD10)				
Sea transportation	1 200	0	546	1 745
Railway transportation	3 700	0	182	3 882
Difference	*-2 500*	0	364	***-2 137***

As it can be seen from the Table 6, the influence of price erosion and inventory holding costs is not the same for different products. For mobile phones they significantly increase the final cost of sea transportation making it far less competitive to railway transportation. In case of copying paper, the situation does not change at all – the railway transportation remains more expensive than sea transportation.

4. Conclusions

The more sophisticated and expensive is the product, the more price erosion and inventory holding cost will have effect in total cost. When shipping different items in full loaded containers between different continents, the shipping costs are usually extremely low per item. And more expensive products (e.g. mobile phones) have a very low transportation costs if compared with their value. Punakivi and Hinkka (2005) have also found out that the high value and especially high price/kg ratio of products, short life

cycles and worldwide markets are typical reasons to use rapid modes of transport. The high price/kg ratio of products and the short life cycles, for example in the electronics industry, cause high price erosion and support selecting transport based on speed, as proportional transport costs remain small, even when using expensive transportation modes

When taking into account the price erosion and inventory holding costs, the time spent in transportation plays a major role. Taking account these factors, it is sometimes cheaper to use this "more expensive" rail transport between Europe and Asia. Railways are in position where maritime transport can offer cheaper transportation costs (also when including price erosion and inventory holding cost) for bulk products another products with low price/kg ratio. On the other hand air transport is much faster but the prices are higher. This task is not easy for the railroads but when everyone involved in this has a will to make it possible, there are great changes to succeed.

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Strategic Level Supply Chain Management: A Supply Chain Architecture Point of View

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Abstract

Strategic level supply chain management deals with issues like the number and location of suppliers, manufacturing units, warehouses and distributors, and the choice of transportation channels. In the above introduced context, the concepts of supply chain structure and supply chain design are widely used. The importance of the concepts can be emphasized by the fact that it has been claimed that 80 % of supply chain costs are locked in the design.

Supply chain architecture is suggested to be a subjective mapping of structure, control principles and configurability of structure. It is a broader concept compared with supply chain design or supply chain structure, covering issues such as the choice of order decoupling point and centralization vs. decentralization decisions in addition to the sourcing, location and transportation issues, and hence can be claimed to give a more comprehensive view of the matter.

This paper aims to give an overview of different supply chain strategies and their relation to supply chain architecture. Lean and agile supply chain concepts are discussed as two main supply chain strategy alternatives. In addition, hybrid strategy that strives to combine lean and agile concepts is examined. It has been widely recognized that structure should follow strategy and the same logic can be claimed to apply in supply chain management context. The paper also aims to shed new light on the concept of supply chain architecture, which is not widely used, and illustrate different architecture types by comparing those in use in the industry.

Keywords: supply chain strategy, supply chain architecture, lean supply chain, agile supply chain, hybrid supply chain

1. Introduction

Scott and Westbrook (1991) say that while the short term objective of supply chain management is to increase productivity and reduce inventory and cycle time, the long term strategic goal is to increase customer satisfaction, market share and ultimately profits for all members of supply chain. Similarly, according to Hicks (1999) the objective of strategic level supply chain management is to serve the customers in the market by means of most efficient and profitable supply chain. While stressing the efficiency and profitability factors, the definitions of strategic level supply chain management bring forward the importance of the customer. Customer requirements vary,

and so do companies' supply chain strategies. Some customers value high service level whereas some value low cost. In this paper lean and agile supply chain concepts are considered as two main supply chain strategies to meet the customer needs; lean supply chain to realize low cost and agile supply chain to realize high service level. In addition, hybrid strategy, also known as the leagile concept (Christopher & Towill 2001), is examined in the same framework.

Strategic level supply chain management is perceived in a diversity of ways. It can be said that strategic level supply chain management deals with issues like the number and location of suppliers, manufacturing units, warehouses and distributors, and the choice of transportation channels (Ganeshan and Harrison 1995). In this mentioned context, the concepts of supply chain design and supply chain structure are widely used. The importance of the concepts and the research done in this field can be emphasized by the fact that it has been claimed by the practitioners that 80 % of supply chain costs are locked in the design. However, the research on this area of supply chain management is yet at an early stage and the terminology is largely ambiguous. A coherent discussion of the field is missing.

Supply chain architecture is suggested to be a subjective mapping of structure, control principles and configurability of structure. In our view, it is a broader concept than supply chain design or supply chain structure, covering issues such as the choice of order decoupling point and stock centralization vs. decentralization decisions and the configurability of supply chain structure in addition to the sourcing, location and transportation issues, and hence can be claimed to give a more comprehensive view of the matter.

It has been widely recognized that structure should follow strategy, and the same logic can be claimed to apply in supply chain management context. A lot of research has been done focusing on either supply chain design related issues or on supply chain strategies. The former comprises mainly of optimization models developed in operational research under the rubric of supply chain design and focusing on strategic decision making. The latter focuses typically on one type of strategy or another. This paper aims at bringing together supply chain strategies and supply chain architecture by examining the relation between the two entities. It overviews lean, agile and hybrid supply chain

concepts, their decision determinants and the relation of these strategies to supply chain architecture; how does the architecture follow strategy?

2. Theoretical basis

2.1. Lean, agile and hybrid supply chain strategies

Lean thinking has gained significant attention among academicians and practitioners as a paradigm that serves to optimize performance and improve competitive position. Leanness is aimed at minimization of waste (muda) throughout the whole supply chain (Womack & Jones 1996). During the 1990's and in the beginning of 21st century, agile manufacturing paradigm has evolved as an alternative to lean thinking (Richards 1996). It seeks to provide quick response to changing market needs. While the main focus in lean concept is to minimize total costs, agility aims at providing high service level. Since high service level can not be always achieved when costs are minimized, these two strategies are often seen as alternative. However, increasingly, customers want not only high service level but low costs as well. According to Christopher et al. (2001) lean and agile concepts can be combined into a hybrid strategy in order to achieve both targets.

Among different approaches to a hybrid strategy (Christopher et al. 2001), one, that is closely connected to the subsequent decisions on supply chain architecture, is to use lean methods until customer order de-coupling point and agile ones after it. Order decoupling point separates the part of supply chain based on planning and forecasted demand from the part based on customer orders and actual demand. This idea is similar to that of manufacturing postponement: to hold inventory in a modularized form at some point of a value-added network and complete the final product assembly only when a precise customer order is known.

On the contrary to Christopher's and Towill's view on combining lean and agile supply chain concepts, Fisher (1994) claims that a supply chain can successfully emphasise only one generic function, i.e. either be physically efficient or market responsive. The definition of Fisher's physically efficient supply chain is parallel to that

of lean supply chain and market responsive to that of agile supply chain. However, Selldin and Olhager (2002) present empirical findings which indicate that supply chains that are both market-responsive and physically efficient do exist. Based on Fisher's model of physically efficient supply chain and market responsive supply chain to match certain types of products (discussed further in the next chapter) Olhager, Selldin and Wikner (2006) suggest a concept of pursuing different operations strategies before and after the order decoupling point. However, unlike Christopher and Towill they propose two order decoupling points: Product Supply Decoupling Point (PSDP) to present material decoupling point and Demand Mediation Decoupling Point (DMDP) as information decoupling point (Figure 1). In their model, physically efficient supply chain is to be used upstream from the PSDP and market responsive supply chain downstream from the point. In some cases the demand information is available upstream from the PSDP but not early enough to practice make-to-order operations. In this case, the information can be used for improving the forecasts in order to improve the service level without increasing cost at the PSDP (Zone II in Figure 1).

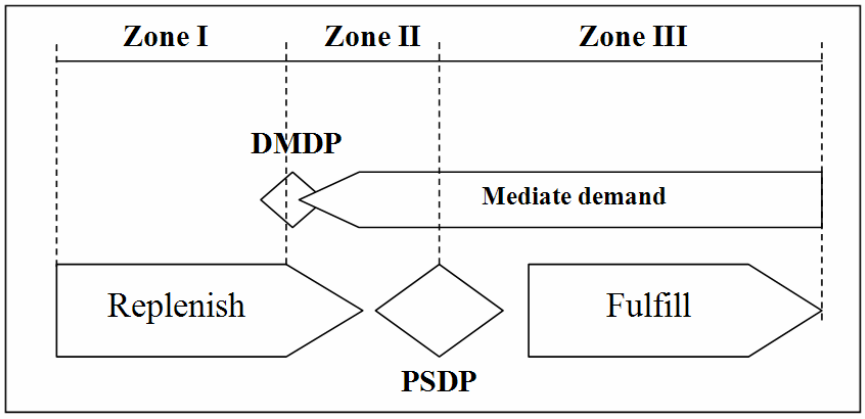

Figure 1. Supply chain management operations strategy concept by Olhager, Selldin and Wikner (2006).

2.2. Decision determinants

The aim of strategic planning is to serve efficiently customers on a certain market; hence decision on which strategy to choose should be based on how well a certain strategy may

satisfy customer needs. Market requirements that have to be met as well as other important characteristics that are necessary to take into account are referred as decision determinants.

According to Christopher and Towill (2001), two important market determinants are nature of market demand (stable/volatile) and nature of customer requirements (highly/low customized). Markets with stable demand and low level of customization can be successfully satisfied with lean type of supply chain, and highly customized markets with unstable demand are better served when supply chain is agile. If a final product should be not only available (high service level) but also affordable (low cost), a hybrid strategy is to be used.

Vonderembse, Uppal, Huang and Dismukes (2006) recognize other market determinants: product characteristics and the stage of product life cycle. Products can be standard (design changes incrementally; demand can be forecasted accurately; long life cycles), innovative (new products that satisfy emerging customer needs; demand can not be forecasted; shorter life cycles) and hybrid (improvements are introduced periodically; long life cycles). The stages of product life cycle are introduction, growth, maturity and decline. Vonderembse et al. (2006) say that for standard products lean supply chain strategy suits best. For innovative products during introduction and growth stages it is better to use agile strategy whereas during maturity and decline stages lean or hybrid strategy is more appropriate. For hybrid products hybrid supply chain strategy is good throughout all product life cycle stages.

Fisher (1997) also recognizes product characteristics as decision determinants. According to Fisher's model, products can be divided into functional products and innovative products. Functional products – products with predictable demand and low variety – are best matched with physically efficient supply chain. Innovative products – products with unpredictable demand and high variety – are best matched with market responsive supply chain. A summary of supply chain strategies and their decision determinants is presented in Table 1.

Table 1. Decision determinants of supply chain strategies.

Decision determinants	Supply chain strategy
Stable demand, low customization; standard product or innovative product during maturity and decline stages of its lifecycle; special manufacturing capabilities; global company moves to local market	Lean
Volatile demand, high level of customization,; innovative product during introduction and growth stages; manufacturing and logistics characteristics; current state of a company's position on a market	Agile
Hybrid product, innovative product during maturity and decline stages of its lifecycle; manufacturing and logistics characteristics; current state of a company's position on a market	Hybrid

2.3. Supply chain structure

Structural decisions deal with issues such as the number and location of companies in each tier and choices of transportation channels. Ernst and Kamrad (2000) divide different supply chain structures according to the combined levels of modularization and postponement. The framework includes four types of supply chain structures: rigid, postponed, modularized and flexible (Figure 2).

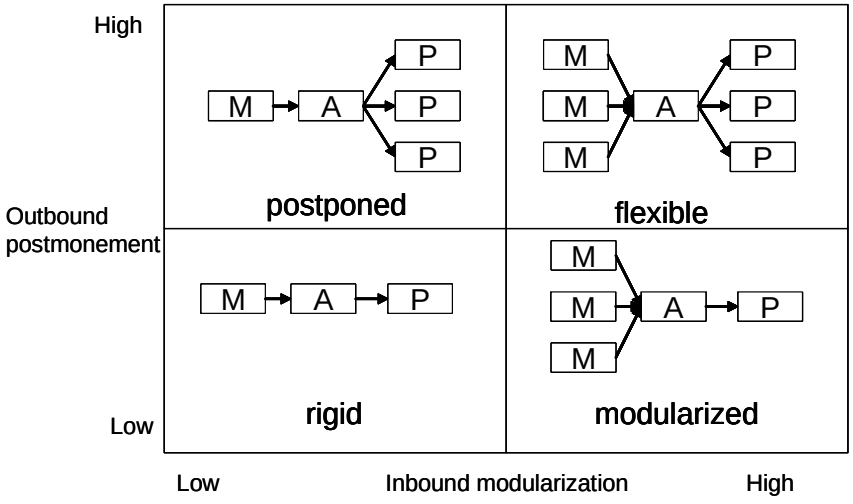

Figure 2. Framework for supply chain structure (M = manufacturing, A = assembly, P = packing) (Ernst and Kamrad 2000).

The rigid structure represents the traditional, vertically integrated supply chain. With rigid supply chain structure, the objective is to gain competitive advantage through economies of scale and high availability by maintaining large inventories of finished goods. The flexible supply chain structure represents the other extreme with a greater number of suppliers and distributors. Besides the two extreme structures, the framework includes two intermediate structures: postponed, with high level of postponement but low level of modularization, and modularized, with low level of postponement but high level of modularization.

3. Supply chain architecture and supply chain strategies

Supply Chain Architecture is a subjective mapping of (a) structure: echelons consisting of suppliers, manufacturers, distributors and customers; and the edges connecting the nodes, (b) control principles (centralized, decentralized, order decoupling point), and (c) the configurability of structure. The key decisions that are made within a supply chain architecture are 1) sourcing – number of suppliers, 2) factory location – close to market / close to raw materials, 3) Push / pull boundary – inventory focus, 4) Stability – ability to reconfigure, and 5) Transport – hub and spoke, direct model logistics between nodes.

An example of industrial supply chain is presented in Figure 3. The product produced in the supply chain has characteristics of high customization and relatively low volume. The authors don't have specific information of the strategy pursued in the chain. Distinctively however, the key component factories (second tier from the left) have a large number of suppliers. Furthermore, assembly and distribution is done by several units, which suggests that there is some excess capacity available and the distribution is close to the customer.

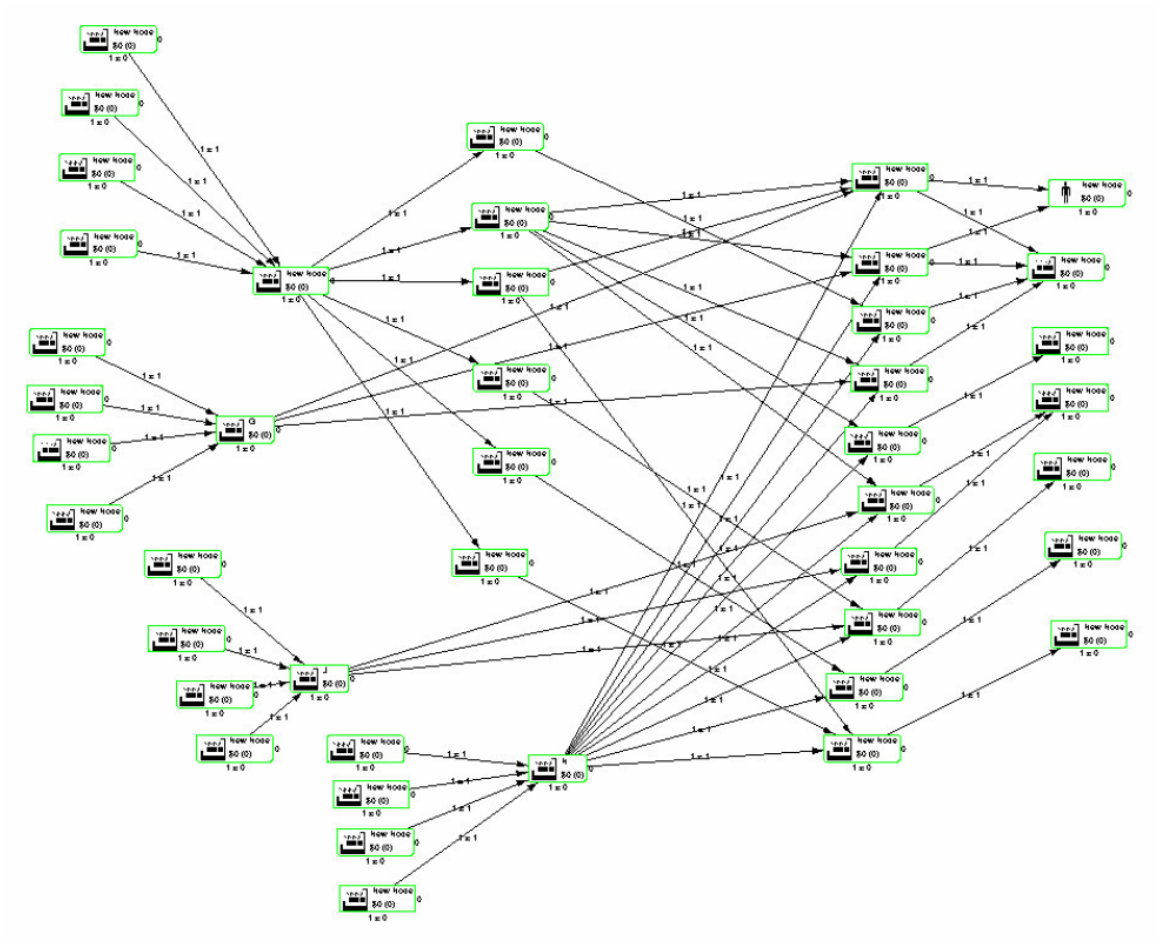

Figure 1. An example of a supply chain producing high customized and low volume products.

A brief analysis of the empirical data available to the authors is presented in Table 2. The summary includes examples from clothes industry (Zara), computer industry (Dell), electrical industry (ABB Transformers) and automotive industry (Toyota). The summary suggests that supply chain architectures of companies that pursue different strategies do differ. In the summary, predominant sourcing, manufacturing and distribution decisions (local, regional, global; centralized, decentralized), order fulfillment strategy and buffering methods are examined as part of supply chain architecture framework.

Table 2. Supply network structures of companies with different supply chain strategies.

	Zara	**ABB Trasformers**	**Dell Computers**	**Toyota**
Predominant sourcing model	Local (multi)	Local (single), Global	Global (multi)	Local (dual)
Manufacturing	Global (centralised)	Regional (multi)	Regional	Regional
Distribution	Global	Regional	Local	Regional
Order fulfillment strategy and point of customization	MTS, Factory	ATO, Factory	ETO, Suppliers (comp)	MTS, Factory (late config.)
Predominant buffering method(s)	Retail, Stock holding, Supplier capacity	Components, Factory capacity	Factory capacity	Dealer stock

To the best of our knowledge, there are no explicit descriptions of supply chain structures that correspond to lean or agile strategies. However the logic of "structure follows strategy" should be applicable when devising them. In agile production, excessive capacity, which is available in very short notice time, is reserved (Mason-Jones, Naylor and Towill 2000). As the main goal of leanness is elimination of all the waste, it could be concluded that with equal production volume the number of companies/facilities is less than when agility strategy is pursued. Furthermore, as the leanness strategy is claimed to be the most suitable for high production volumes, the labour costs play a role when operating in global markets. The production volume also affects the choice of transportation channel, together with the intended level of responsiveness. A brief summary, based on theoretical background and supported by empirical findings, of lean and agile supply chain strategies and their relation to supply chain architecture is presented in Table 3. Hybrid strategy is not included in the summary since the authors don't have reliable enough empirical data of supply chains pursuing hybrid strategy.

Table 3. A summary of the relation between lean and agile strategy to supply chain architecture variables.

	Lean	**Agile**
Number of facilities in each tier	Low	High
Location of manufacturing	Close to raw material	Close to customer
Location of suppliers		Close to manufacturing
Order fulfilment strategy and point of customization	Make-to-stock, assembly-to-order	Make-to-order, assembly-to-order
Transportation channels	High capacity, low speed	Low capacity, high speed

The summary suggests that lean supply chain is characterized by low number of facilities, (regional) manufacturing close to the raw materials, suppliers close to raw material sources and exploitation of MTS and MTO order fulfilment strategies. Furthermore, it is suggested that the transportation methods in lean supply chain focus on high capacity and low cost (speed). Subsequently, an agile supply chain is characterized by high number of facilities (capacity), manufacturing units close to the customer, suppliers close to manufacturing and exploitation of MTO and ATO order fulfilment strategies. It should be noted anyhow, that the classifications are on a rough level and yet to be further tested.

4. Conclusion

In this paper an attempt to examine lean and agile supply chain strategies' relation to supply chain architecture is presented. The work is rather schematic and by no means complete.

The architectural decisions of supply chains are related to several parameters, which may define the performance and the strategic positioning of the system. It also follows that customers' needs can be satisfied with different types of strategies. As well different strategies may lead to different type of supply chain architectures and these structures evolve during time. Also the product architectures, varying from integrated to different types of modular ones, are enabler for supply chain decisions. As seen in many industries,

postponement and smart strategies of product derivatives enable new productive and fast supply chains.

The results suggest that supply chain architectures of companies that pursue different strategies do differ. There are some somewhat evident differences, such as the number of facilities, but also some open to various interpretations, such as the order fulfillment strategy. However, the linkage between supply chain strategies to certain types of supply chain architecture types is yet to be further examined.

Based on these perceptions, further research how structure is connected performance measures such as reliability, lead-time and on-time delivery is needed. An overall framework is needed which takes into account the aspects of supply side, product strategy, distribution and control. Additionally, a thorough comparative research of is required to find empirical support on the propositions made in this paper.

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Electronic Commerce Readiness and Development in Supply Chains of SMEs – A Study of Kymenlaakso Region in Finland

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Abstract

This paper examines how small and medium sized companies attempt to develop new capabilities to utilize electronic commerce in supply chains. Results from a survey of 229 SMEs are reported which indicate that the likelihood of ecommerce adoption increases when results can be seen and communicated within a company. The paper argues that internal efficiency and time and cost savings were the most important reasons to develop e-business in the SMEs. Overall, many of the reasons were internal and only a few, such as close cooperation with partners and customer require, related the performance of the whole supply chain, were external. The results show that e-business is used in upstream (supplier) and downstream (customer) relations equally, but at the same time companies employ electronic solutions in customer relationship management remarkably often, which may refer that enterprises used e-business more in the customer relations.

Keywords: electronic commerce, supply chain, SME, survey

1. Introduction

Electronic commerce has been an urgent research arena for modern companies since the Internet boomed. Potential of the Internet and its applicability for supply chain development with e-commerce has appeared mostly on large, multinational companies. However, rather many developed applications have not been used in SMEs.

The paper examines electronic commerce development in supply chains of SMEs. Paper aims at measuring readiness of SMEs to invest in new e-commerce technologies and methods, and evaluating potential benefits and drawbacks in supply chain when development activities are inplace. Research is carried out by survey of 229 SMEs in Kymenlaakso region in Finland during 2003.

The following section describes e-business and e-commerce and their characteristics in business. Section three summarizes elements of supply chain and its management. In section four, e-business in supply chain is discussed and theoretical settings of the study are describes. The paper then turns on to a description of the data, methodology and

reasoning of companies using e-business in their activities. Readiness of developing e-business is described in section six followed by details of e-business in supply chain in SMEs. The paper concludes with a discussion of the study's implications for theory and practice and future research.

2. E-business and e-commerce

Business-to-business electronic commerce has been growing fast, which has resulted from widespread use of IT, emergence of communication infrastructure and adoption of Internet and web technologies all over the world. Basically, e-commerce system is a platform to facilitate data administration and transmissions. It consists of technologies, applications, processes, business strategies and practices necessary to electronic business. (Tang 2001, p. 50-51) E-commerce infrastructure based on VAN (value-added-networks) and EDI (electronic data interchange) technologies is changed in several companies to Internet and web-based infrastructure (Lee 2003, p. 350-351). The web is having a significant impact on the way companies interact with each other and their customers. Past stumbling blocks of supply chain integration, such as high transaction costs, poor availability of information, and the challenges of managing complex interfaces between functional organizations are all vanishing on the web. (Johnson and Whang 2002, p. 413)

Johnson & Whang (2002, p. 414) divides electronic business into three activities: electronic commerce, electronic procurement and electronic collaboration. E-commerce regards buying and selling goods and services by using information technology and communication network instead of traditional phone and paper (Owens 2006, p. 24). E-collaboration on the other hand is "business-to-business interactions facilitated by the Internet" (Johnson & Whang 2002, p. 420).

Cagliano (2005, p. 1310) classifies e-business tools in e-commerce, e-procurement, which refers to sourcing, procurement, tendering, and order fulfillment processes, and e-manufacturing - supporting demand and capacity planning, forecasting and internal supply chain integration. Lee et al. (2003, p. 351) distinguish basic electronic commerce from collaborative electronic commerce. Basic e-commerce refers to sending and

receiving documents, but Lee et al. argue that with collaborative e-commerce, companies can achieve much higher efficient and productivity. Collaborative e-commerce goes beyond information sharing, it mean constructing the B2B network with new collaborative mechanism with the partners of the supply network.

Figure 1 represents the e-business adoption process in small firms. It suggest that the development process of communication technologies in SMEs build up step by step starting with simple solutions, such as e-mail, and go through different development stages, website, e-commerce and e-business. The final stage is the integration of almost all internal processes in business through the ICT. This ladder model assumes that the positive benefits from ICT and Internet-based operations will occur in small companies and create the desire to develop e-business further.

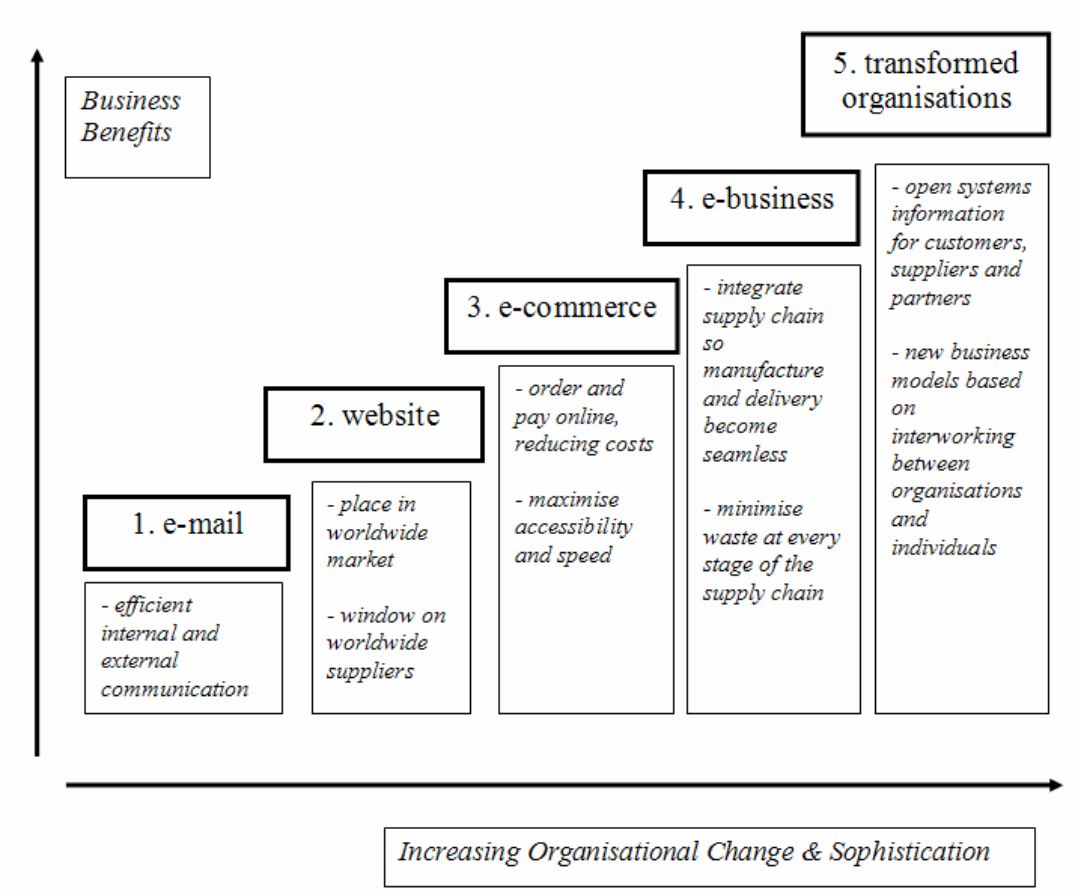

Figure 1. Development steps of e-business in SMEs (Martin & Matlay 2001, p. 400, adapted from Cisco-led Information Age Partnership study on e-commerce in small business)

Electronic commerce encompasses the ability to exchange information with partners and customers, and includes the adoption of supply chain management tools. The scope of electronic commerce initiatives in many industries requires high level of cross-functional integration in order to select key processes and not necessarily the entire supply chain. (Cassivi et al. 2005, p. 560)

3. Supply Chain

Basically supply chain can be defined as a system of suppliers, manufacturers, distributors, retailers and customers where material, financial and information flows connect participants in both directions. Mostly supply chains are composed of independent agents with their individual preferences. It is expected that no single agent has the power to optimize the whole supply chain. (Fiala 2004, 419) All firms participate in supply chains, from the raw materials to end users. Usually, this means more than just one supply chain. It would be rare for a firm to be part of only one supply chain. For the most companies, the supply chain looks less like a pipeline or chain than an uprooted tree, where branches and roots combine an extensive network of customers and suppliers. (Lambert & Cooper 2000, p. 69)

Globalization has forced the research on logistics, as well as on manufacturing, to not only consider material flows in the traditional value chain, but rather in a network of facilities. Firstly, it is important to include the customer perspective in a supply chain definition. Second, most companies at present try to work with processes rather than functions. Third, a collaborative environment is growing and it is better to study organizations than linked facilities. Rudberg et al. (2002) represent a definition, which encompasses all these three issues. According to that, a supply chain is the network of organizations that are involved, through upstream or downstream linkages, in the different activities and processes that produce value in form of products and services in the hand of ultimate consumer. (Rudberg et al. 2002, p. 597)

The development of supply chains over the years has been slow as companies develop mainly individual parts of their supply chains. The goals of supply chain systems are

multidimensional and include areas such as cost minimization, increased level of service and improved communication among supply chain companies. Throughout the 1960's, 1970's and 1980's the ability of companies to achieve these goals was limited, since the communication and knowledge links in the existing supply chains did not bring together all the key databases and the reluctance of the part of firms in the supply chain to share data with each other. Today, much of the reluctance to interface with other firms in supply chains is breaking down due progress both in attitudes and in technology. (Lancioni et al. 2000, p. 45-46)

Relationships are important to the structure of the supply chain and the way parties interact with each others. Gulas & Burges (1996, p. 32-33) divide buyer-supplier relationships in two major types: adversarial and collaborative and argue that relationships are evolving from adversarial the model with tough negotiations, price focus, short-term contracts and multiple sourcing towards the collaboration model with co-operation, trust, relational exchange and mutual benefits.

More severe competition has led most companies to seek means of enhancing performance beyond their wall boundaries. The ability of company in collaborating with its upstream and downstream partners defines its success in attaining better performance. With means of collaboration, a firm has better potential to serve fragmented markets in which ultimate customers have constantly increasing demands. Companies, such as Wal-Mart, Hewlett-Packard, IBM and Intel, have achieved better profitability as a result of collaboration in supply chains. (Simatupang & Sridharan 2005, p. 349) Collaboration with the partners of supply chain has been increased also due to outsourcing (McIvor et al, 2003; Leger et al. 2006). In the past decades companies out-sourced large proportions of their activities. Supply chain has become focus area of the business and supply chain management (SCM) an essential part of management. (Carrie 2000, p. 289)

4. E-business in Supply Chain

Supply chain management seeks to enhance competitive performance by tightly integrating the internal function within a company and moreover effectively linking them

with the external operations of supplier and chain member over all. Flexibility is a key dimension of supply chain performance. Vickery et al. (1999) groups the supply chain flexibility into four main dimensions. First of them is the flexibility with products, which requires effective collaboration of other functional players. Second type is volume flexibility, which for one requires close coordination with manufacturers and suppliers. Third type, access flexibility, can be facilitated by the close coordination of downstream activities in supply chain whether performed internally or externally to the company. The final dimension of flexibility in supply chain focus is responsiveness to target markets which hinges on a firm's ability to leverage the capabilities of the supply chain to meet the exceed the requirements of customers. (Vickery et al. 1999, p. 16-17) It is detectable that all these forms of flexibility, essential to performance of supply chains, require close coordination, collaboration and information sharing in supply chain. In this connection, it is obvious that e-business as a connective and flexible tool can be to advantage of making supply chain more effective.

E-commerce has had an utter impact on supply chains of many products (Johnson & Whang 2002, p. 414). Furthermore, advance in electronic commerce have unveiled new opportunities for supply chain, especially for their management. Electronic commerce has had an enormous effect on the manner in which businesses order goods and have them transported with the major portion of these transactions being in the form of business-to-business. For example, estimates of B2B electronic commerce range from 0,1 to 1 trillion dollars in 1998 and approximately 4,8 trillion dollars in 2003 in the United States. According to the National Research Council (2000), the principal effect of B2B commerce, of which 90 % estimated to be electronic commerce by value and volume, is the creation of more profitable supply chain network. (Nagurney et al. 2005, p. 121)

Cassivi (2005) argues in his article that e-commerce strengthens the relationships in supply chain because of major investments required for new systems and more extensive information sharing. In addition, e-commerce is used as a safeguarding mechanism in supply chain network. Leger et al. (2006) have presented that inter-organizational electronic collaboration is used in firms, which are dependent on the other partners of the supply chain, to prevent opportunistic behavior in the network. They mention a specific method, collaborative planning forecasting and replenishment (CPFR), which aims to

define rules and key actions to collaborative relationship. From the knowledge-based theory point of view inter-firm collaboration in supply network is an effective access to external knowledge and in the e-commerce context, electronic knowledge has low transfer costs. Knowledge can be exchanged with large number of the members of the supply chain with little expense and short time. (Leger 2006, p. 771)

Monczka & Morgan (1997, p. 69) list requirements for integrated supply chain and integrated information systems and e-commerce linkages is one of the important aspects. However, external system integration may be challenging job with language, currency and cultural barriers and legislative differences. Openness, trust and collaboration required by e-commerce also cause problems to the partners of the supply chain (McIvor 2003, 151; Owens 2006, p. 27). Only collaborative e-commerce can have significant impact on companies' performance. When adopting e-commerce approach in supply networks, it has to be gone beyond the basic e-commerce (linkages from one computer to another). New collaboration mechanism has to be searched, too. (Lee 2003, p. 359) Cagliano et al. (2005, p. 1319) made similar conclusions. They argue that e-integrators have higher pay-offs that e-sellers from e-commerce, which proves that the fully integrated strategy in e-commerce is the most effective. Also, Leger (2006, p. 764) picks up the importance of information visibility in the collaboration of value networks.

Supply chain structure is moving towards deepened partnerships and supply networks, where partners are more dependent on each others. Electronic commerce has had a great impact on that evolution. Electronic commerce tools makes the demand forecasting, material management process and scheduling more effective and reduce inventories, delivery lot-sizes and purchase orders and invoices by efficient information sharing through supply chain. Collaboration in new product development can benefit from e-commerce. With web-based design tools the communication between the customer and the supplier improves, which minimizes design changes and leads to shorter development times. In addition, e-commerce increases efficiency of both the customer and supplier by automating routine tasks and eliminating activities. Companies can focus more on "value adding activities". (McIvor 2003, p. 148-151)

5. Survey Settings

The data analyzed in the paper is connected to e-business project for the small and medium enterprises (SMEs) of Kymenlaakso Region. The project aims to improve electronic business capabilities of SMEs in the region and by doing that improve their competitiveness. Data was collected for the background of the project in 2003 by Tuomas Lonka during the work with his Master's Thesis.

The survey was carried out by a questionnaire that was sent to SMEs in the region by mail. The companies could also answer electronically on the Internet. 229 SMEs responded. Most of the respondents (over 80 %) were small enterprises, which employ less than 20 persons (table 1). In addition, in almost 80 % of the companies, turnover was less than 2 million euros in 2002. Companies in the survey represent several industries; 44 % of them operate in business-to-business markets and 36 % business-to-all markets and the type of business of the rest was business-to-consumers (20 %).

Table 1. Size of the analyzed companies.

personnel	**Number of companies**	**%**
1-4 person	110	48,0
5-9 person	51	22,3
10-19 person	27	11,8
20-49 person	20	8,7
50-99 person	10	4,4
100-250 person	4	1,7
Not answered	7	3,1
Total	***229***	***100***

6. Reasons and Obstacles to Use E-business in SMEs

Enterprises were asked to estimate given reasons and obstacles to develop e-business with the scale from 1 to 5, where 5 is very important and 1 not at all important. Figure 2 represents the average scores of the most important reasons and obstacles to develop e-business in region's SMEs.

Time savings was recognizably the most important reason to invest in e-business. Responded companies also found better customer service, better communication, cost savings, internal performance, effective information acquiring, better competitive edge and better quality of processes important. Notable fact is that customer requirement was clearly the least important factor. The most important e-business development obstacles are typical problems for small companies. Lack of time, scarce resources, large initial investment cost and following maintaining costs were the biggest obstacles to the use and development of e-business. The respondents also considered security issues, finding a solution provider, personnel know-how and partners readiness as problems to e-business. Least problems caused personal resistance, juridical issues, current level of IT-equipment and lack of standards.

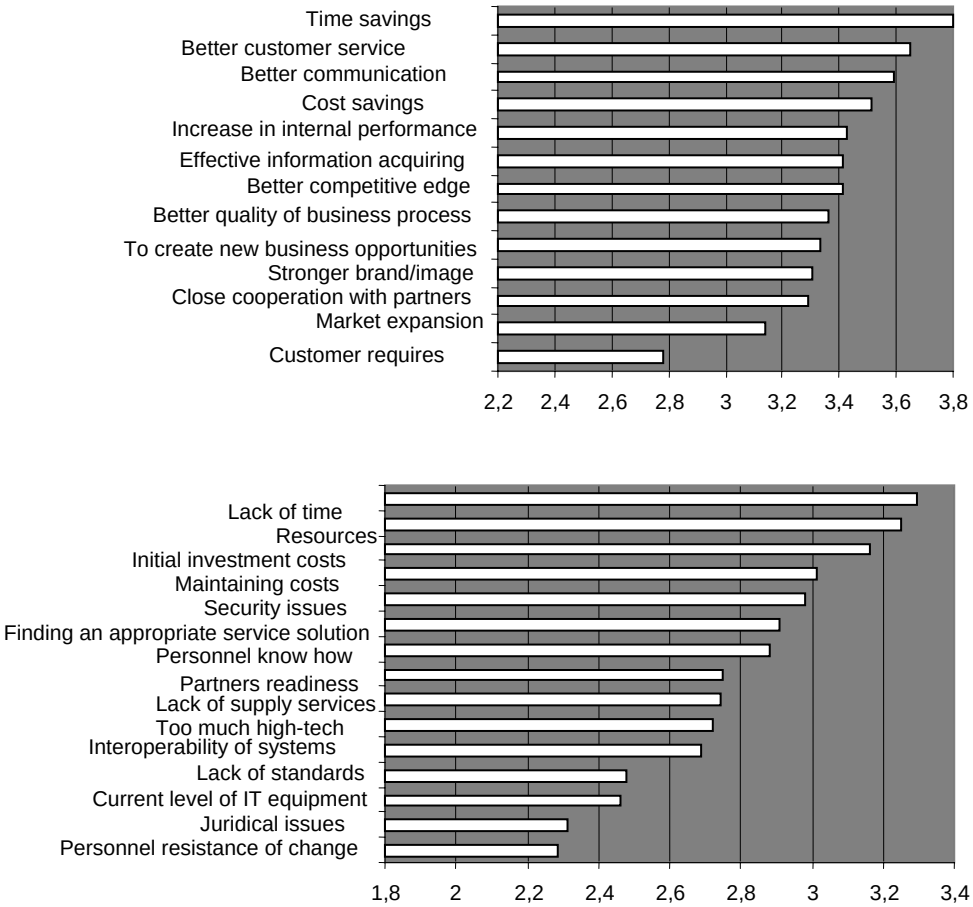

Figure 2. Most important reasons and obstacles to e-business development

7. Preparedness of Developing E-business in SMEs

Office environment and finance administration are important factors when it comes to development of e-business activities. Both of these can be considered as ground for the other systems used in the company. In the survey, office infrastructure included office software, e-mail, security, intranet, and extranet. In addition, companies were also enquired after software rental, e-government services and involvement in electronic market places. Questions of finance administration dealt mainly with sales invoice and purchase invoice, payment transactions, budgeting, calculation of wages and bookkeeping.

Basic tools are in use quite well in the companies of the survey as can be found in figure 3. Hence, there should be adequate base conditions for further development of e-business. More than 80% of the companies used office software and e-mail, but then 7 % reported these tools are not in on the activities of the company. Nearly half of the companies utilized e-government services, 33 % had intranet and 22 % extranet in use. Program rental was not common in the companies of the region, only 21 % used these services. 33 % involved in electronic market places, but as much as 53 % of the companies were not active in this area at all. The most important need of development was in security as 25 % of respondents wanted to develop their current system.

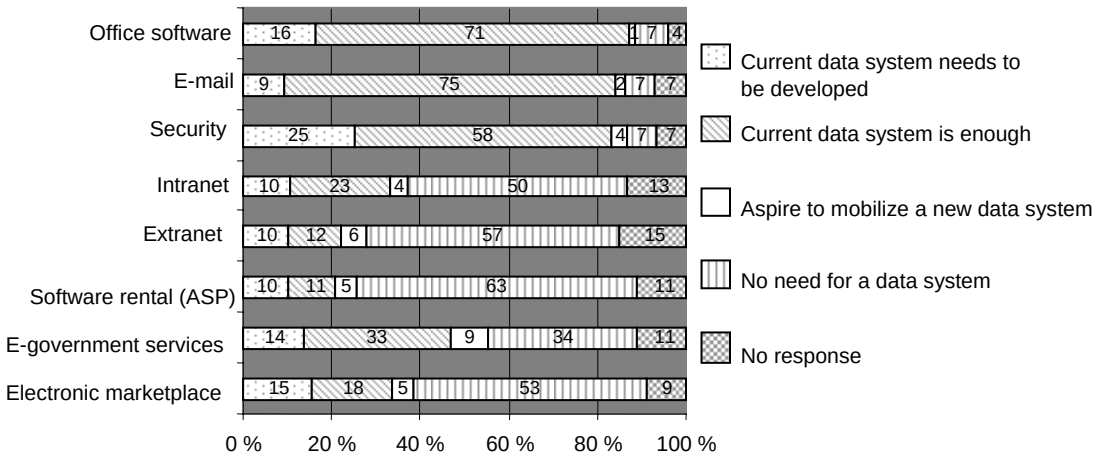

Figure 3. E-business in office environment.

As noticeable in figure 4**,** part of the activities in finance administration was already electronic and especially invoicing was well proceeded. 78 % of the companies used information technology as support when handling sales invoices and 47 % when handling purchase invoices. 65 % had abilities to send invoices via e-mail, but only some 30 % of the companies were able to send electronic invoices and to receive them. Obviously, the most commonly used tool was Internet bank, with 83 % of respondents using them.

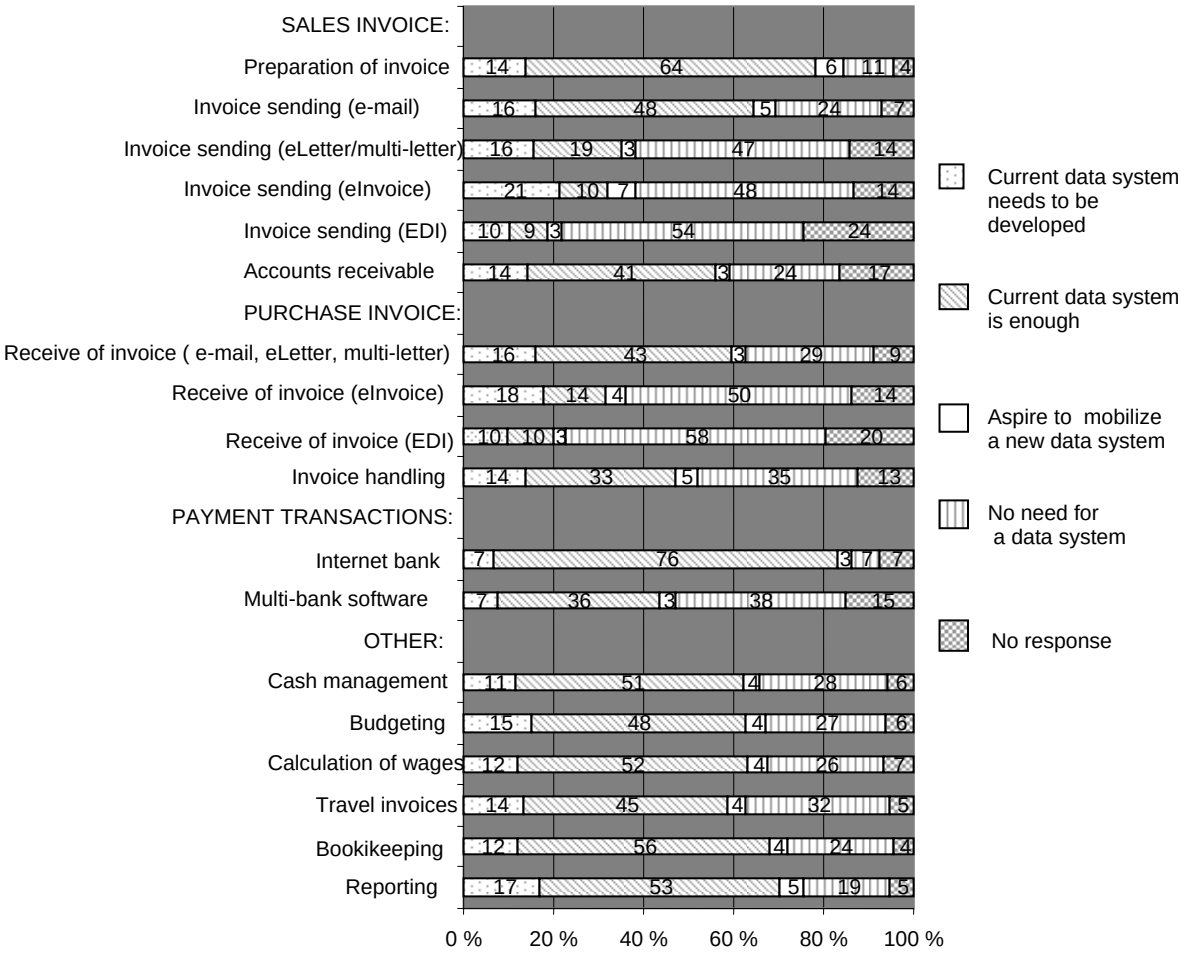

Figure 4. E-business in finance administration.

8. E-business in Supply Chain in SMEs of Kymenlaakso Region

In the survey, e-business in supply chain is divided into procurement, production and supply. SMEs in Kymenlaakso Region used e-business mainly in procurement actions.

Making orders, making contracts and management of purchase were carried out electronically in over 40 % of the companies, while only 20-30 % of the enterprises exploit e-business in production and 30-40 % of them in supply (figure 5). In other words, e-commerce was used in supply chains, but the level of other e-collaboration was quite low. However, the need for develop the current system further was the same in the all three areas (approximately 15 %). On the other hand, majority of the companies saw that they do not have a need for any kind of data system in supply chain management.

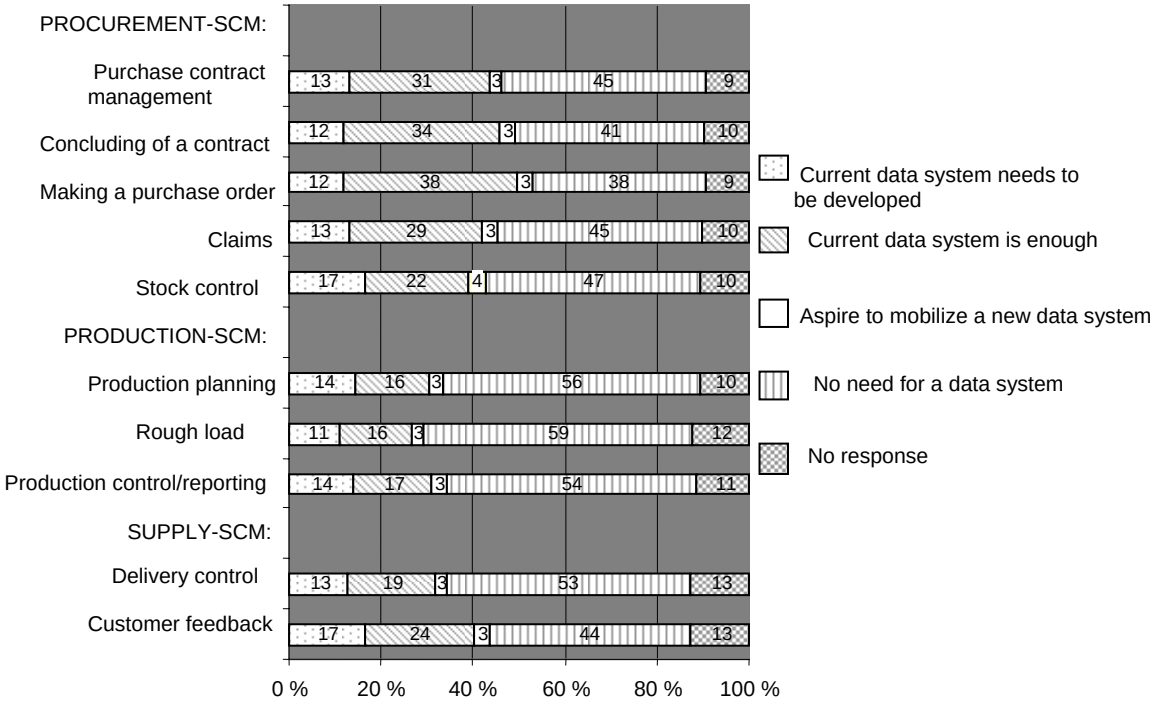

Figure 5. E-business in supply chain management.

The survey also examined the utilization of e-business in supplier and customer relationships. According to the survey, there was no difference in the use of electronic business between those relationships. E-business with suppliers was used in 44 % of the enterprises and e-business with customers was used in 42 % of the cases. Remarkably large amount of respondents, over 45 %, used electronic business methods with neither suppliers nor customers.

We also include customer relationship management (CRM) in the supply chain management review. This part discusses e-business in customer service, sales and

marketing. Customer relations can be considered to be one of the key areas of e-business. The interest towards customer-oriented business and the development of customer relationship management came up in the survey, too. As can be seen in figure 6, over 20 % of the respondents were willing to develop their current data system further or to mobilize a new data system in almost every area of CRM. In addition, customer service, sales and marketing were carried out electronically in over 50 % of the enterprises. Especially, offers, sales document management, sales management and customer information management were managed with electronic data systems.

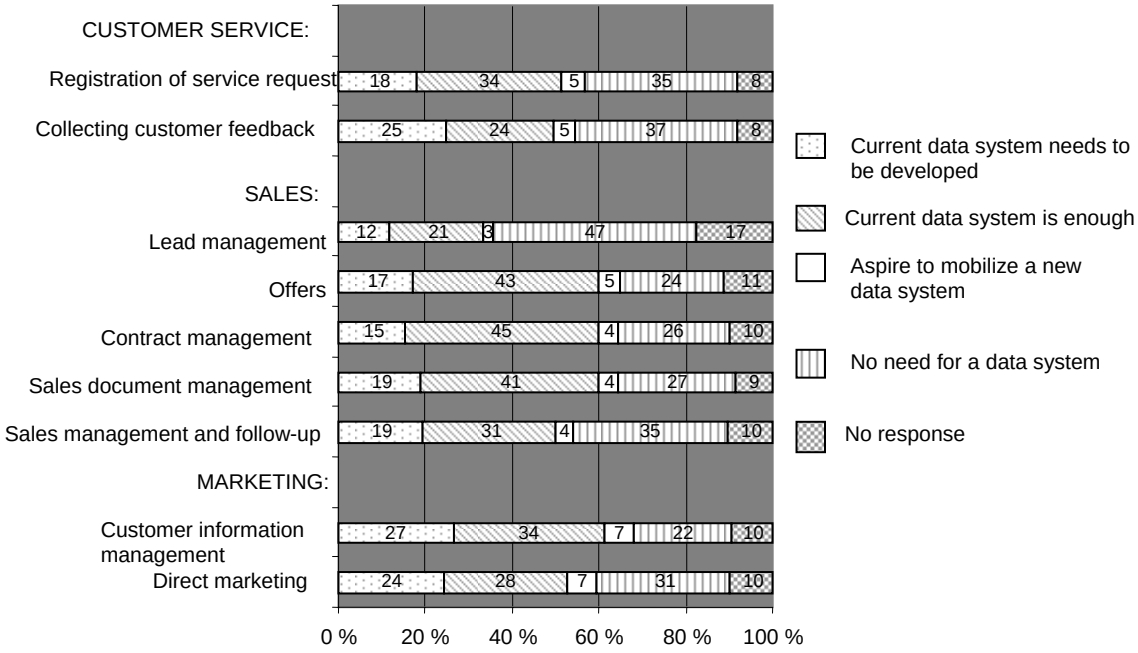

Figure 6. E-business in customer relationship management.

In the survey, there were questions about company's own websites. The results suggest that the size of a company correlates with the existence of homepages. 72 % of the enterprises, which employ over fifty persons, had homepages. Overall, 50 % of all respondents had their own websites and 17 % planned to get those. Web pages of the companies offered contact information, information about products and possibility to give feedback. However, not more than 40 % offered the possibility to send an offer request and only 20 % offered the possibility to place an order through websites. It reveals that SMEs still have a lot of development work to be done with e-commerce applications.

9. Conclusions

In the paper, we discuss the use of e-business in the SMEs of Kymenlaakso Region. The analyzed data is a part of data collected in the beginning of e-business project for the small and medium enterprises (SMEs) of Kymenlaakso Region. Especially, we have concentrated to analyze e-business in supply chains in SMEs of the region. Literature review suggests that e-business and e-commerce has positive impact on the productivity of supply chains.

Internal efficiency and time and cost savings were the most important reasons to develop e-business in the SMEs. Overall, many of the reasons were internal and only a few, such as close cooperation with partners and customer require, related the performance of the whole supply chain, were external. Low use of e-business seems to be matter of finance and economy, because personal resistance, juridical, current level of IT-equipment and lack of standards were not problems to the companies.

Already, basic tools and processes of e-business are quite commonly in use in small and medium enterprises in Kymenlaakso Region. However, there is still need for substantial development in many important areas of e-business, such as in e-invoicing. Certainly, there are differences between companies and therefore different needs for training and development, too. Mostly, e-business is exploited internally and e-business tools, such as Internet bank, are broadly used. In supply chain management e-commerce is utilized to a certain degree, but for example defective websites show that e-commerce could be exploited wider. Other type of e-collaboration in supply chain is not so common. Majority of the responded enterprises did not see the need for e-business tools in supply chain management, but like suggested in the literature review, companies should go beyond e-commerce and implement new e-collaboration methods to be more productive and efficient.

When it comes to supply chain management, SMEs utilize e-business particularly in customer relationships. The results show that e-business is used in upstream (supplier) and downstream (customer) relations equally, but at the same time companies employ electronic solutions in customer relationship management remarkably often, which may refer that enterprises used e-business more in the customer relations. The result is

expected, because small and medium enterprises usually are suppliers and see that customer relations are more important than supplier relations. This may be one reason for the disparity in sending and receiving electronic invoices: Companies have abilities to send the invoices to the customers than receiving them from the suppliers.

Acknowledgements

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Economic Prosperity and Efficiency of Railway Freight Operations

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Abstract

It has been generally assumed, and also proven with statistical samples, that economic prosperity of a country leads to more logistically friendly environment, and more efficient distribution channel solutions. However, this assumption has not further been tested with single transportation modes, like railways. In this paper we evaluate GDP per capita of a respective country and its technical efficiency level in railways (DEA). Based on our research results, either one of our used two DEA models (constant and variable return on scale) does not show any relation to the level of GDP per capita. Interestingly, our further analysis also reveals that economic prosperity could not be explained with increasing/decreasing scale economics among the country's railways either. Research results open new interesting avenues for research, concerning railways, but other transportation modes as well.

Keywords: Railways, freight transports, whole world, DEA, GDP

1. Introduction

During last decades the efficiency of logistics has improved in the firm as well as national level, and for example Hesse & Rodrigue (2004) argue that logistics costs from GDP have declined in manufacturing sector from approx. 14 % to 10 % in last four decades. As logistical costs from GDP in developed country (like US) currently take below 10 % from GDP (e.g. FMO 2005), the estimates for poorly developed countries could be 15-20 %, and in the situation of landlocked and poor even 20-30 % (Barros & Hilmola 2006; Korovyakovsky & Szoltysek 2006). It has been concluded generally in the logistics and distribution management research that distribution structures (e.g. amount of middle men, larger customers/wholesalers, information sharing, continuous replenishment programs etc.) have tendency to develop among the rising level of GDP (Mallen 1975 & 1977); for example, Hilmola, Abraha & Lorentz (2008) have shown that in the case of Russia, distribution structures have changed during last twenty years in the rhythm of macro economic changes (Soviet era, transition period of 90's, and post 1998 currency crisis). Interestingly, Naula & Ojala (2002) have reported from global logistics friendliness survey, arguing based on the large sample that friendlier environment for logistics in

particular country, larger the GDP. However, quite large amount of company specific as well as macro economic research has been concentrating on quick response systems and just in time, witnessing the degree of efficiency improvement during last decades (e.g. Chen et al. 2005; Kros et al. 2006), but research lacks the knowledge concerning transportation modes. In this research we try to answer on this question with the efficiency analysis of world railways. Analysis method called Data Envelopment Analysis (DEA) has been used for service systems efficiency measurement during last three decades, and its usefulness in evaluation process of efficiency has been widely proven in thousands of different journal articles (Gattoufi et al. 2004 estimated that in the end of 2001 were published nearly 1800 journal articles from DEA).

As the interest in this research work is on the prosperity of economy and efficiency of railway freight operations, we are using World Bank's (2006) railway database and year 1999 to evaluate the efficiency of freight operations. As our DEA model contains four input variables, and two outputs, quite large number of countries was left out of the evaluation due to the reason that some item of these six variables was unavailable for this particular year. We used Statistics of Finland (Stat 2006) to gather GDP per capita figures from 1999 and linked these in the DEA results. Overall our sample contains 40 observations, and countries are representing different continents. Our research problem could be stated with following research questions: *"Does efficiency of railway freight transports have relation on GDP per capita?",* and *"Is increasing/decreasing scale connected to GDP per capita?"*

This paper is structured as follows: In the following section 2 we will review DEA literature of railway efficiency evaluations. Earlier research in the field has concentrated on West European railway efficiency, and issues like scale economics, but privatization effects have been under interest. Section 3 represents our research method, methodology and data. We use publicly available DEA efficiency software to evaluate the performance of different countries, and report both constant and variable return on scale efficiency measurement results. In the following section 4 two main research questions, and two hypotheses are being statistically analyzed. Our research does not find any support for assumption that efficiency would improve as GDP per capita increases, and do not find either that e.g. decreasing scale economics would be present in the poorer countries. In

the final section we will conclude and discuss about the results, and propose avenues for further research.

2. Literature Review: Data Envelopment Analysis in Railways

Efficiency comparison with Data Envelopment Analysis (DEA) has been popular research topic in the previous decade; Charnes, Cooper & Rhodes (1978) developed it originally as a non-parametric efficiency evaluation technique, especially applicable for governmental and non-profit organizations (see e.g. Faucett & Kleiner 1994). From service (and governmental, as applicable) context have research been interested about the efficiency of hospitals (Banker et al 1986), electricity production & distribution (Goto & Tsutsui 1998; Jamasb & Pollitt 2003), banks (Soteriou & Zenios 1999; Seiford & Zhu 1999; Ho & Zhu 2004; Gutierrez-Nieto, Serrano-Cinca & Mar Molinero 2006) and retail trade (Keh & Chu 2003). These application areas of DEA all represent difficult, complex, and low productivity improving environments, in where other traditional improvement techniques have not worked – this is possibly the primary reason why DEA has become so popular research topic among the years (e.g. Gattoufi et al. 2004). However, the connection from efficiency (technical issue) to profitability is still challenging question, and some research works have tried to build-up causal models to propose chains of efficiency improvement to eventually enhance profitability (Soteriou & Zenios 1999); Keh & Chu 2003). Interestingly, DEA shares some similarities with Cobb and Douglas (1928) model, and all the total factor productivity and technical change research arising from that context (e.g. seminal work of Solow 1958).

Table 1. Literature review from transportation systems related DEA research in railways.

Author(s)	Year	Topic	Region	Results
Oum & Yu	1994	Railways	Europe (+ Japan)	DEA models used in this research consist two different sets of two pair outputs (pass-kms & tonne-kms as well as pass. train-km & freight train-km) and seven inputs. Research analyses years 1978 and 1989, and concerns West European countries. In both of the models, and among the years, it is found that poor performing countries are Greece and Turkey, while among the top performing countries are UK, Ireland, Japan, Netherlands, Spain and Sweden. Variability exist in efficiency measurement results.
Chapin & Schmidt	1994	Railways	USA	DEA used to evaluate the effects of merger and acquisitions (M&A) wave of US first class railways. Based on the regression model built from DEA model, it is being stated that M&A did not provide scale in either infrastructure or operations, but improved the efficiency of infrastructure providing. M&A gave more power for larger operators to gain oligopoly like market power.
De Jorge-Moreno & Garcia-Cebrian	1999	Railways	Europe	Technical efficiency of European (West) railway companies is being examined through DEA, and consist period of 1984-1995. Research results indicate that larger railway companies have diminishing scale economics.
Cantos et al.	1999	Railways	Europe	Productivity of European (West) railways have increased between 1985-1995 considerably. Most efficient railways in this period were Switzerland, Holland, Sweden, Belgium and Finland.
Cowie	1999	Railways	Switzerland	Private railways are more efficient as compared to public. This concerns technical and managerial efficiency.
De Jorge & Suarez	2003	Railways	Europe	Technical efficiency of European (West) railway companies differs quite much (observation period 1965-1998), and factor requirement and quadratic functions are used in DEA to reveal these.
Hilmola	2006	Railways	Europe	Passenger operations efficiency of European railways is leaden by Netherlands, Portugal and Denmark during 20 year observation period. Partial productivities are hardly improving at all in the whole sector, and some of the countries show really low efficiency levels.

Literature review related to DEA use in railways shows, that interest has been mostly in West European efficiency, and research has been mainly published during 90's. We could conclude that generally efficiency levels differ quite much between different countries (or companies; Oum & Yu 1994; De Jorge & Suarez 2003; Hilmola 2006). Also scale effects are questionable, and in some cases railway companies have been considered as too large with respect of economics of scale (Chapin & Schmidt 1994; De Jorge-Moreno & Garcia-Cebrian 1999). Until so far there exist only one research work from privatization effects, and it has concluded that governmentally owned railway companies are less efficient than private ones. However, research concerning European railways, we could conclude that wealthier (measured with GDP) countries could have more efficient railway operations. Also global logistics friendliness research as well as macro economic observations support the presumption that wealthier countries have more efficient logistical operations. Therefore we could propose following hypotheses:

Hypothesis 1: *"The higher the level of economic prosperity in a country, the more efficient railway freight operations are."*

Hypothesis 2: *"Scale economics in railway freight transportation is related to economic prosperity."*

3. Research Method and Data

DEA analysis of this paper uses data gained from World Bank (2006) railway database, which is strengthened with GDP per capita information taken from Statistics of Finland (Stat 2006). World Bank database provides information concerning approx. 100 different countries, and their railway operations. Although, as number of countries is impressive, a bit larger efficiency models (like used in here, see Figure 1), limit the amount of countries being analyzed, since information is not complete in all of the data items. Therefore, our research sample was limited to 40 countries, from which 25 represented Europe, 8 originated from Africa, 6 countries from Asia and Middle-East, and one from North-America (see Appendix A for details). We have certainly European bias in our analysis, but GDP per capita represents whole world in a quite good manner, since average was USD 9,203.92, and standard deviation 119 %.

In the data envelopment analysis we used 'Data Envelopment Analysis Program' ver 2.1 (DEAP), which is freeware and available at Internet (DEAP 2006). Although this program is rather old (1996), and operates in MS Dos mode it is still today used in contemporary DEA research (like Fung 2006; Hu & Wang 2006; Fandel 2007). Efficiency calculations were validated with another freeware 'Efficiency Measurement System' ver 1.3 (EMS 2006), and in both of the cases constant return on scale (CCR) as well as variable return on scale (VRS) calculations were identical with DEAP software.

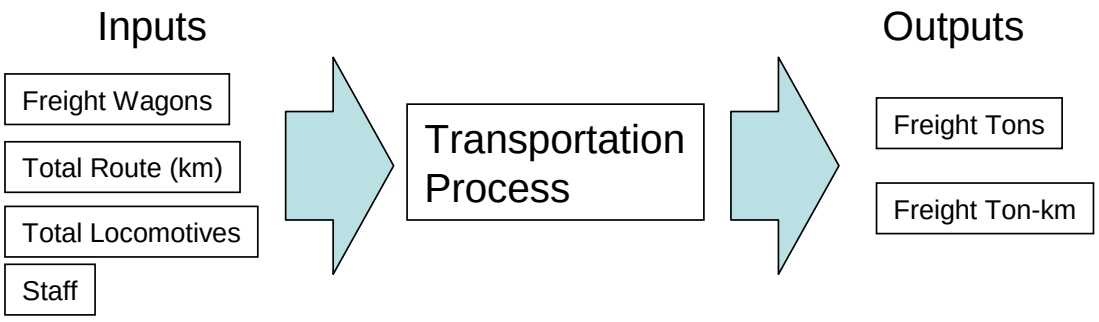

Figure 1. Two different DEA models based on freight tons and tonne-kms, and respective four inputs.

As Figure 1 shows our DEA analysis consist one input oriented model, where four different inputs create two kinds of outputs from railway transportation process. It should be reminded that our analysis is delimited in a way that three out of four inputs could also be used in passenger operations (for further discussion from joint-inputs, see Brehmer & Ojala 1997), and therefore our analysis in this paper favours more those countries, which have well developed freight operations in railways, and insignificant amount of passengers on rails (like US).

Equation 1. Conventional DEA model, with constant return to scale (CCR) assumption.

$$\max_{u_i, v_j} \frac{\sum_{i=1}^{M} u_i y_{i0}}{\sum_{j=1}^{M} u_j y_{j0}}$$

subject to

$$\frac{\sum_{i=1}^{M} u_i y_{il}}{\sum_{j=1}^{M} u_j y_{jl}} \leq 1 \; \forall \; l = 1,...,L$$

$$u_i, v_j \geq 0 \; \forall \; i = 1,...,M, \; \forall \; j = 1,...,N$$

, where L is the number of analyzed European countries (and their railway performance), y_{il} and x_{jl} correspond to *i*th output and *j*th input of the *l*th country, and M and N are denote the number of outputs and inputs used in DEA model.

Linear programming model was standard one in both of the cases (CCR and VRS), and therefore we did not put any weight constraint on the model (like staff should have at least 15 % weight on the proposed linear programming solution). Equation shows DEA

model using CCR assumption; VRS differs from this in a way that scale economics curve is not ‘constant’, and it enables better to identify small decision making units, which would be doomed based on CCR model as inefficient ones.

4. Empirical Data Analysis – Efficiency of Railway Freight and Economic Prosperity

We applied in this research work two different DEA methods, assuming constant return on scale (CCR) and variable return on scale (VRS). The difference between these two is the assumption of scale economics; latter one has been found to favour smaller decision making units, as scale economics curve is fitted into data better. As could be noticed from Figure 2, CCR and VRS efficiencies are related, and VRS performance is at the higher level in the whole observation group. Dramatic changes occur in the number of very low performing railways of CCR model (circled area consisting five different observations); all of these countries have relatively small railway operations, since these include countries like Macedonia, Armenia, Cameroun, Zambia and Sri Lanka. So, new scale economics curve favours these countries significantly, but from the rest of the group we could say that relationship between CRS and VRS performance is linear. It should be noted that observation groups hinder great differences among decision making units; in CCR model average is 0.36 and standard deviation 77%, while in VRS model average is 0.55 and st. dev. 50%.

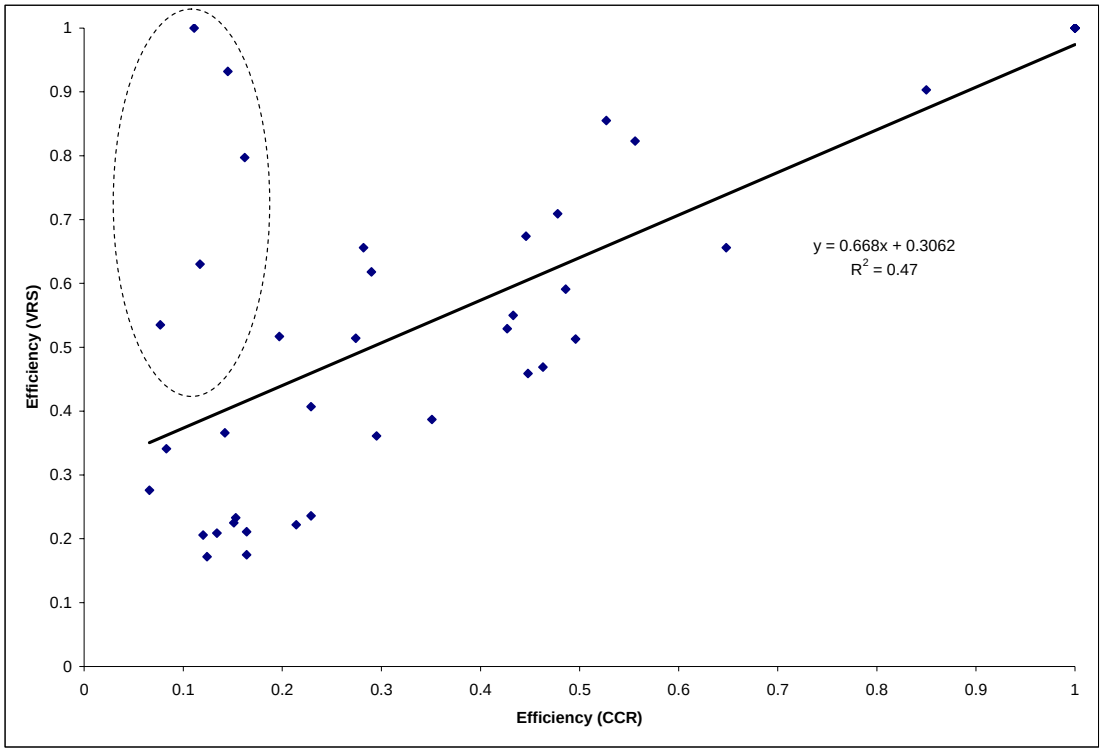

Figure 2. Relationship between constant and variable return on scale concerning observed countries in world-wide context (n = 40).

As economic prosperity of particular country is tried to be explained with efficiency level of either two models used, generally it could be concluded that there does not exist relationship between efficiency in railway operations concerning freight transports and GDP per capita (Figures 3 and 4). In both of the cases observation points are just scattered around, and no significant relation can be detected. Therefore, we reject H1 concerning economic prosperity level and efficiency of railway operations. It seems to be the case that logistic efficiency is taken from other points of supply chain rather than railway operations. Or alternatively railway operations are efficient for customer operations, but railway companies of each respective countries just absorb all the unnecessary input items, and operate with largely with governmental subsidies.

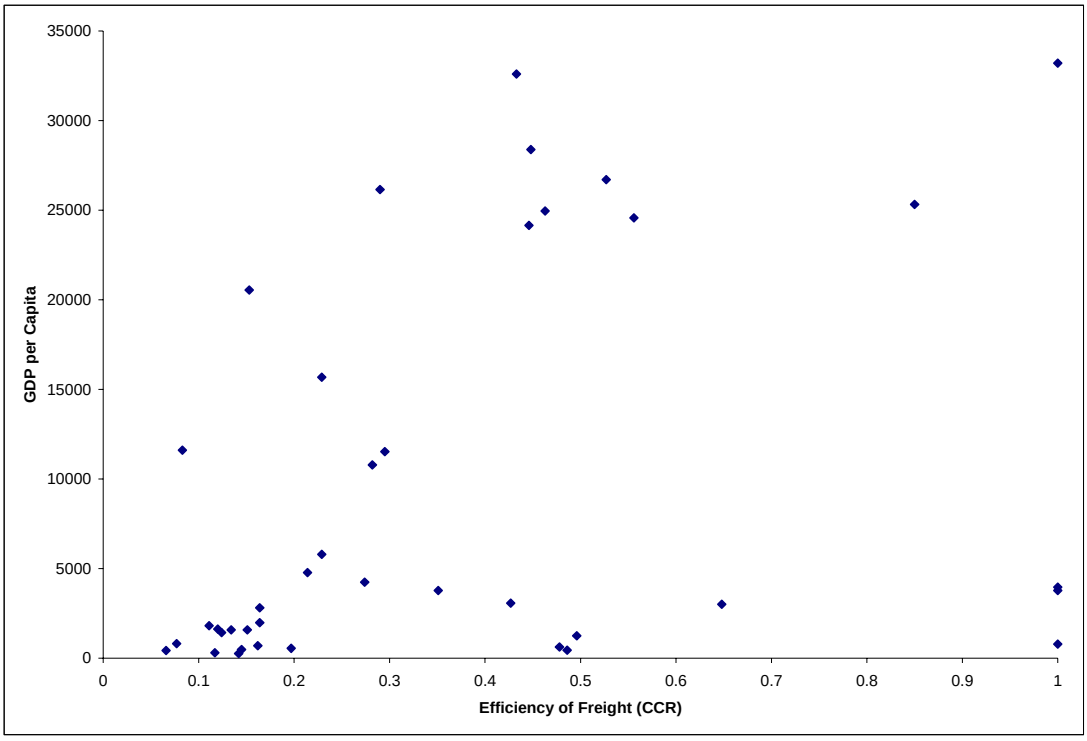

Figure 3. Technical efficiency (constant return on scale) and its relationship on GDP per capita in observed countries (n = 40).

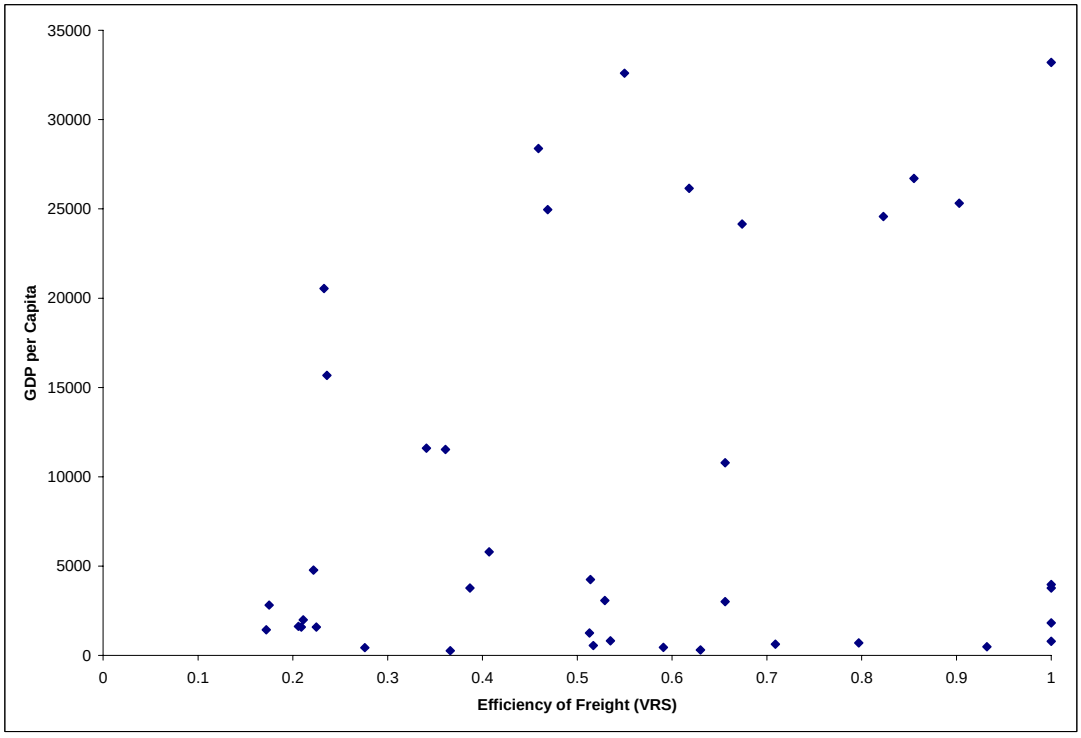

Figure 4. Technical efficiency (variable return on scale) and its relationship on GDP per capita in observed countries (n = 40).

With VRS model we are able to identify whether decision making unit has increasing or decreasing scale economics. Those decision making units, which show 100 % efficiency with both of the DEA models, could not be argued to belong either of these classes. In this research work we identified China, Estonia, Gabon and US (Class I) railroads to represent such small group of abnormally high performing countries. However, rest of the analyzed countries (n = 36) did not show any statistically significant values as we programmed increasing economics of scale as 1 and decreasing scale correspondingly as 0. So, interestingly it seems to be the case that poorer countries do not have unnecessarily large railway operations, since decreasing scale economics was detected in such high GDP per capita countries like Austria, Belgium, France, Germany and Italy. Thus, increasing scale was detected in their counterparts, like Denmark, Finland, Greece, Netherlands, Portugal, Slovenia, Spain and Sweden. Therefore, we need to reject H2, and we conclude that increasing/decreasing scale economics of railways does not have anything to do with GDP per capita.

Table 2. Scale economics identified by DEA method, and its relationship on GDP per capita (n = 36).

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.195
R Square	0.038
Adjusted R Square	0.010
Standard Error	10564.978
Observations	36

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	149481349.28	149481349.28	1.34	0.26
Residual	34	3795038010.10	111618765.00		
Total	35	3944519359.38			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	11949.00	3049.85	3.92	0.00	5750.97	18147.03	5750.97	18147.03
Scale	-4322.63	3735.28	-1.16	0.26	-11913.64	3268.38	-11913.64	3268.38

One might argue that richer countries disturb the analysis, and in very poor countries, situation is different and decreasing scale is present. However, further analysis of our data does not support this argumentation either. If GDP per capita is distilled with rule of below $1000 per capita, we find that only two countries belong to the group of decreasing scale economics, namely India and Ukraine. Interestingly Armenia, Cameroun, Georgia, Kenya, Sri Lanka, Tanzania and Zambia belong to the increasing scale economics group.

5. Conclusions

Earlier research has clearly shown that logistical performance increases as economic prosperity improves in particular country. However, these research works have not concerned individual transportation modes, and based on this preliminary analysis from year 1999, it seems to be the case that e.g. freight operations in railways do not have any connection to more advanced economy. Also interestingly, scale economics (irs/dec) is not connected into economic status of a country. So, poorer economies do not show to have massive transportation structures to satisfy transportation needs of larger grows with low cost; or other way around, richer countries seem to have in some number of occasions too large railway transportation structures. Thus, we would like to stress that these results might be disturbed with the joint inputs, since in quite number of countries railways are operated via organization having monopoly in this mode, and also requirement to satisfy both customer groups (passengers & freight). Therefore, in order to gain more evidence on the findings presented in this paper, research should be enlarged into passenger operations, as well as consisting larger DEA model, taking into account of these two customer groups simultaneously.

Among railway operations, it would be interesting to analyze other freight transportation modes with respect of economic prosperity. For example, truck transportation is used extensively for local distribution, and it would be interesting to analyze whether it has any connection on performance of particular economy. Other transportation modes, like air and sea transports are more significantly used in cross-border deliveries, and their relation on economic prosperity of a single country is difficult, if impossible, to analyze. However, inventory holdings as well as available warehousing spaces would be easier to relate into economic performance of one country, and therefore this makes it as another interesting avenue for further research.

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Appendix A – Countries, continents, efficiencies, scale effects and GDP per capita of 40 countries involved in research.

Country	Continent	crs	vrs	scale	irs/drs	Year	GDP per capita
Algeria	Africa	0.120	0.206	0.583	irs	1999	$1,630.07
Cameroun	Africa	0.162	0.797	0.203	irs	1999	$699.00
Egypt	Africa	0.124	0.172	0.721	irs	1999	$1,435.87
Kenya	Africa	0.066	0.276	0.237	irs	1999	$438.03
Morocco	Africa	0.496	0.513	0.967	irs	1999	$1,255.12
Tanzania	Africa	0.142	0.366	0.388	irs	1999	$265.68
Zambia	Africa	0.117	0.630	0.185	irs	1999	$307.05
Gabon	Africa	1.000	1.000	1.000	-	1999	$3,970.59
USA: All Class I Railways	North-America	1.000	1.000	1.000	-	1999	$33,197.00
Sri Lanka	Asia	0.077	0.535	0.143	irs	1999	$815.00
Thailand	Asia	0.164	0.211	0.778	irs	1999	$1,984.94
India	Asia	0.486	0.591	0.822	drs	1999	$446.50
China	Asia	1.000	1.000	1.000	-	1999	$788.13
Armenia	Asia/Middle-East	0.145	0.932	0.156	irs	1999	$485.62
Georgia	Middle-East	0.197	0.517	0.381	irs	1999	$549.66
Bulgaria	Europe	0.134	0.209	0.638	irs	1999	$1,581.00
Denmark	Europe	0.433	0.550	0.787	irs	1999	$32,590.84
Finland	Europe	0.463	0.469	0.987	irs	1999	$24,960.00
Greece	Europe	0.083	0.341	0.243	irs	1999	$11,611.23
Latvia	Europe	0.648	0.656	0.988	irs	1999	$3,008.80
Lithuania	Europe	0.427	0.529	0.809	irs	1999	$3,075.80
Macedonia	Europe	0.111	1.000	0.111	irs	1999	$1,817.48
Netherlands	Europe	0.850	0.903	0.942	irs	1999	$25,320.93
Portugal	Europe	0.295	0.361	0.819	irs	1999	$11,527.56
Slovenia	Europe	0.282	0.656	0.430	irs	1999	$10,792.45
Spain	Europe	0.229	0.236	0.972	irs	1999	$15,683.12
Sweden	Europe	0.448	0.459	0.977	irs	1999	$28,379.05
Turkey	Europe	0.164	0.175	0.941	irs	1999	$2,818.50
Austria	Europe	0.527	0.855	0.616	drs	1999	$26,699.45
Belgium	Europe	0.556	0.823	0.676	drs	1999	$24,576.97
Czech Republic	Europe	0.229	0.407	0.563	drs	1999	$5,795.76
France	Europe	0.446	0.674	0.662	drs	1999	$24,151.30
Germany	Europe	0.290	0.618	0.469	drs	1999	$26,148.26
Hungary	Europe	0.214	0.222	0.964	drs	1999	$4,773.28
Italy	Europe	0.153	0.233	0.659	drs	1999	$20,546.08
Poland	Europe	0.274	0.514	0.534	drs	1999	$4,249.16
Romania	Europe	0.151	0.225	0.668	drs	1999	$1,588.74
Slovakia	Europe	0.351	0.387	0.905	drs	1999	$3,779.88
Ukraine	Europe	0.478	0.709	0.674	drs	1999	$632.64
Estonia	Europe	1.000	1.000	1.000	-	1999	$3,780.42

Deregulation and Privatization Process in Finnish Railways

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Abstract

Deregulation and privatization process has concerned in the recent decades all of different transportation modes, while railways have gained the reputation as the most difficult one. This negative publicity is result of different factors, like political decision-making, subsidiaries and ownership of the governments. Also some processes have resulted in the short and medium term on undesired side effects (like UK's situation in late 90's). However, among UK's process, also US, Japan and Sweden all show impressive results on the longer-term; nearly in all of the cases demand has been attracted back on rails, and governmental funding has decreased impressively. In this research we will review the situation of Finland. Based on the analysis of legislation, and other relevant agreements, we conclude that railway freight will experience some amounts of competition, while passenger transports remains nearly untouched. We also compare Finnish situation into early adopter countries, and especially find Swedish situation to share number of similarities with it.

Keywords: Deregulation, privatization, railways, Finland

1. Introduction

Productivity improvement in railway operations has been central theme world-wide during recent decades; millions of workers have been re-engineered (e.g. World Bank 1997), and e.g. in US quite large proportions of rail tracks have been removed due to profitability reasons (Association of American Railroads 2006). Despite of these changes, quick analysis through UIC's (2004) database reveals that during year 2003 following European countries produced deficits in railway operations: Belgium, Bulgaria, Croatia, Czech Republic, France, Greece, Hungary, Ireland, Luxemburg, Portugal, Romania, Slovakia, and Turkey. Interestingly this list does not include European privatization and deregulation early adopters, like Sweden, UK and Estonia. Also examples from US (Hilmola & Szekely 2006; Hilmola, Szekely & Ujvari 2006) and Japan (e.g. Martin 1998; Tamamura 2002) show further that being at break-even is not the final outcome in this process, but shareholder value improvement, and new business creation is also possible, if deregulation and privatization processes are successful enough.

In this research work we try to sketch the current status and likely future outcome of deregulation and privatization process concerning Finnish railways. In the European landscape this process is interesting due to close proximity to Estonia and Sweden, countries which have showed already good results in this process. Particularly interesting is Estonia, since it shares similar characteristics with Finland: (1) important transit harbour for Russian export (Finland is more like a Russian import transit area), (2) shares same railway gauge width, and (3) both countries make a part of EU's eastern border line (customs and tariff issues are important, and nowadays congestion at a border is a problem). However, among similarities with its neighbours, Finland has also some own special characteristics; as Finland is like a shore, as looked from Central Europe, international transports in railways are economically feasible only with Russia. Research questions in our study are following: *"What is the scale and future changes in Finland with respect of European railway deregulation and privatization process?",* and *"How current situation, and future development trends in Finland relate to current situation with early adopter countries in this process?"*

This paper is structured as follows: In the following section we will review the motivation for deregulation and privatization in railways, and analyze briefly outcomes from the early adopter countries. Thereafter, we will review Finnish situation in this respect, through laws and norms given by government and authorities. Also Finnish situation is compared into European railway packages, and special characteristics of Finland are being analyzed. In the fourth section we will discuss about the future changes in competition in Finnish railways, and estimate current as well as future deregulation and privatization process to early adopter countries. Final section concludes our paper, and proposes new avenues for further research in this area.

2. Privatization and Deregulation Process in Early Adopter Countries

Privatization and deregulation of railway operations is often identified as an ideal example of US, where Stagger's act opened up competition during 1980. Japan followed this example within 1987, and Sweden 1988. Later on the number of other countries have

implemented similar actions, among of those are UK, Estonia and Switzerland. In privatization and deregulation process key-decision issues are related to the possible separation of infrastructure from operations, as well as the level of free competition. For example, in US and Japan early parts of privatization process gave established companies right to own and maintain tracks as well as operate trains (e.g. Gomez-Ibanez 2004). UK chose different alternative, where these two functions were separated from each other, and infrastructure operator Railtrack was listed in the stock exchange (Tyrrall 2003; Grompton & Jupe 2003; Mathieu 2003). This listing and short-term thinking of new owners created significant number of negative side effects, like inaccuracy of passenger trains, relatively large-scale accidents, lack of investments and increased outsourcing activity. Railtrack's story ended in governmental intervention during 2001 (company was in bankruptcy), and nowadays it is still in governmental ownership, and track availability is sold for intensively competing passenger and freight operators under the new name of Network Rail. EU also supports this diffusion of infrastructure ownership and operations, and in number of EU countries this has already taken place. However, the national characteristics play important role: (1) in Denmark it has been discussed that one alternative to avoid poor example of UK is to lease infrastructure with long-term contract for private investors (MMW 2006), and (2) in Sweden largest operator SJ and infrastructure holding are still in the ownership of government, and in passenger transports free competition is still a bit constrained (Bergdahl 2005; Swedish Competition Authority 2005), and (3) Estonia has given infrastructure for railway operators, which are forced to sell its availability for other operators as well (Ojala, Naula & Queiroz 2005).

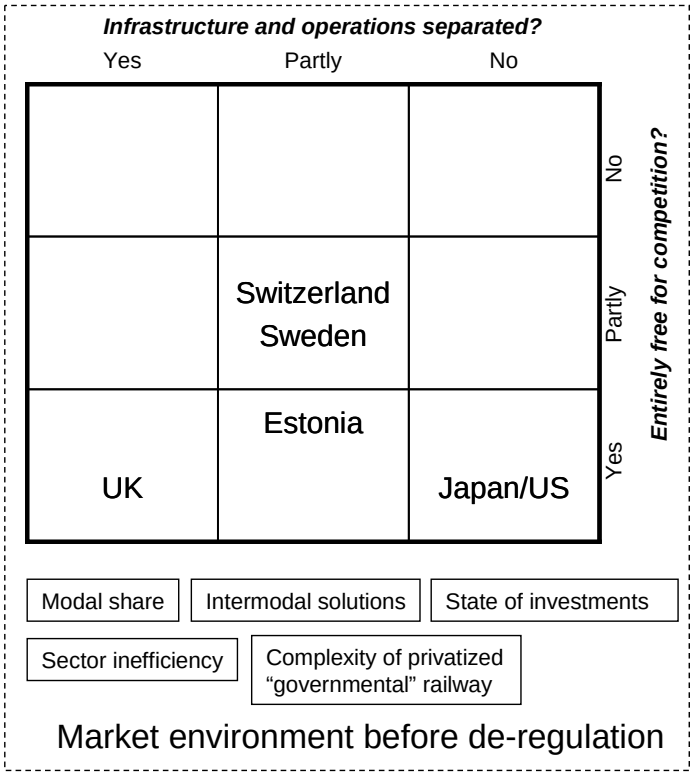

Figure 1. Deregulation framework and early adopter countries. Source: Hilmola & Szekely (2006) and Hilmola, Szekely & Ujvari (2006), modified with addition of Estonia, Japan and Switzerland

Main motivation for governments for railway sector privatization and deregulation is to decrease the amount of subsidies. In passenger transports its presence is the worst; Denmark is one of the most efficient in passenger operations of railways in Europe as well as world context (e.g. Hilmola 2008), but still OECD (2005) estimated that governmental subsidies for single passenger ticket is higher than actual ticket price! Similar situation was well identified in Japan, before privatization and deregulation took off in 1987; Japanese railways recorded first loss year in 1964, and in 1980 losses increased into one trillion yen (OECD 2005). However, small-scale of privatization has not been fruitful either; this is highlighted with the case of Switzerland, where governmentally owned railway company SBB dominates the market and takes care of railway infrastructure. In Switzerland governmental support for private railways increased significantly in time period of 1958 to 1972 (Steinmann & Kirchhofer 2006). However, consistent and significant enough privatization and deregulation process steps

have proven their usability in real-life, as in US and UK governmental subsidies are not anymore needed in that large-scale, and private railway companies produce currently profits and shareholder value. Similar development has been identified in Japan as well, where privatized passenger railway companies are nowadays part of retail and hotel business conglomerates (e.g. Seibu Group, Odakyu Electric Railway, Tokyu Group).

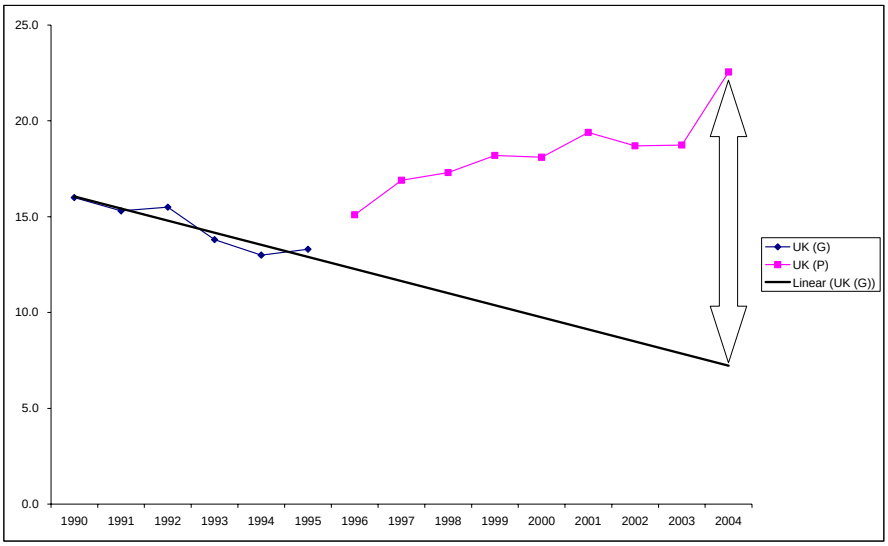

Figure 2. Privatization and deregulation effect on UK's railway freight (tonnekms, G denotes governmental monopoly and P correspondingly privatization and deregulation period). Source: European Union (2005)

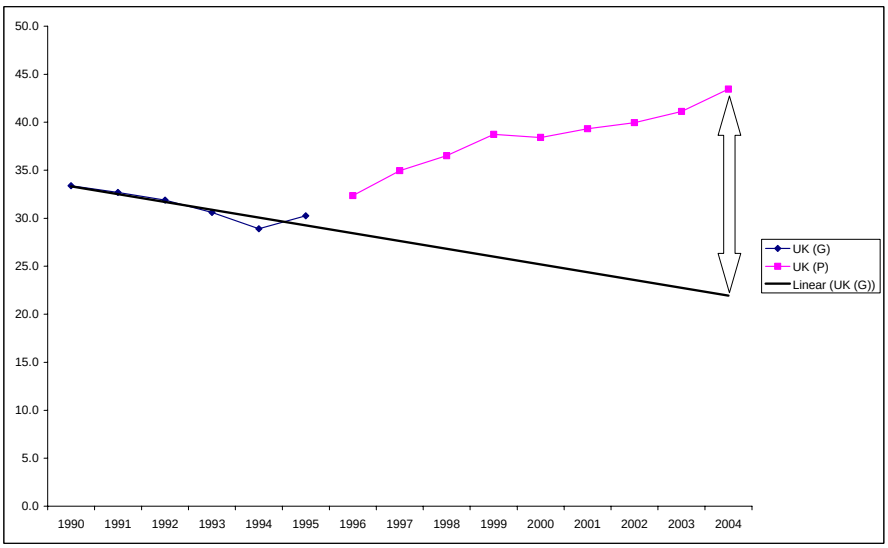

Figure 3. Privatization and deregulation effect on UK's railway passenger transports (pass-kms, G denotes governmental monopoly and P correspondingly privatization and deregulation period). Source: European Union (2005)

In longer-term privatization and deregulation processes provide turnarounds for railway demand, as e.g. example from UK market shows (Figures 2 and 3) – in both of these cases railway demand has changed its general downward trend into considerable increase (this was especially the case with freight transports). Similar, but lower magnitude change has happened in Japanese passenger operations after privatization (demand increased in first ten years nearly with 20 %; see e.g. Tamamura 2002). In US the first two decades marked approx. 50 % increase in freight volume, and its market share from freight transports in US is remarkably high, nearly 40 % (Hilmola & Szekely 2006).

3. Deregulation and Privatization Process in Finnish Railways through Legislative Regulations

Deregulation Process in EU and Adaptation for Finnish Environment

The European Commission has made a proposal for opening up international passenger services in the European Union in 2010. The proposal is a part of the third railway package (all of the packages are shown in Table 1) aimed to improve the competition possibilities of the railway traffic, and the Council of Transport Ministers has supported the proposal. At the moment the proposal does not concern Finland, because there is no passenger traffic between the European Economic Area and Finland. Furthermore, according to a national law, the passenger services are going to remain operated only by the national railway company VR Ltd (Law 20/1995). Neither does the possible opening up of the competition concern the traffic between Finland and Russia based on the mutual agreement between these countries.

The latest Finnish railway act (555/2006), which implements the second railway package of the EU in Finland, opens the door for competition of the national freight traffic on January 1st 2007. The act became as a law on September 1st, 2006. The former Finnish railway act (198/2003), which implemented the first railway package, enabled the

free competition of the international freight traffic. However, no competition appeared, and up until today the Finnish VR Ltd, owned by the state, has remained the sole railway operator in Finland.

Table 1. Railway packages I, II and III of European Union. European Commission (2006).

Railway package I
The EU directives (2001) implemented by the Finnish law 198/2003 (overruled)
1) Development of the Community's railways: 2001/12/EC (changes: 91/440/EEC)
2) Licensing of railway undertakings: 2001/13/EC (changes: 95/18/EC)
3) Capacity and Infrastructure Charge: 2001/14/ EC (overrules: 95/19/EC)

The contents of the directives in brief:

- The opening up of the competition of international freight traffic in the European Economic Area
- Objective: create an equal and open procedure of licensing undertakings,

Railway package II of the European Parliament and Council in 2004, implemented in Finland by the Railway Act 555/2006 (new)

1) Agency Regulation (881/2004/EC)
2) Railway Safety Directive (2004/49/EC (changes: 95/18/EC, 2001/14/EC))
3) Interoperability 2004/50/EC (changes: 96/48/EC, 2001/16/EC)
4) Development 2004/51/EC (changes: 91/440/EEC)

The contents of the directives in brief

- Opening up of the competition of the national freight traffic
- The founding of European railway agency
- Forming European security regulations including a demand for a separate agency for security matters in each EU country
- Development of interoperability

Railway package III

The four new proposals of The European Commission (COM (2004) 140,141,142,143,144)
The contents of proposals in brief:
1) Contractual quality requirements for rail freight services
2) Certification of train and locomotive drivers carrying passengers and goods, including on-board staff performing safety tasks
3) Opening up of the market for international passenger services by rail in Europe
4) Regulation on international rail passengers' rights and obligations

In practice the railway connection between Finland and Sweden is long, it goes through the north via cities of Tornio (Finland) and Haparanda (Sweden). Another possible reason for the non-existence of competition is the difference in the track gauge. The memorandum of the national Ministry of Transport and Communications on the guidelines (MINTC 2005) and development principles was commented by the Finnish Competition Authority in June 2005 (Finnish Competition Authority 2005). The bureau stated that no competition would be likely in the beginning of 2007, if there were no measures taken on promoting a more effective use of resources in the freight traffic between Finland and Russia and in passenger traffic. According to the bureau the rural train traffic of the Helsinki metropolitan area and the traffic in other parts of the country, that is considered as public or is subsided by the state, should be opened for competition as soon as possible. It also suggests that the traffic control services and the professional education should be run by independent operators, which would create a basis for reasonable and equal competition. The bureau also emphasized the importance of finding out the possibilities of enabling an access to station areas, transport terminals, warehouses, railway yards, engine depots etc. The mere listing of these obligations in the railway law and in the railway service regulations is not enough, states the Finnish Competition Authority.

In 2006, two committees were set by the Finnish Ministry of Transport and Communications to find out and analyze how the equal treatment and openness in the traffic control service could be ensured, and that the possibilities of equal and open

professional education of the railway branch would be secured, and whether there is a need for a change in the present state of affairs.

Current Status with Regulations and National Adaptation of EU guidance

In addition to the package I directives in Table 1, the EU Parliament and Council have given a directive on the interoperability of the trans-European high-speed rail system in 2001 (96/48/EC) and on the interoperability of the trans-European conventional rail system (2001/16/EC). These directives were implemented by the Finnish Act on the Interoperability of the Trans-European Rail System (561/2002) and by the Finnish government decree (765/2002). In the beginning of 2005, Finland got a law on qualifications and education of traffic security personnel (1167/2004).

Railway Legislation in Finland

As Table 2 below reveals, there exists a selection of the railway legislation enabling the opening of competition in Finland. The legislation on the railways as a whole and the wide national legislation are excluded here. A potential operator has to fulfil a variety of laws and regulations concerning the railway traffic. The detailed information is available on certain conditions at Finlex, the national database owned by the Finnish Ministry of Justice.

Table 2. Laws and decrees concerning railway operations in Finland. Source: Finlex (2006).

Law, decree	number	overruled	valid since
Railway Act (previous)	198/2003	x	
Act on the Interoperability of the Trans-European Rail System	561/2002	x	
Railway Act (new)	555//2006		1.9.2006
The Finnish Ministry of Transport and Communications' decree on basic charge of infrastructure	756/2006		1.9.2006
The Government decree on the timetable period in rail traffic and the application for infrastructure capacity	751/2006		1.9.2006
The Government decree on Railway safety and interoperability	750/2006		1.9.2006
Law on qualifications and education of traffic security personnel	1167/2004		1.1.2005
Law on changing the law of qualifications and education of traffic security personnel (1167/2004)	556/2006		1.9.2006
Law on Railway Agency in Finland	1094/2005		1.9.2006
The Government decree on the Railway Agency in Finland	668/2006		1.9.2006
Law on the Finnish Rail Administration	1095/2005		1.9.2006
The Government decree on the Finnish Rail Administration	669/2006		1.9.2006

The Implementation of the Railway Package II by the Finnish Railway Act 555/2006

The Finnish Railway Act enables the opening of the national freight traffic into competition on January 1st 2007. A potential railway operator has to have a license authorized by the Ministry of Transport and Communications or a licence authorized by another EU member state. In addition to this a safety certificate licenced by the Finnish Rail Agency is required. Prior to the start of the traffic the licensed operator has to have

an accepted railway infrastructure capacity and an agreement for the use of railway infrastructure.

The European Commission, after consulting the interested parties, including the national safety authorities, railway undertakings, and staff representatives, and also the social partners, has given the "third railway package" by publishing four new proposals on March 3rd 2004.

4. Discussion – Finland in Privatization Process Grid

Like in quite number of other legislative and structural issues in other branches, Finland follows most likely the road of Sweden in its railway sector. However, as country presents currently EU's one eastern border line, and is like a shore in European logistical map, European Union's railway packages are partly ineffective for increasing competition in this branch of Finland. Similarly to Swedish process in the end of 80's, freight operations are the first free competition sub-sector – most probably in the next decade market share of new entrants will not exceed 15 % (Swedish situation see, OECD 2005; Hilmola & Szekely 2006; Hilmola, Szekely & Ujvari 2006), if analogy to Swedish market is used. However, in internal freight transports of Finland, major customer group is still forest industry (approx. 60 % from freight, e.g. Iikkanen & Varjola 2002), which is currently under great pressure to improve its competitiveness. If new operators are able to offer more frequent, flexible and lead time efficient solutions to main forest industry harbours, Kotka and Rauma, they surely do hold an advantage. If these freight services could be integrated into railway system of e.g. Germany, new entrant would have significant competitive advantage. However, in any case, we do not believe that market share of new private companies would not exceed 20 % in one decade time.

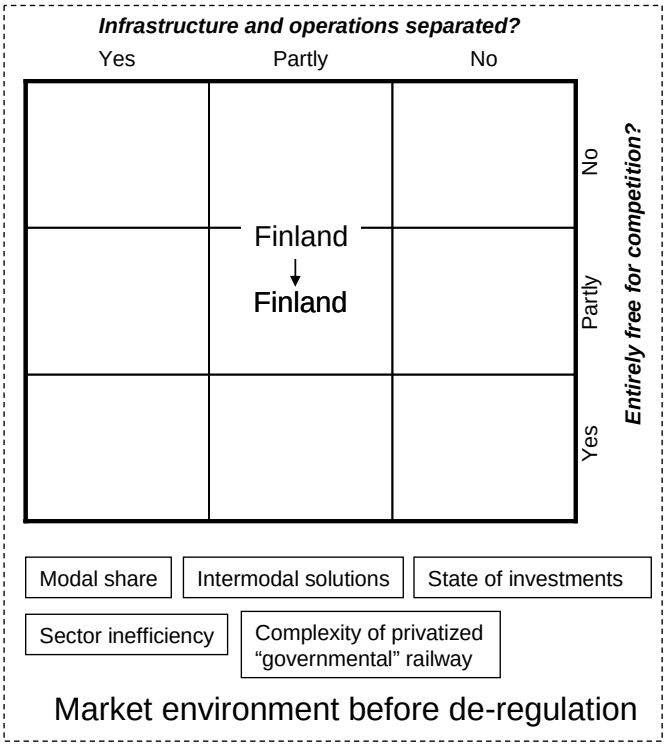

Figure 4. Deregulation framework, where most probable development of Finnish railways is added.

Due to the made decisions and international contracts, passenger operations seem to remain nearly entirely in the governmental control through its own railway company, VR. However, in Sweden passenger operations are currently more under market forces, but still market share of private companies is small in longer passenger trips (approx. 10 %). However, in the short distance, and airport traffic situation is different (total 50 % is in the hands of private companies). We could therefore expect more discussions about privatization to appear in the passenger transport issues of the larger economic area of Helsinki, as well as Helsinki/Vantaa airport train connection. One large venture capital fund has already notified that it is interested in the Helsinki/Vantaa airport connection investment as well as operations. If we compare what happened in Sweden, Arlanda city express was funded (connection airport Arlanda and Stockholm with high speed train), and currently operated with private equity (other positive experiences could be found from UK, like Lythgoe & Wardman 2002). Thus, in the next decade time, we do not

expect private passenger operations overall market share to increase above 5-10 % level from total demand.

Due to special characteristics of Finland, we could position railway operations in the deregulation framework in the same neighbourhood with Sweden (Figure 4). However, in the latter country passenger operations have been open for competition for nearly two decades (although it is still a bit limited), and also international freight transports (e.g. with Denmark) is open for competitive forces. Thus, during the next decade, we could predict Finland to open-up a bit its passenger operations for private companies to operate as well, and therefore we are confident that before 2015-20, we approach the situation, which is present in Sweden at the moment.

5. Conclusions

As could be concluded from literature review, deregulation and privatization of railways in world context started during 80's. All of the early examples, like US, Japan and Sweden have turned positive outcomes from this process. As the long-term analysis from UK's process in 90's shows, this process resulted in this case in a turnaround, and improved demand for services considerably. However, UK's example has made other countries rather cautious about this process implementation speed and depth, and therefore in number of European countries this process has been enforced to start with railway reform packages. Finland is typical European country in its process depth, and we could also argue that speed of privatization is rather moderate, or even slow. However, definitely positive issue is the opening up of freight operations, but passenger side remains nearly as untouched. New entrants in markets will not disturb the market share of the leading company too much, since Swedish process was even more open, but resulted in situation, where governmental railway company still had dominant role in operations.

As a further research in this area, we would like to sketch the possible profiles of new entrants in Finnish railway markets – most probably privatized companies will either concentrate on freight or passengers (as latter one becomes feasible alternative). Our intuitive opinion is that these companies remind 3rd Class railway companies of US in

freight side (Johnson et al. 2004), and operate only particular cherry-picked routes. In freight side this might mean factory and respective export harbour, while in passenger operations like airport express type of railways. Also the ownership of privatized railway companies in Sweden would be interesting to analyze; what is the level of investment need, cost structures for operations both in passenger and freight business (as infrastructure is in the ownership of another organization). Most probably similar characteristics will be present in new entrants in Finnish market.

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A Research Note: Russian Railways' Information Technologies

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Railway transport has developed very actively until middle of 1990s in Russia. But it was overloaded and one of the economics "bottlenecks". At that stage railway transport perfected effective ways of its operation. For the achievement of minimum of transportation expenses there were special forms of organization, e.g. wagon flow organization and schedule for train moving. Main theoretical researches concentrated on lines and stations capacities. Figuratively, we can imagine railway transport as one big tube for pass of uniform cargo flows.

At that stage technology of wagons and trains organization was formed. Nobody talked about management of cargoes for clients. Insufficient development of information technology could not facilitate cargo (shipment) management. Economic system of that time did not demand complex expenses and losses calculations.

Cargoes for the clients transported in the parties that were not convenient for handling because lack of cargo management. Clients had to have additional stocks and reserves of loading capacity. There were documents defining interaction of railway transport and clients with favour of railway. This lead to huge losses in pair "transport-production".

On first stage main task was "transportation" and in main figures priority was not for economical figures. But on second stage (after the middle of 1990s) main priority shifted to "transport service", guaranteeing for the client maximum quality of transportation services with minimum costs. Economical difference between these tasks is the following: in first case only transportation costs for railways are declining and in second case full transport part with cross-docking costs is declining. In "transportation" function all cross-docking costs are related to production, in "transport service" function to transport. Only in second case we can talk about transport logistics.

Growth of export cargoes values leads into a common situation of "abandoned" trains on railway lines near ports and border stations. In market economy it's quite difficult to coordinate interests of production industry, consignor, carrier and consignee, for example

in harbour. Every side tries to minimize costs and maximize their own profits. When planning and organizing of transportation at the same time we need take into account rhythm of the work of producers, characters of production, presence of ready rolling stock for carriers, and from another side – special peculiarities of the work in points of unloading and transshipment. For example, for the port it's impossible to plan incoming ships for a long period of time, e.g. because of unfavorable weather conditions and lack of capacity in railway station near the port.

Every component of logistic system has its own significance and tracking information connects all elements of the procedure as a whole. In present time there is new function for Russian railways – cargo flow management. Agreed approach cargoes for the ports, border stations and large consignees demand for changing of transportation technology into more flexible direction. Cargo flows management demands new, more detailed cargo moving tracking system and also making of a whole new information environment for railway transport with harbours, consignees and foreign transport systems.

They have built a challenging information environment to make technology "transparent". JSC "RZD" has to collect and process information, continuously coming from more than 20 thousand of computers and more than 15 thousand facilities of automatics from all-around-country in real-time (Kozlov 2006).

Value of transferred and processed information for the last time has grown up a lot. This demands quick development of data network and power of information centers. A scale telecommunication network was built. As its base there are fiber-optic wires with huge capacity doubled with satellite network system.

Processing enormous volume of information demands renewal of information infrastructure. Base for computer resources of Central Computer Center is mainframe IBM 9672 under OS/390. All data placed at different disc arrays with full memory more than 4 Terabytes. More than 10 terabytes takes archive memory in robot complexes. Demand for computer complexes is constantly growing up. Combined processor power demand in last four years has grown 190 % and computer memory demand has grown 490 %.

Significant quantity of computerized systems exists in this powerful and challenging telecommunication environment, for example:

- “ASOUP” – automated system for operative transportation management;
- “DISPARK” – automated system for each-wagon register, tracking control, analyze of using and regulation of wagon park on railway transport;
- “AKS FTO” – automated complex system for firm transport services;
- “DISCON” – automated system for operative management of container park;
- “Cargo express” – system for planning and controlling of transportation processes;
- Automated system for operative management “GID Ural”, first applied at Gorky railroad;
- “PALMA” – now system is in experimental operation for registering of transportation rolling stock and containers;
- “SIRIUS” – principally new automated system, integrating management systems.

All these systems work under conception of development of information technologies on railway transport.

In 2005 regulations from the Conception were applied to some specific projects for creating and integrating automated systems. This saved at least $10 million for the company JSC “RZD” only, because of not using different programs for communications, but solution was common as well as uniform protocols for software module interaction.

In the Conception they recommended to use platforms J2EE, CORBA and .NET for programming servers. For integration of software it was recommended to use international standard protocols Inter ORB Protocol (IIOP) for the CORBA/J2EE technology and XML/SOAP for web-services technology.

Next step for JSC “RZD” was preparing of Information Infrastructure Program. Program counts more than 50 projects, combined into 7 sub programs: 6 of them are functional, reflecting structure of industry processes of JSC “RZD”, and one sub program is for integration.

Sub programs

First of these sub programs is “ELCOM” (Electronic Commerce). It aims to create favourable business relationship with clients and other participants of transport service, and in the frame of integrative decisions with systems “ASOUP” and “EK ASUFR” makes up information technology base for JSC “RZD”.

Projects of “ELCOM”-program have linked structure, where all directions are united with common information base, electronic document flow and interrelated by business-processes: from marketing of transport service to quality control systems. Every project or functionality subsystem of the project “ELCOM” makes very heavy conditions for adjacent subsystems and takes control over it.

On the way of development “ELCOM”-project in 2005 one of the base system - “ETRAN” was applied. “ETRAN” is main basis of “ELCOM”-project, and it supplies technological processes of collecting, processing and control of primary documents, that arise in process of sales of cargo services JSC “RZD”. Nowadays volume of documents going through “ETRAN” is more than 2 million. “ETRAN” gives possibility to form wagon-sheets, checks, cargo tickets, orders for wagons and other documents.

Important parts of the “ELCOM”-project are its interactions with adjacent information systems. In 2006-2007 there is a plan to enlarge computer cooperation with foreign railroads and on this base supply full information escort of transportation at transport corridors. Another plan is to prepare and apply the system of interaction with Federal Customs Service.

2nd Sub program is “Sale and organization of passenger transportation management”. Technology has switched from system “Express-2” to system “Express-3” in 2004. The basement for new system is complex of orders processing in real-time and analytics data bank.

Nowadays nine regional centers of the system “Express-3” successfully work with servicing of 7.5 thousand tickets offices and more than 7 thousand automated working places for managers of passenger complex all over Russia. In addition, through the system information about train movements, ticket prices and other such things is given to passengers at railway stations.

Until the end of this year there is the plan to finish work of integration of “Express-3” with European system for tickets sales. This allows people from CIS to arrange tickets in Europe.

For local train tickets are still separate from this system, and in future they should also be automated and admitted through one function. Obviously not enough attention is paid to operation of local trains.

3rd Sub program is “Operational process management”. Now about half of financing of research and development program (42%) comes to development and applying of Network Integrated Information-Control System (SIRIUS). System is very actively developing and in the future will be one of the integrative factor for different information systems (Latushkin 2005).

4th Sub program is “Optimization of infrastructure and rolling stock management”. In this stage-by-stage program JSC “RZD” has to make passports for all objects of main activity and production base. This then serves as information base for all other blocks of sub program, provides monitoring of technical conditions of main activity objects, analysis and the reliability control of technical means, and finally organizes planning and management of technical service and maintenance.

5th Sub program is “Organization of effective budgeting, accounting and taxes controlling, management of finance, work-force and material resources”. 6th sub program is “Strategical development and system management, optimization of innovation and investment management”. 7th Sub program is “Unification and integration of automated systems”

Development of architecture centralized operation in JSC “RZD” is going not very easy. There was no elementary order in registration of automated systems, their documentation and software sources. When new version of program was written documentation is not renewed. Program interfaces and information software are not detailed described or not actual. There were registered only 15-20% of all working systems. As the result JSC “RZD” is in risk to lose control over intellectual property and information resources of operation systems in which development invests billions of rubles. To change this situation as a first step registry of automated system was built and works have started to fulfill it.

Operational system

Now let's briefly describe some of the main Russian railway systems. "ASOUP" – is a base system in the field of railway operational system. Common systems means of "ASOUP" were constructed in type of project solutions. This allows unifying of the main processes of data handling in Railroads information-computer centers.

There was projected electronic data interchange between Central Computer Center, Railroad Computer Centers and Computer Centers of Neighbour Foreign Railways. Applying of "ASOUP" was the base for information network on Russian railways.

Main part of "ASOUP" is a database at railroad level. There are operative number models: train, wagon, container, locomotive, locomotive personnel, order and also arrays about condition, location and working of railway objects. At first stage of building "ASOUP"-system there were realized models of trains, locomotives and special rolling stock. System opens wide possibilities for perfection of railway operational management. It allows receiving whole information about operational situation on controlled lines mostly real-time for leadership and dispatchers of railroads and departments.

The system can inform users about availability, allocation and condition of wagon fleet, transportation and dislocation of trains, locomotives, loading, unloading and other similar things. There were possibilities to forecast and for operative planning for future work. "ASOUP" gave possibility for station specialists to form set of technological documents for each train. It was foundation for creating of set of new automated systems and complexes in system of transportation process management.

Unifying the main principles in the field of information, software and technical base opens wide possibilities for fast replication and application of the system. Development of "ASOUP"-system was finished in July 1982 and from 1983 system first started to operate on North railroad. As a part of "ASOUP" there are great amount of different computer programs and documentation has more than 150 books (Bavrin 2006).

But there is one main disadvantage in "ASOUP": its database is closed for other automated systems. As a result of it when new information or control system was developed for a long time every system construct their own database, instead one source

for primary information was “ASOUP”. Statistics shows that 69% of all data request from ASOUP are only to support local databases.

Every automated system taking results from ASOUP work up with their own algorithms and as a result we have different data about the same events. The question of convergence of databases takes a lot of resources but result is still not very positive.

Another problem is user interface. With presence of many amounts of software programs on the same technological processes presence of own databases and own interfaces leads to impossiblity of making uniform interface on every level of management without rebuilding of many applications.

All these factors lead to situation in year 2000 of creating united railroad database of operational process with data from ASOUP. For last three years new system with using DB/2-technology (so called ASOUP-2) is applying. ASOUP-2 uses all information from ASOUP and in future JSC “RZD” will fully work only with ASOUP-2. This strategy was chosen to make ASOUP more open. And as a result we already have automated systems SIRIUS, OSKAR-M and others, functioning on ASOUP-2 base. Unified database includes dynamic models with maximum description for every element of transportation process.

Set of ASOUP-2 tables is a model informing supply chains with all objects of transportation process and unity of reporting. With this open architecture “Cargo express” system was built. Its functionality is consolidating principles of logistics when cargoes come to harbours and border stations.

Let’s have a look of it’s functioning from logistics point of view – planning, organization of transportation and control of it. Main task of planning is forecast rhythms of loading and cargo transportation process to make good transport connection for the client. System supports planning of loading and transportation itself. At the stage of loading system forecasts cargo approach to the port from all stations on Russian network depending from time of wagons loading. This allows define cargo approach in volumes and in nomenclature.

At stage of transportation specialists can make forecast for unloading in regions, in addition to network situation with loading to harbours and border crossing points. One can see model of real situation of cargo transportation at working places in Centers of

Firm Transport Services in graphical or table view. Functions of operative information collection and analysis of transportation process, long-term forecast on the way of movement and in points of unloading, imitation models for preliminary valuation of operative decisions.

One of main tasks of JSC “RZD” – guaranteed delivery of cargoes for clients in time documental mentioned. For its successfully solving there is need for control of transportation process from planning moment and operative regulate transportation. System “Cargo express” allows specialists of dispatching centers control of delivery time. In addition, specialists of unloading stations have a possibility to plan their work beforehand.

On the screen in real-time one can see the picture of distribution cargo shipments on the railroads, dislocations with taking account of delivery time in table and graphic view. All shipments that are going without any delay are colored with green color. All shipments that are going through control points with delay are shown in yellow. Red color denotes all the shipments that already are late. For “red” and “yellow” shipments dispatcher has to make operative intervention to speed up the transportation.

Management functions, mentioned above, are all inside the competence of Transportation Management Center of JSC “RZD”. However as cargoes approaching stations need is arising for more detailed management of the cargo, sometimes with accuracy of one wagon. Local programs of “Cargo express” give this possibility to station specialists. Local programs installed at railroad department and near-harbour station.

On the display the detailed information is showed about dislocation and movement of all cargoes that comes to this transport junction. It’s possible to know more exactly information about wagons in each train. It makes possible to sort cargoes at sorting stations for known ships at harbour. All these functions allow leading special structure of cargoes to whichever port can better handle it.

By this “Cargo express” apply logistic principles of cargo management, uniting interests and possibilities consignee and consignor with interests of carrier. All participants of supply chain have all information for agreed planning and organization of transportation process.

On the basis of "ASOUP-2" for a long time successfully functioning system of wagon fleet management is DISPARK. Main aims of creating system are:

- control of delivery time, working of border stations, using of foreign wagons, wagon maintenance with taking in account distances;
- stop of using wagons with wrong numbers;
- control of wagons reserves, broken wagons, automated reports about loading and unloading wagons;
- automated control of wagons at industry tracks;
- control of empty wagons location and analyze of loading prepare quality.

These aims have been reached because of wagon models were created in which all data about presence of wagons, loading/unloading information, wagon fleet and its elements is collected. Thus, in the system united dynamic wagon model was formed, guaranteed with one-time enter of data multi-time using of it.

On the base of DISPARK interrelated complex of information technologies was applied:

- national wagon fleet management;
- control of wagons effectiveness;
- control of wagons delaying time for more than technological norm;
- tracking of CIS and Baltic-states wagons in Russia and vice versa;
- tracking of private and lease wagons;
- control of effectiveness repair of wagons with a real distances wagon goes;
- time of delivery control;
- control of wagons at 12000 industry tracks (Kuznetsov 2006).

In present time technology of regulating of empty wagons is projected. DISPARK supplies the information about wagons to all main information systems. DISPARK always being in developing process prove its work capacity and economical effectiveness.

Another important part of ASOUP-2 is automated system for container transportation management (DISCON). This system collects all information about container by its number. Main task of the system – increase of container transportation effectiveness, first

of all by more rational work with each container, constant control for its condition and location. No container comes out of reach of the system when it's transported via Russian railways.

Container operations are performed at 41 border stations, 63 stations between railroads, 54 near-harbour stations, 171 stations with industry tracks with container operations, 610 stations with container yard for loading, unloading and sorting of containers (Krestinin 2006). Every day there is more than 5 000 containers loaded. Information from low-level of DISCON comes to railroad level of the system. In each of 17 railroad information centers there is operative dynamic models of operations with containers and these models operates as one part of united model of transportation process. Container model interconnected with wagon, train and shipment models. As a result any operation with container with all information is situated in the model of transportation process of the railroad.

One of the main tasks of the future development is making of automated system for checking numbers of containers. In other countries there are different types of systems that check the numbers. Main types are with use of special sensors attached to container and optical systems. Every one of these systems has their own advantages and disadvantages, and for Russian railways we need to make research in this area. However, optical system has one advantage, because it can work with containers of every owner. Part of RZD-owned-containers in transportation process is always declining. To automate process of reading off numbers from containers it's better to apply optical system.

However, to effectively operate cargoes with taking into account all participants of supply chains, transport has to create logistics center, consolidating information not only from railways, but also from other sources. It should be formed through a joint stock company with participation of Ministry of Transport of Russia, JSC "RZD", big forwarding companies and operators of rolling stock.

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